BASIC RADIO THEORY

Gp Capt Sameera Lankathilake

MSc in Mgt, MSc in Def & Strat Stu, MSc in Def Stu (BAN),
PGDM (Kelaniya), BSc (Def Stu) Elec & Eltc Eng, AMIE (SL), psc

INTRODUCTION

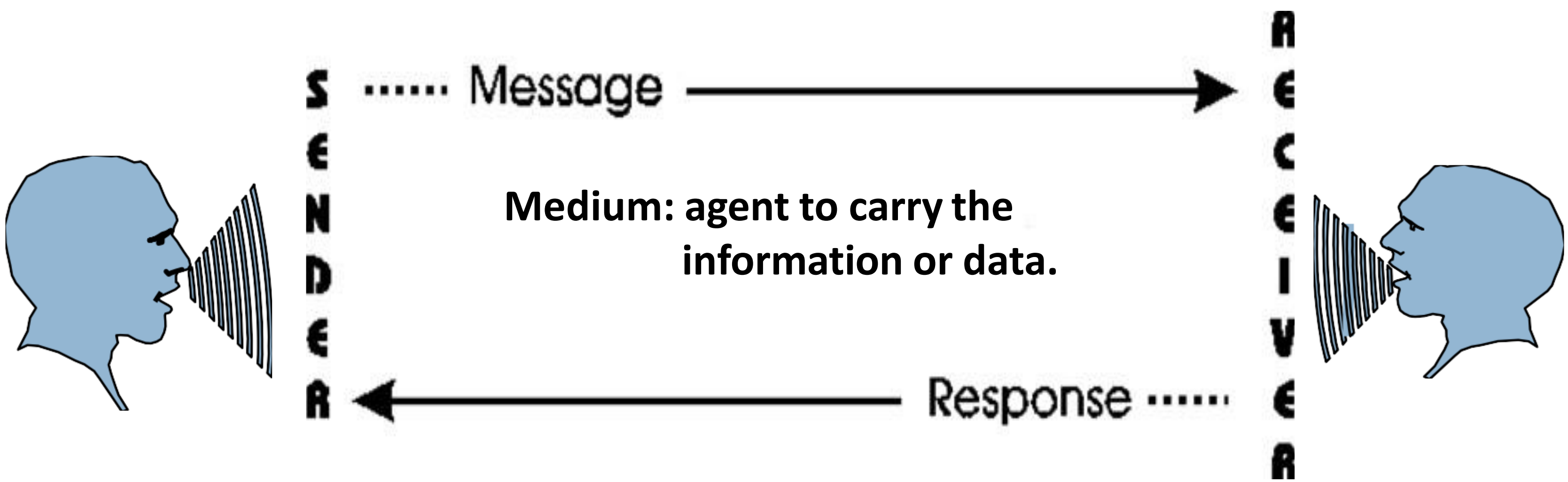
WHAT IS COMMUNICATION ?

- Communication is a process of transmitting **INFORMATION** from one location to another

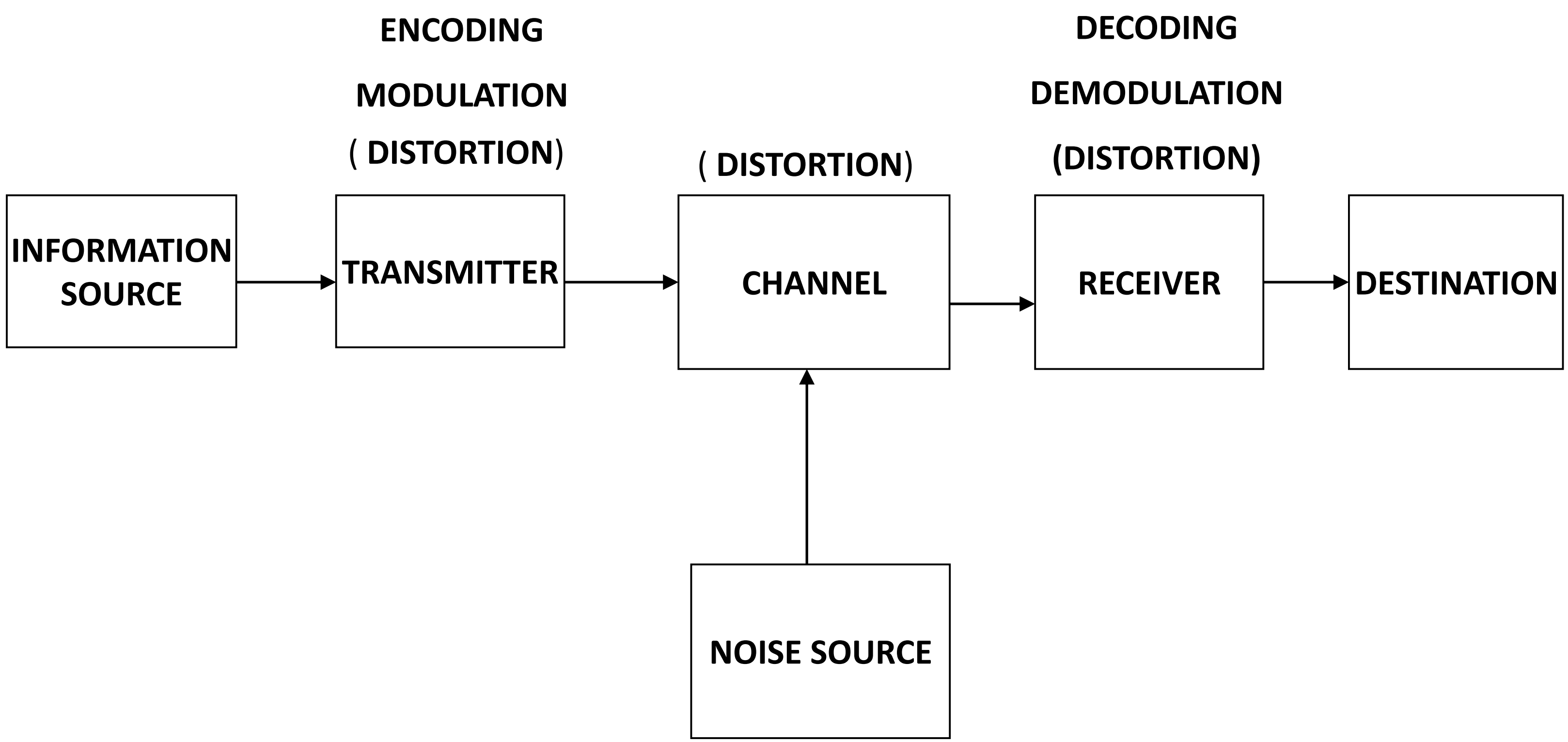
- **MEDIUM** is required for the delivery of the information to be exchanged
  - For Example, transmission medium for television or telephone is cable or fiber optics

WHAT IS COMMUNICATION ?

➢ There are basically four elements to any communication system:



BLOCK DIAGRAM OF COMMUNICATION SYSTEM



PRESENT REQUIREMENTS

- High fidelity communication
- Instantaneous interconnection to one destination or more
- Availabilities of various utilities on a single network
- Access to data/video at home for affordable cost
- Shopping, banking etc from residence
- Access to libraries at residence
- Video conversation etc

AIM

AIM

To acquaint the Student Officers on the Basic Radio Theory

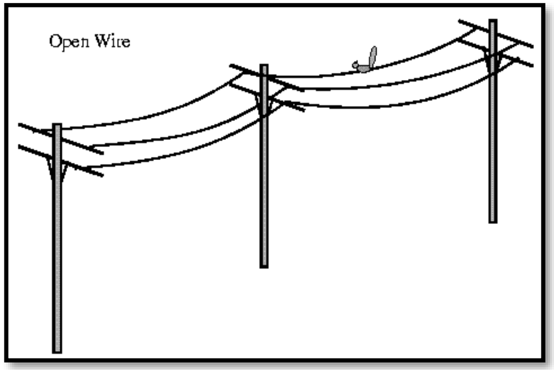
TYPES OF TRANSMISSION MEDIA

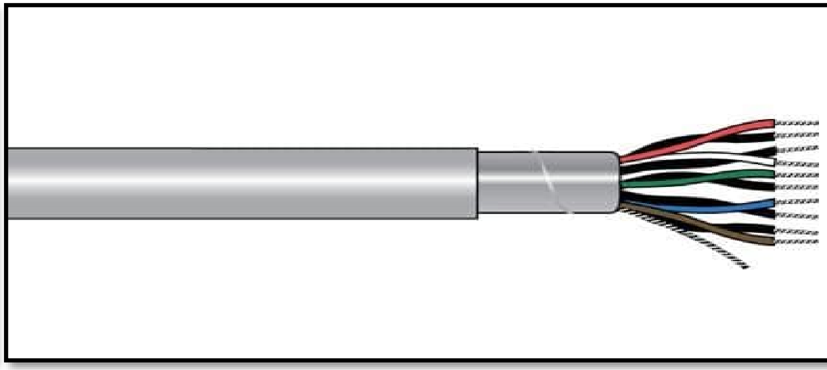
TRANSMISSION MEDIA

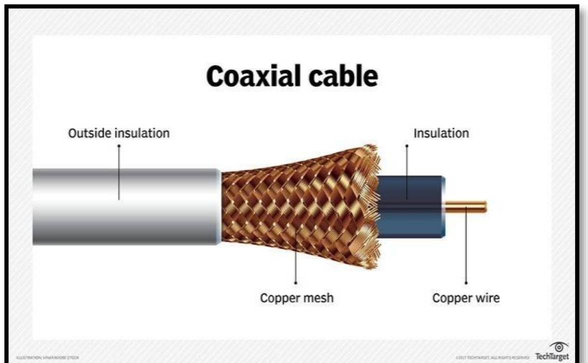
- **Open wire pairs**
- **Paired cables**
- **Co-axial cables**
- **Wave Guides**
- **Fiber optic cables**
- **Radio links**
- **Satellite links**

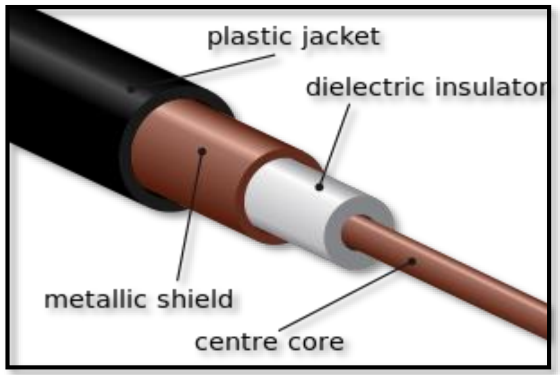
cont…

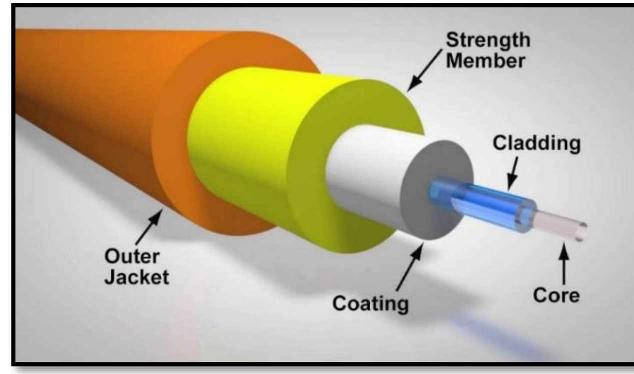
TRANSMISSION MEDIA

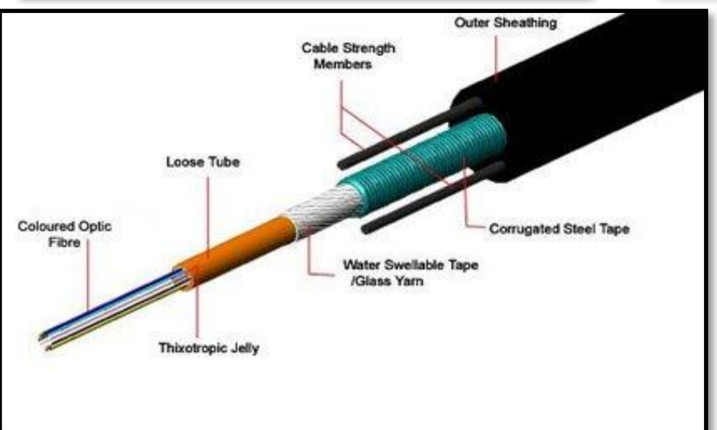




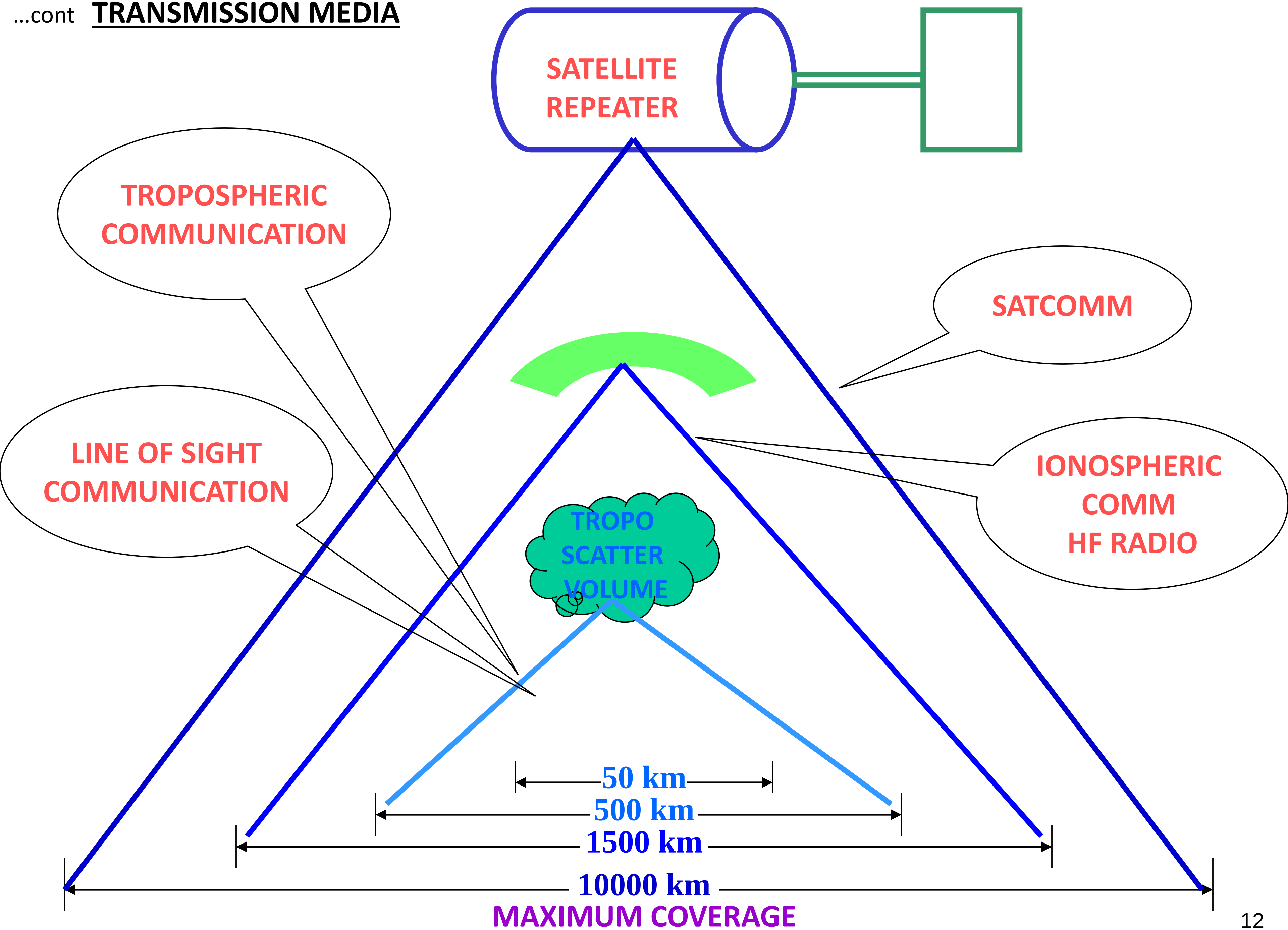








 TRANSMISSION MEDIA



RADIO PRINCIPLES

WHY LEARN RADIO THEORY?

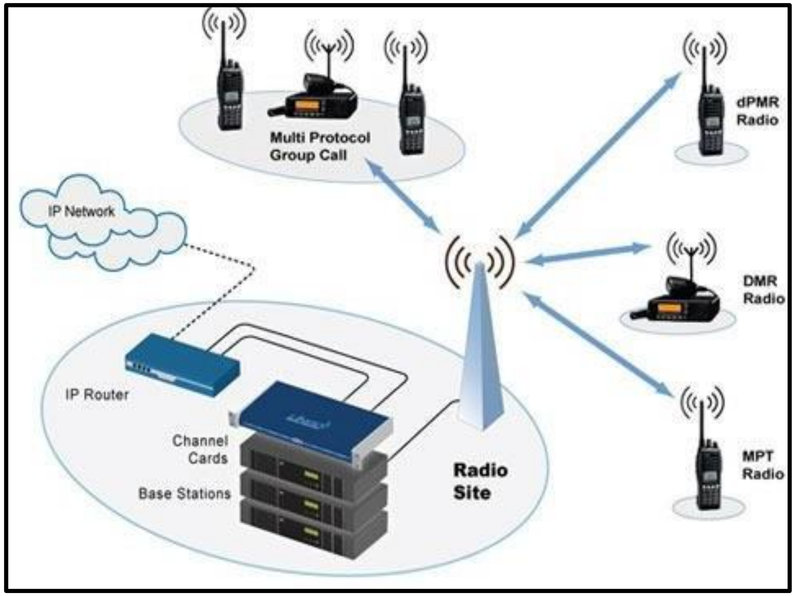
- Radio theory is essential knowledge for the understanding of the reasons why particular frequencies are used for communication and navigational aids/system (DME,VOR & etc..).

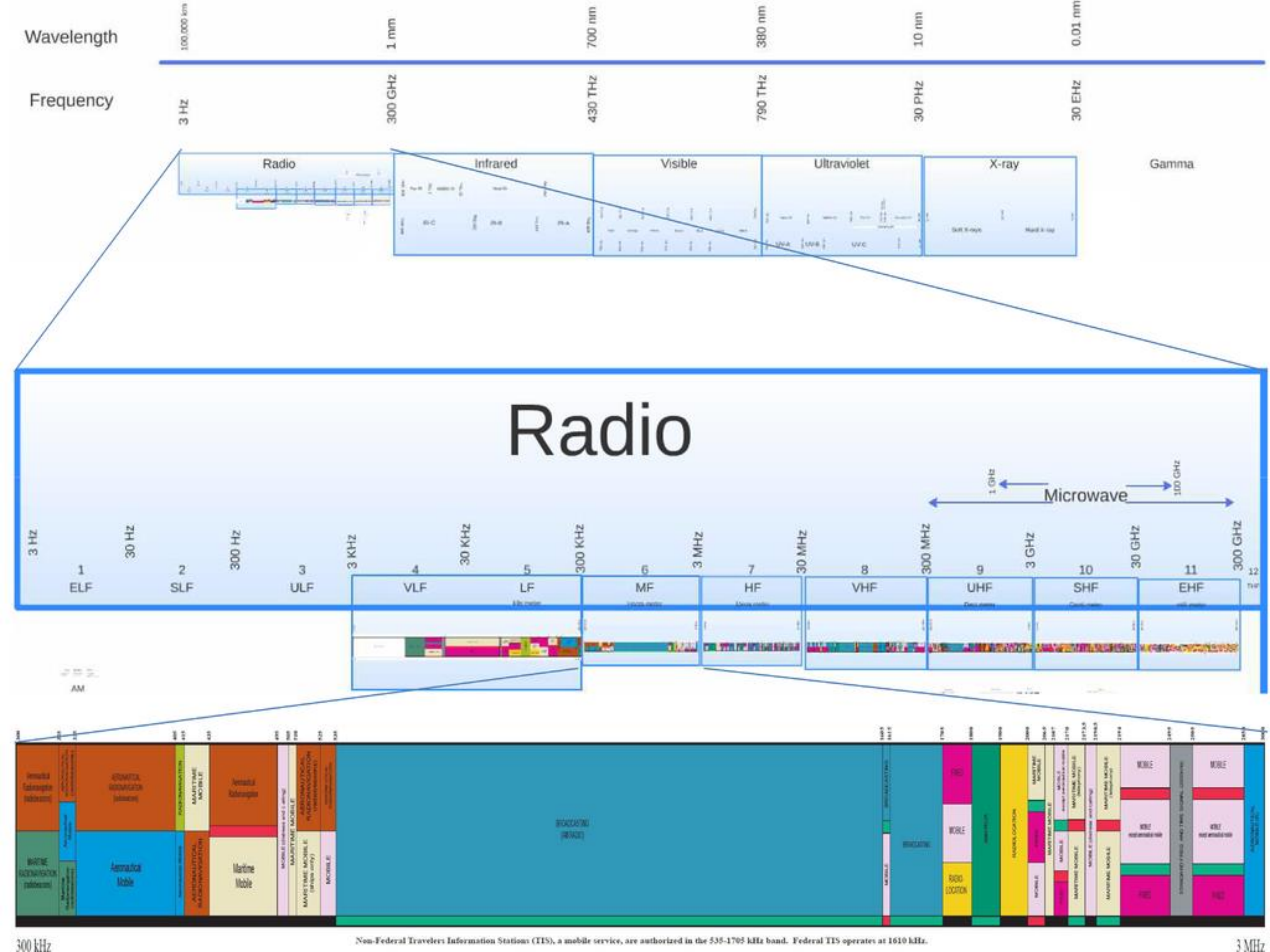
- Appreciate the capabilities and limitations of Radio Equipment

RADIO TRANSMISSION

- Radio is wireless transmission through space of electromagnetic waves in the approximate frequency range from 10KHz to 300,000MHz (300GHz).

APPLICATIONS



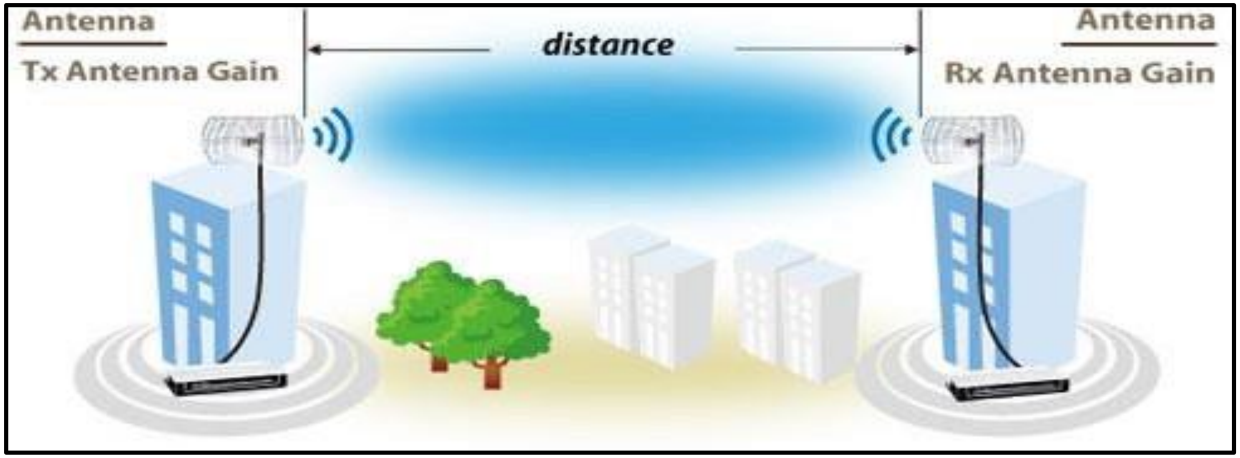


Wavelength
100,000 km
1 mm
700 nm
380 nm
10 nm
0.01 nm
Frequency
3 Hz
300 GHz
430 THz
790 THz
30 PHz
30 EHz
Radio
Infrared
Visible
Ultraviolet
X-ray
Gamma
Radio
1 GHz
100 GHz
Microwave
3 Hz
30 Hz
300 Hz
3 KHz
30 KHz
300 KHz
3 MHz
30 MHz
300 MHz
3 GHz
30 GHz
300 GHz
1
ELF
2
SLF
3
ULF
4
VLF
5
LF
6
MF
7
HF
8
VHF
9
UHF
10
SHF
11
EHF
12
AM
Aeronautical Mobile
Maritime Mobile
BROADCASTING
Non-Federal Travelers Information Stations (TIS), a mobile service, are authorized in the 535-1705 kHz band. Federal TIS operates at 1610 kHz.
300 kHz
3 MHz

TABLE OF RADIO FREQUENCIES

Description	Abbreviation	Frequency	Wavelength
Very Low Frequency	VLF	3 KHz - 30 KHz	100,000m - 10,000m
Low Frequency	LF	30 KHz - 300 KHz	10,000m - 1,000
Medium Frequency	MF	300 KHz - 3 KHz	1,000m - 100m
High Frequency	HF	3 MHz - 30 MHz	100m - 10m
Very High Frequency	VHF	30 MHz - 300 MHz	10m - 1m
Ultra High Frequency	UHF	300 MHz - 3 GHz	1m - 0.10m
Super High Frequency	SHF	3 GHz - 30 GHz	0.10m - 0.01m
Extremely High frequency	EHF	30 GHz - 300 GHz	0.01m - 0.001m

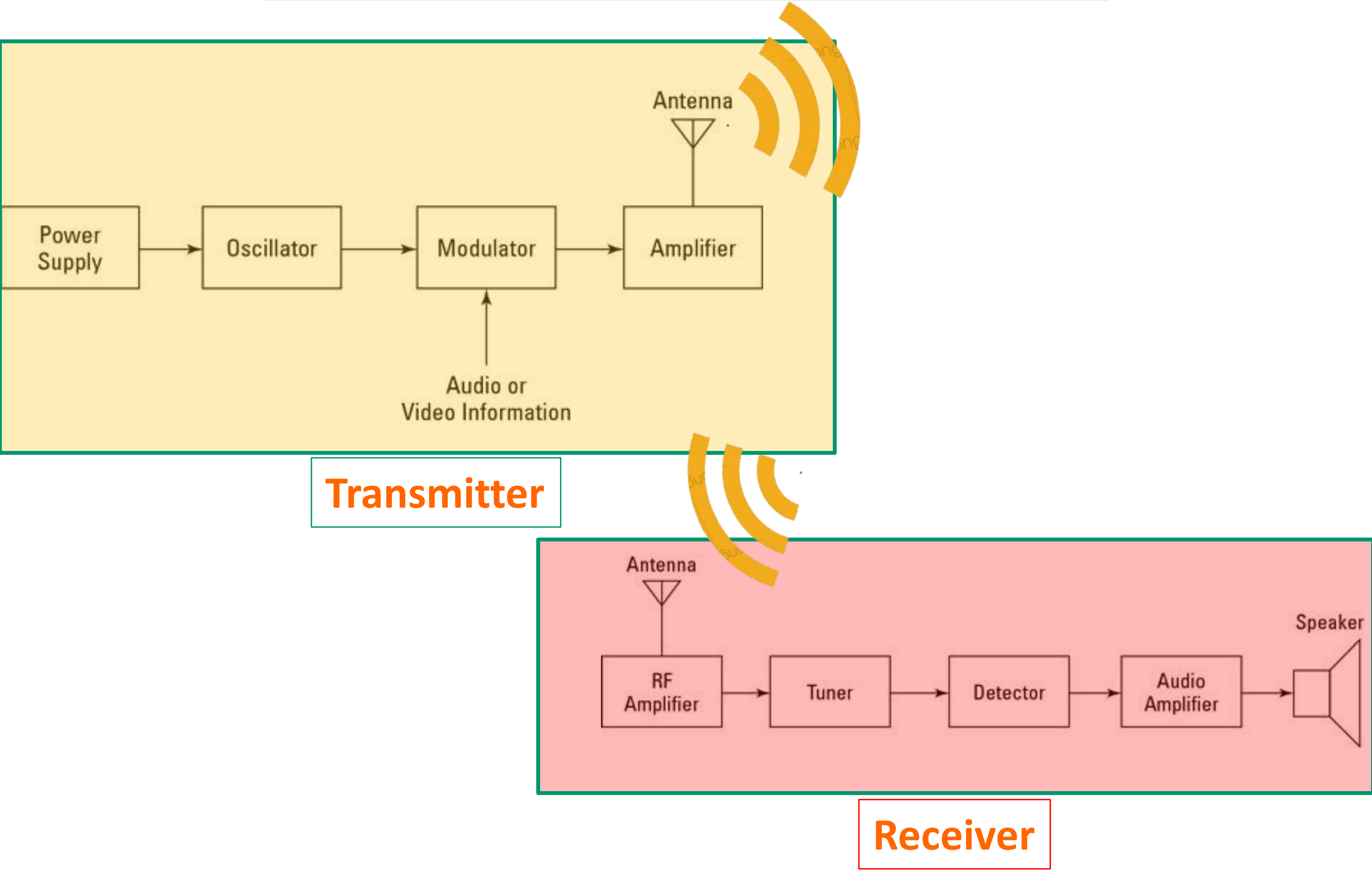
RADIO TRANSMITTING EQUIPMENT



- **Transmitter**: a device used to generate and transmit radio signals [Electromagnetic Waves]
- **Receiver**: a device that receives incoming radio signals and converts them to sound or light

Example: Receiver on radio or television converting broadcast signals into sound or images.

TRANSMITTER AND RECEIVER



ANTENNA

- **What is Antenna?**
  - An antenna is an interface between the space and transmitter or receiver
  - It is a metallic object, often a wire or collection of wires, used to convert high frequency current into electromagnetic waves and vice versa.
  - An antenna can be used either as a transmitting antenna or a receiving antenna
  - Used in wireless communication

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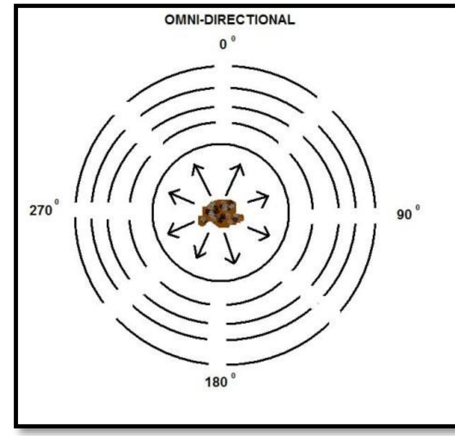
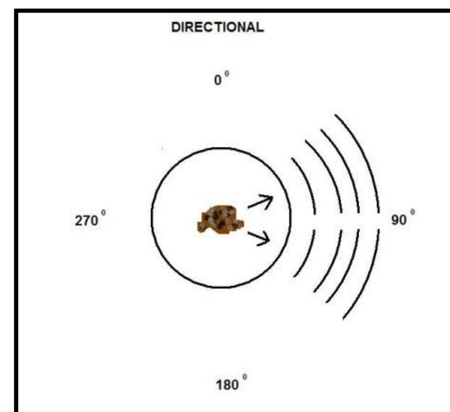
MAIN CATEGORIES OF TRANSMITTING ANTENNAS

➢ **Omni-directional antennas** wave is traveling from the rock to the shore equally in all directions



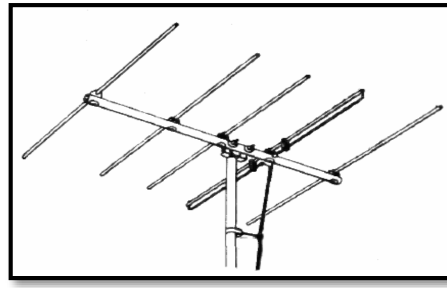
➢ **Unidirectional/directional antennas** wave is traveling from the rock to the shore in a defined directional

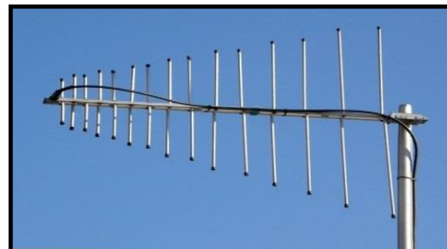


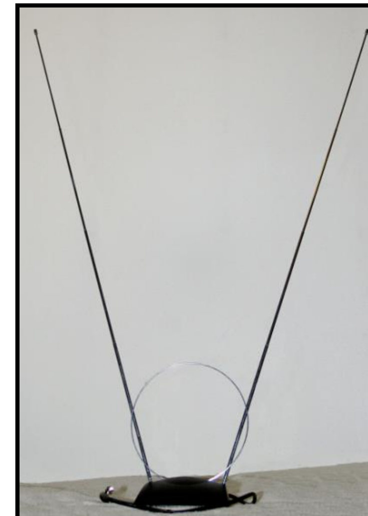
ANTENNA TYPES

➢ Dipole

- Basic dipole antenna consists of conductors arranged symmetrically

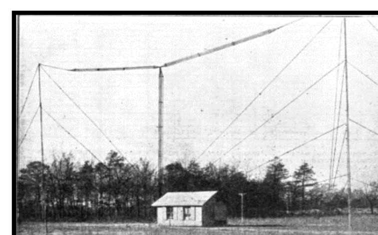






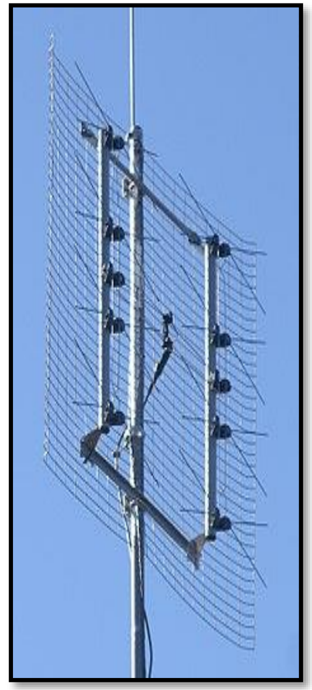
➢ Monopole

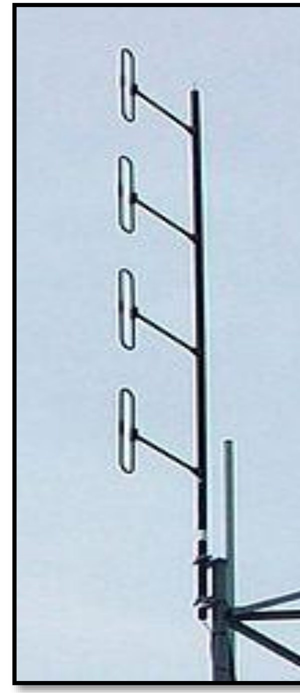
- Consists of a single conductor usually mounted over the ground or an artificial conducting surface

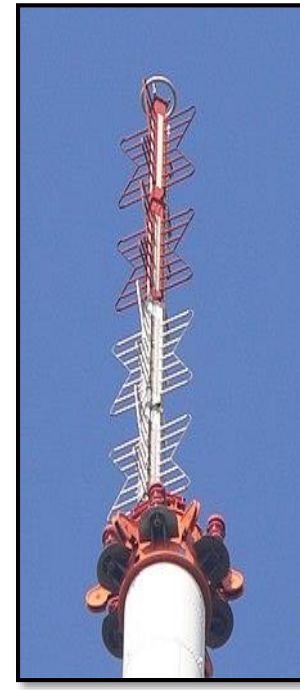


ANTENNA TYPES

- **Array**
  - Consist of multiple antennas
  - Working as a single antenna







- **Loop antennas**
  - Consist of a loop (or coil) of wire

ANTENNA TYPES

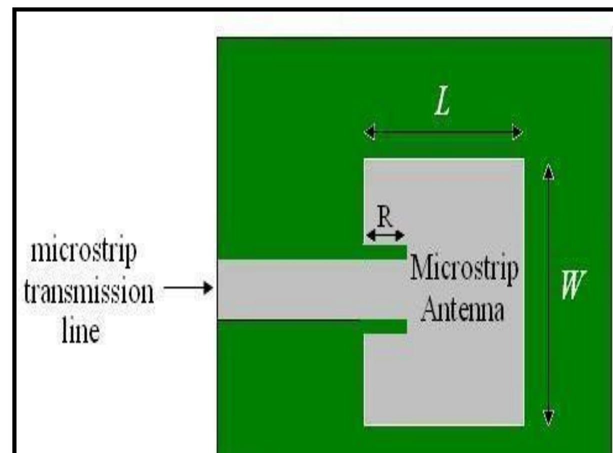
➢ Wire antenna

- Used in long range HF and MF communication

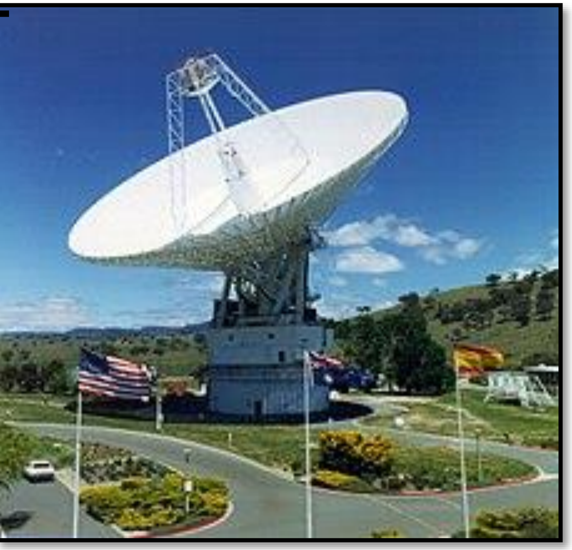
➢ Micro strip antenna

- An antenna fabricated on a printed circuit board

- Internal antenna mostly used microwave frequencies



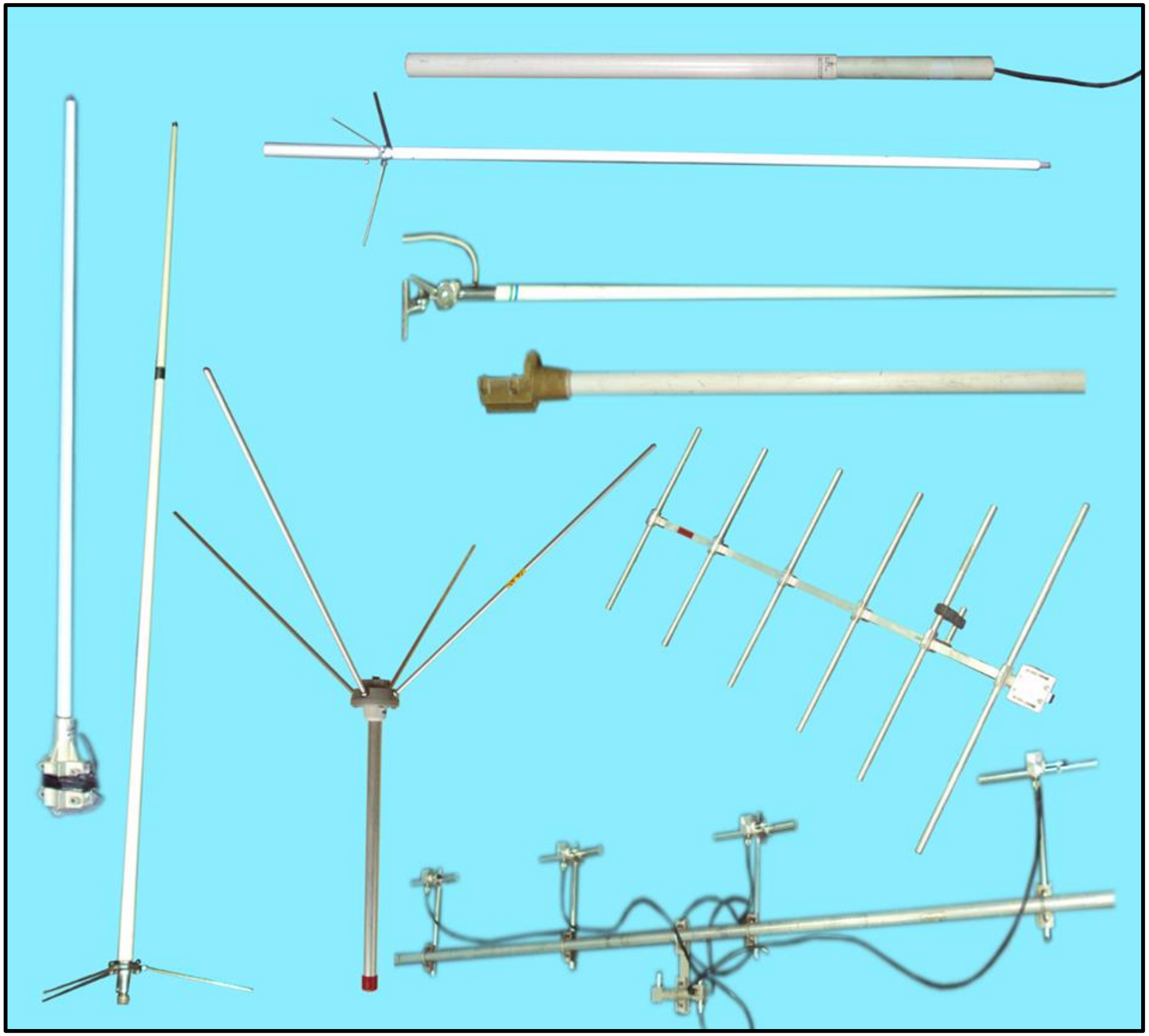
ANTENNA TYPES



- **Aperture antenna**
  - Aperture antennas are the main type of directional antennas used at microwave frequencies and above

- **Lens/Horne antenna**
  - Lens antennas are microwave antennas which direct EM waves to a direction

ANTENNA TYPES IN SLAF



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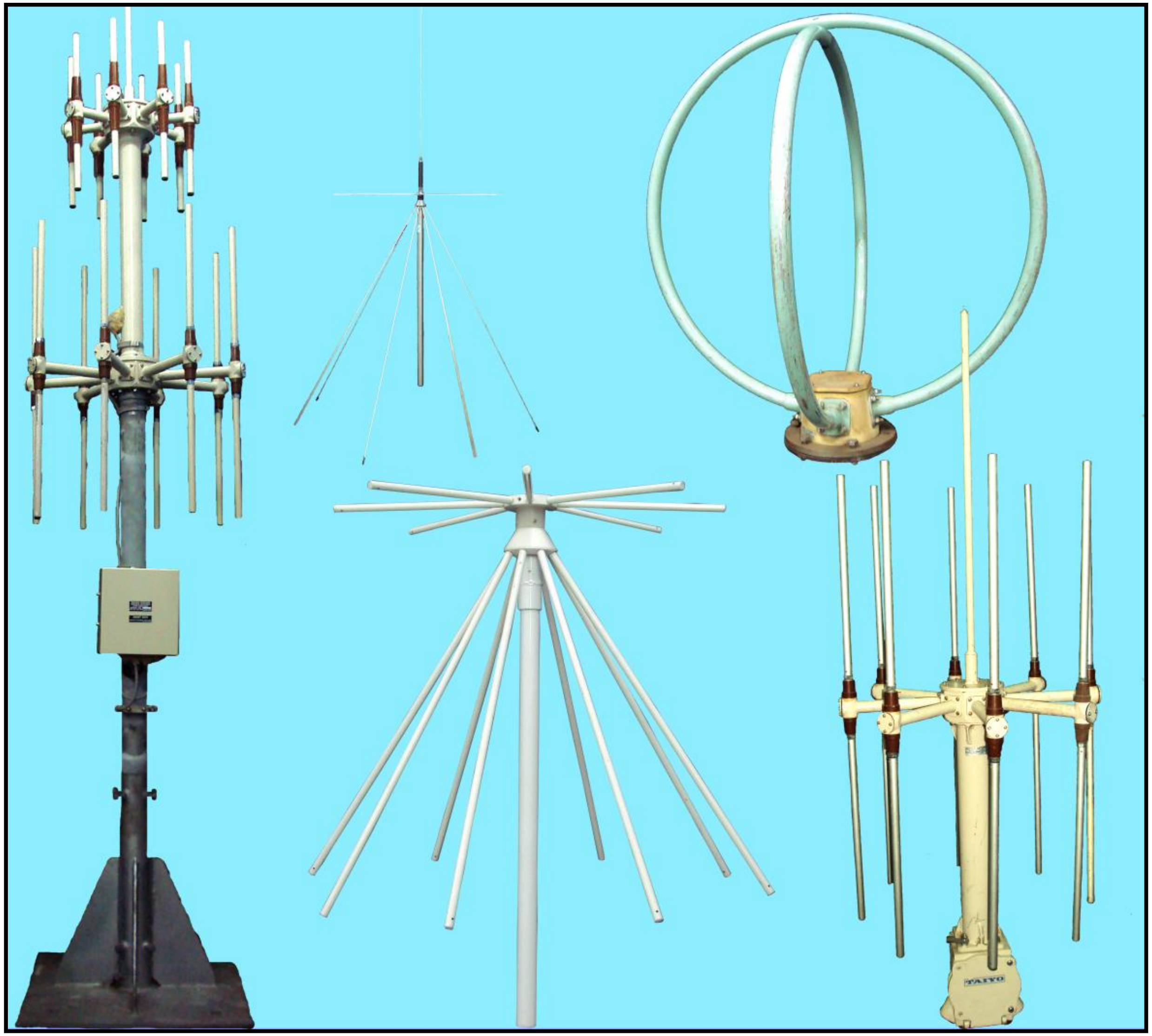
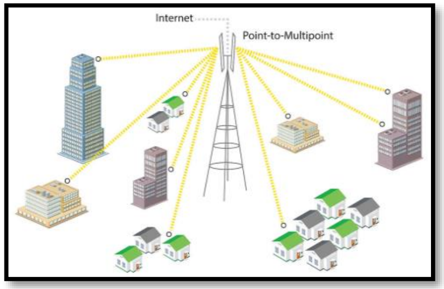
ANTENNA TYPES IN SLAF



ANTENNA APPLICATIONS

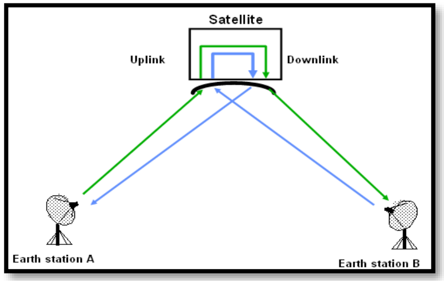
- Point-to-point communications



- Broadcasting applications

- Radar communications

- Satellite communications



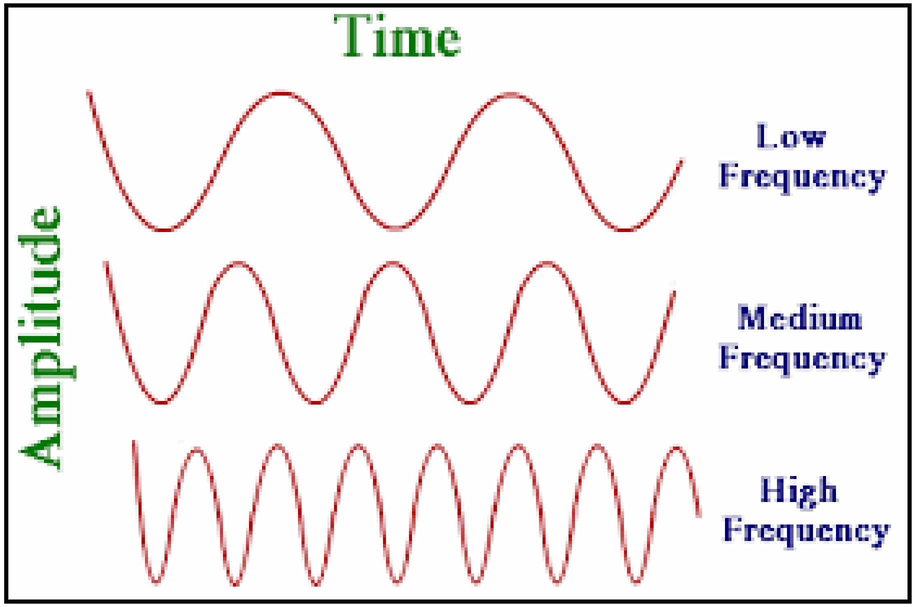
BASIC TERMINOLOGIES

BASIC TERMINOLOGIES

- Frequency (f)
- Amplitude
- Wavelength (λ)

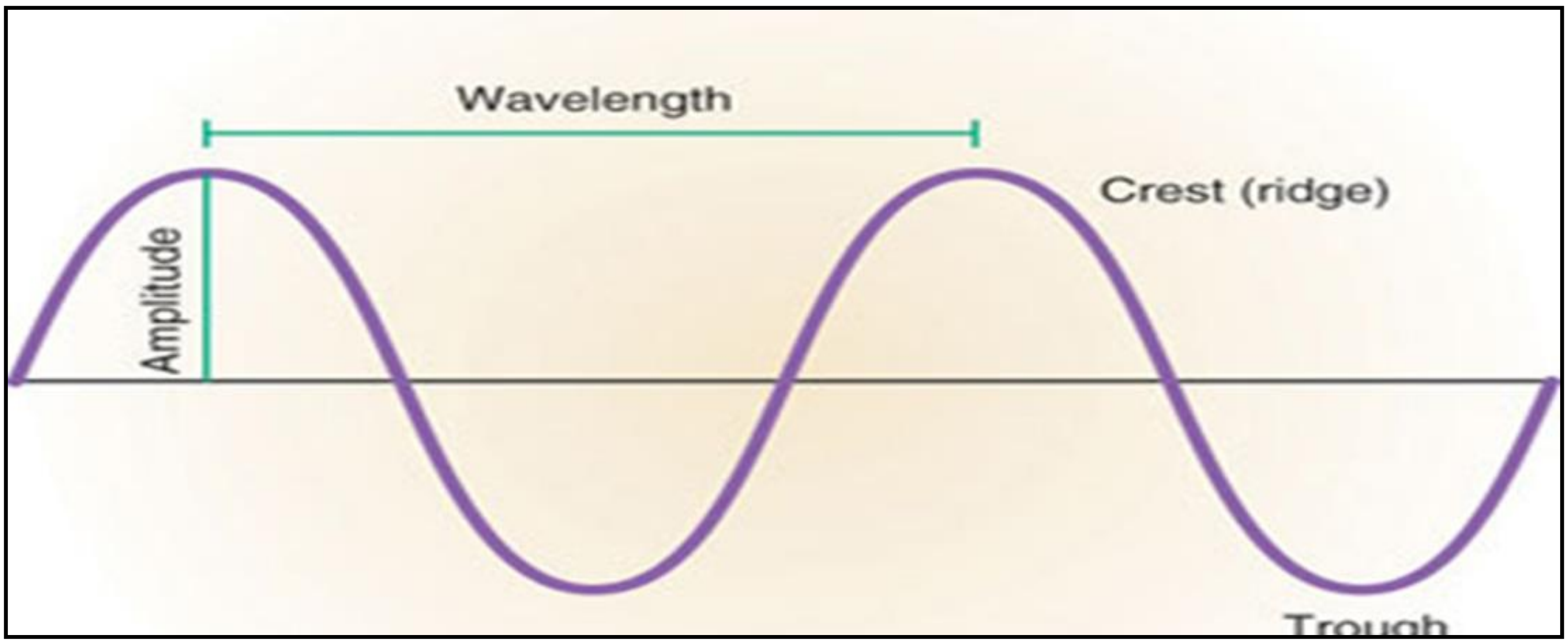
FREQUENCY

- Rate of oscillation or number of oscillations per second
- Measure by 'Hz'
  - 1000 Hz = 1 kHz
  - 1000 kHz = 1 MHz
  - 1000 MHz = 1 GHz



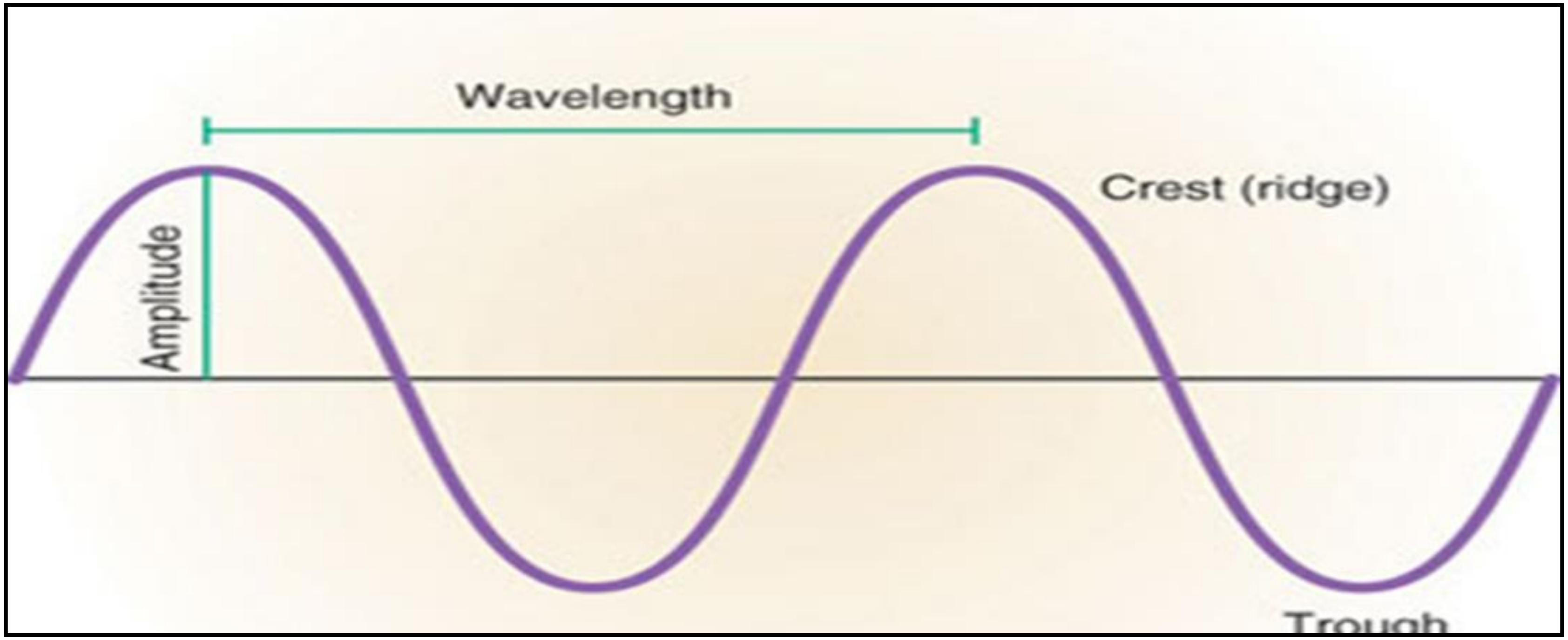
AMPLITUDE

- Maximum displacement or distance moved by a point on a wave measured from its equilibrium position

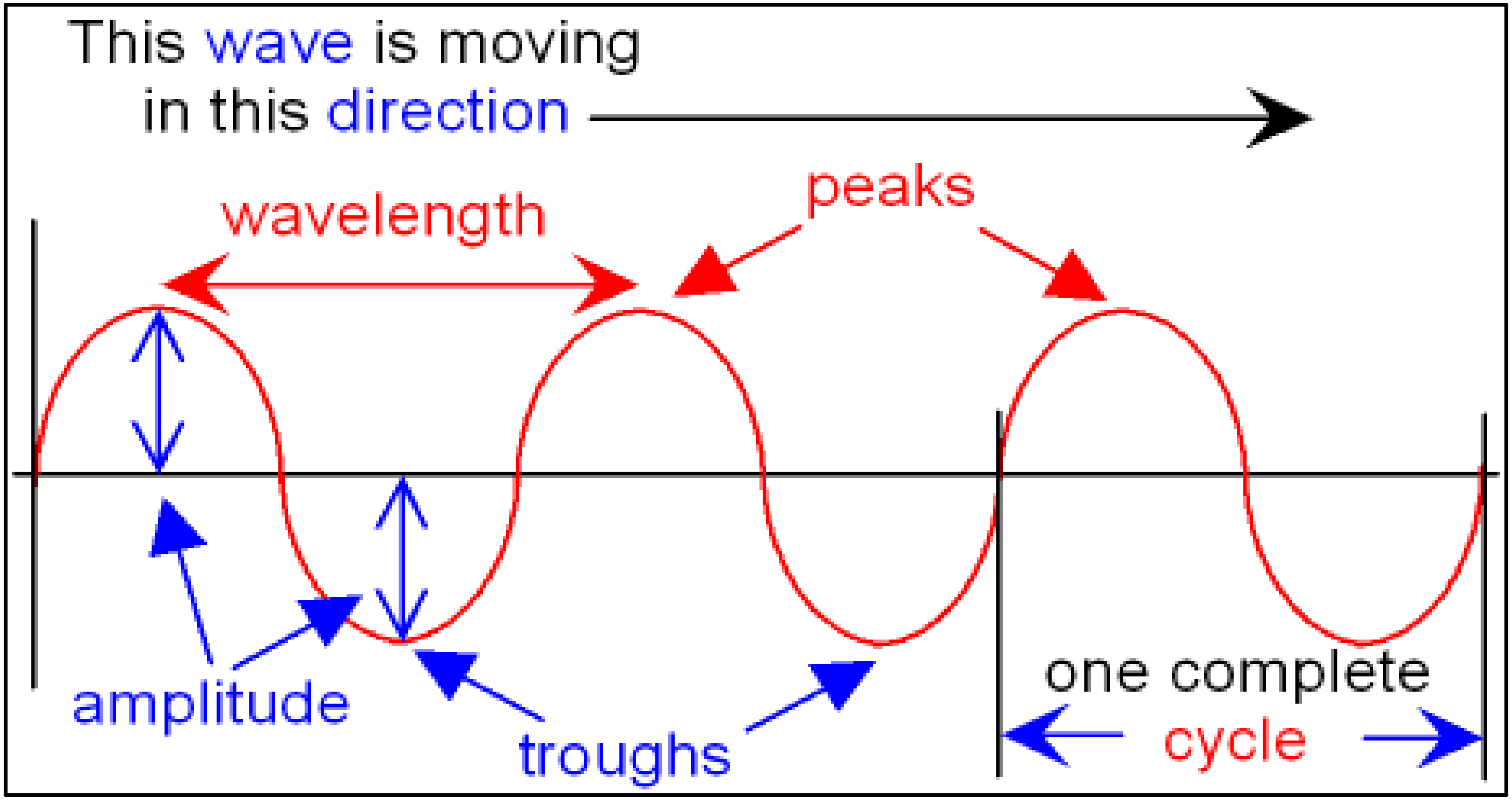


WAVELENGTH

- The horizontal distance between any two successive equivalent points
- Higher the frequency, shorter the wave length.



BASIC TERMINOLOGIES



BASIC EQUATION

BASIC EQUATION

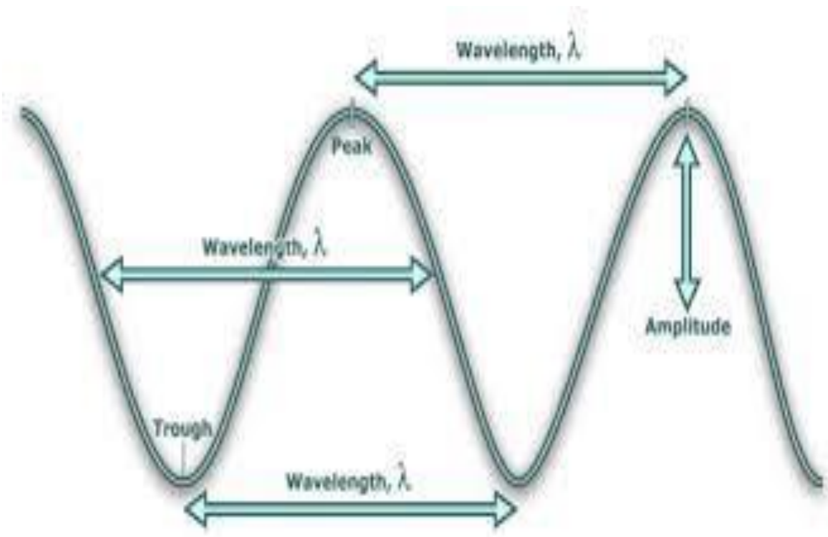
$$C = \lambda/T = \lambda \times 1/T$$

$$f = 1/T$$

$$C = f\lambda$$

$$C = f \times \lambda$$

λ = Wavelength [m]
f = Frequency [Hz]
C = 3×10^8 m/s



EXAMPLE 1

- ➢ What is the frequency of an air traffic control operating at a wavelength of 2.5m? [*Speed of light c* =3x10^8 m/s]

$c = f \times \lambda$

$f = c / \lambda$

$f = 3 \times 10^8$ m/s / 2.5m

$f = 120{,}000{,}000$ Hz

$f = 120$ MHz

EXAMPLE 2

- What is the frequency of Distance Measuring Equipment (DME) operating at a wavelength of 0.3m? [*Speed of light c* = $3 x 10^8$ m/s]

$c = f \times \lambda$

$f = c/\lambda$

$f = 3 \ x 10^8$ m/s / 0.3m

$f = 1 \times 10^9$Hz @ 1000×10^6 Hz

f = 1 GHz @ 1000 MHz

EXAMPLE 3

- What is the wavelength of ILS Localizer operating at a frequency of 100MHz? [*Speed of light c* =3x10^8 m/s]

$c = f \times \lambda$

$\lambda = c/f$

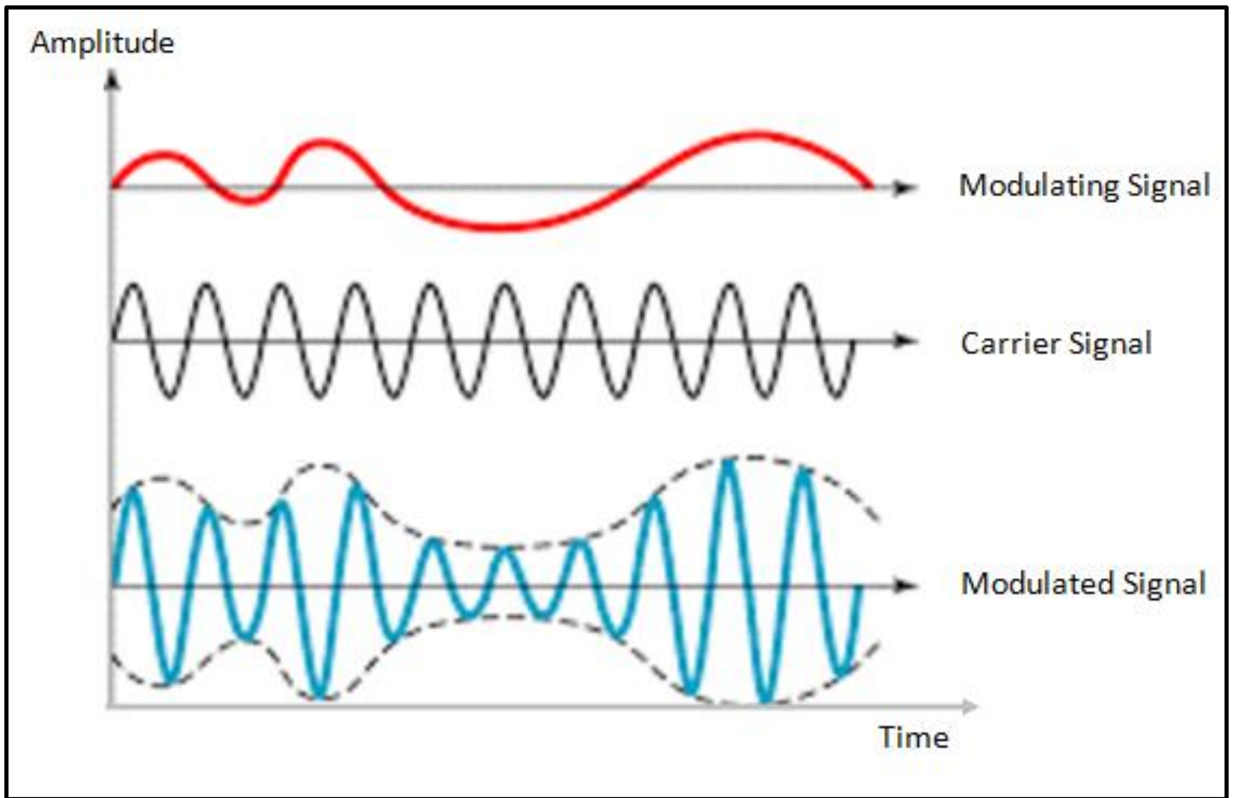
$\lambda = 3 \times 10^8 \text{ m/s} / 100 \times 10^6 \text{ Hz}$

$\lambda = 3 \text{ m}$

MODULATION

MODULATION

- Modulation is the process of changing the characteristics (amplitude, frequency or phase) of the carrier signal, in accordance with the amplitude of the message signal.



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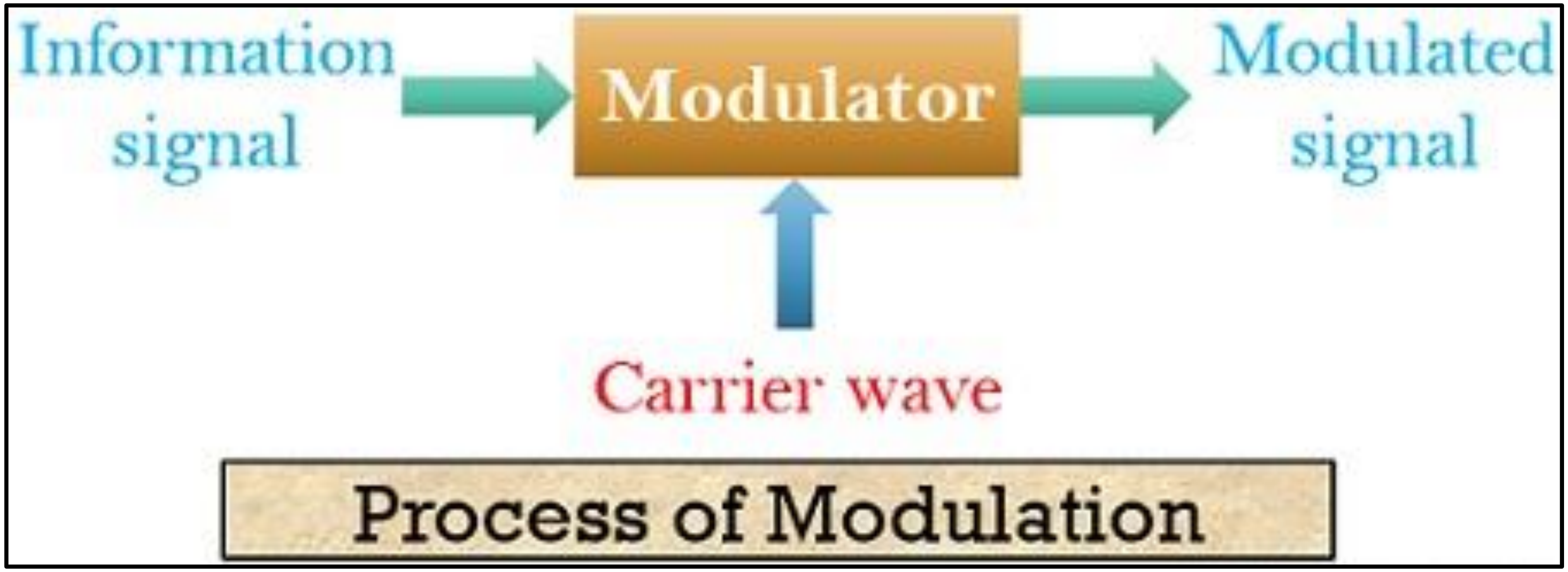
MODULATION



Information signal
Modulator
Modulated signal
Carrier wave
Process of Modulation

IMPORTANCE OF MODULATION

- Avoids interferences from other signals
- Increase the range of communication
- To enable wireless communication
- Reduces the effect of noise
- Reduces transmitting and receiving antenna size

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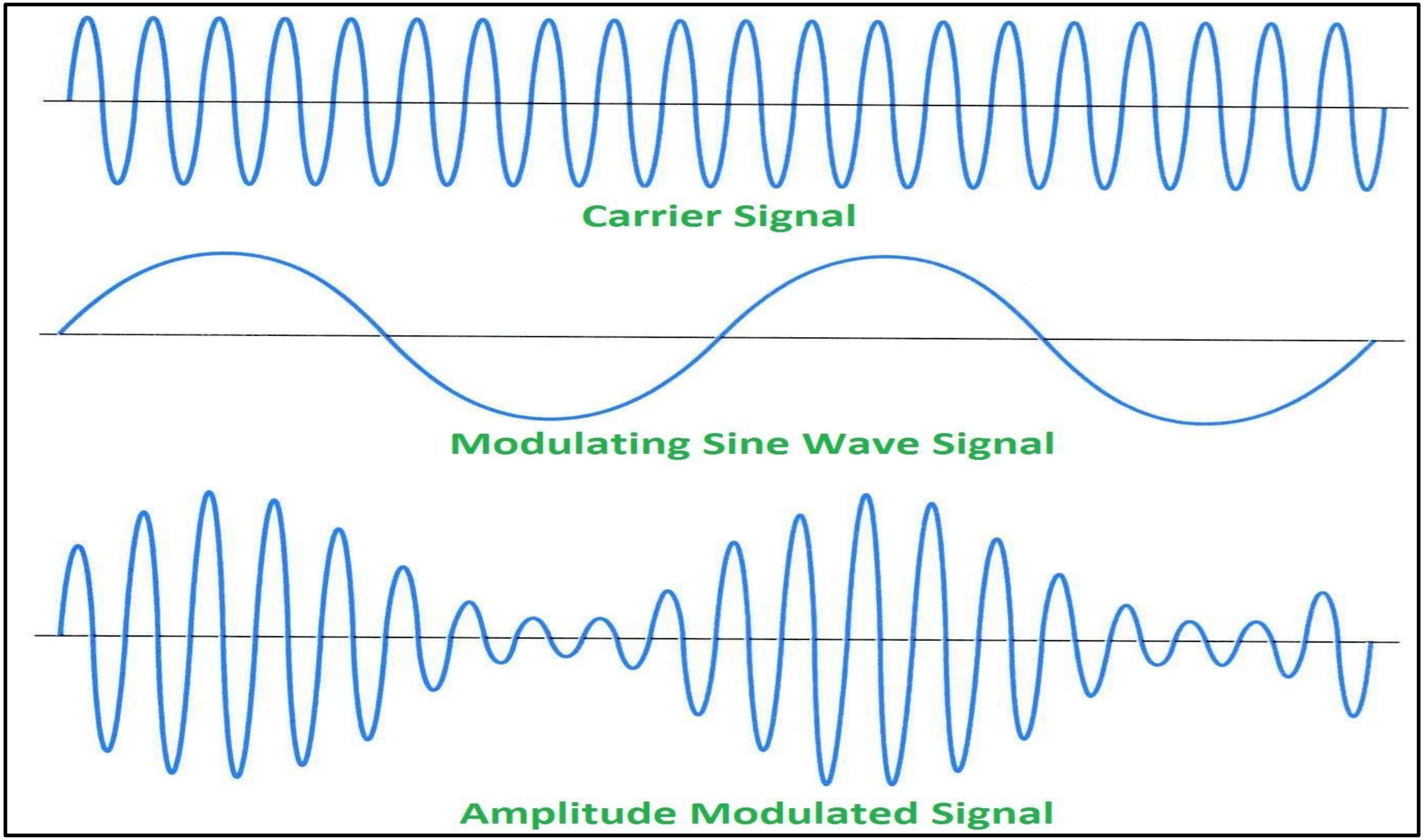
AMPLITUDE MODULATION



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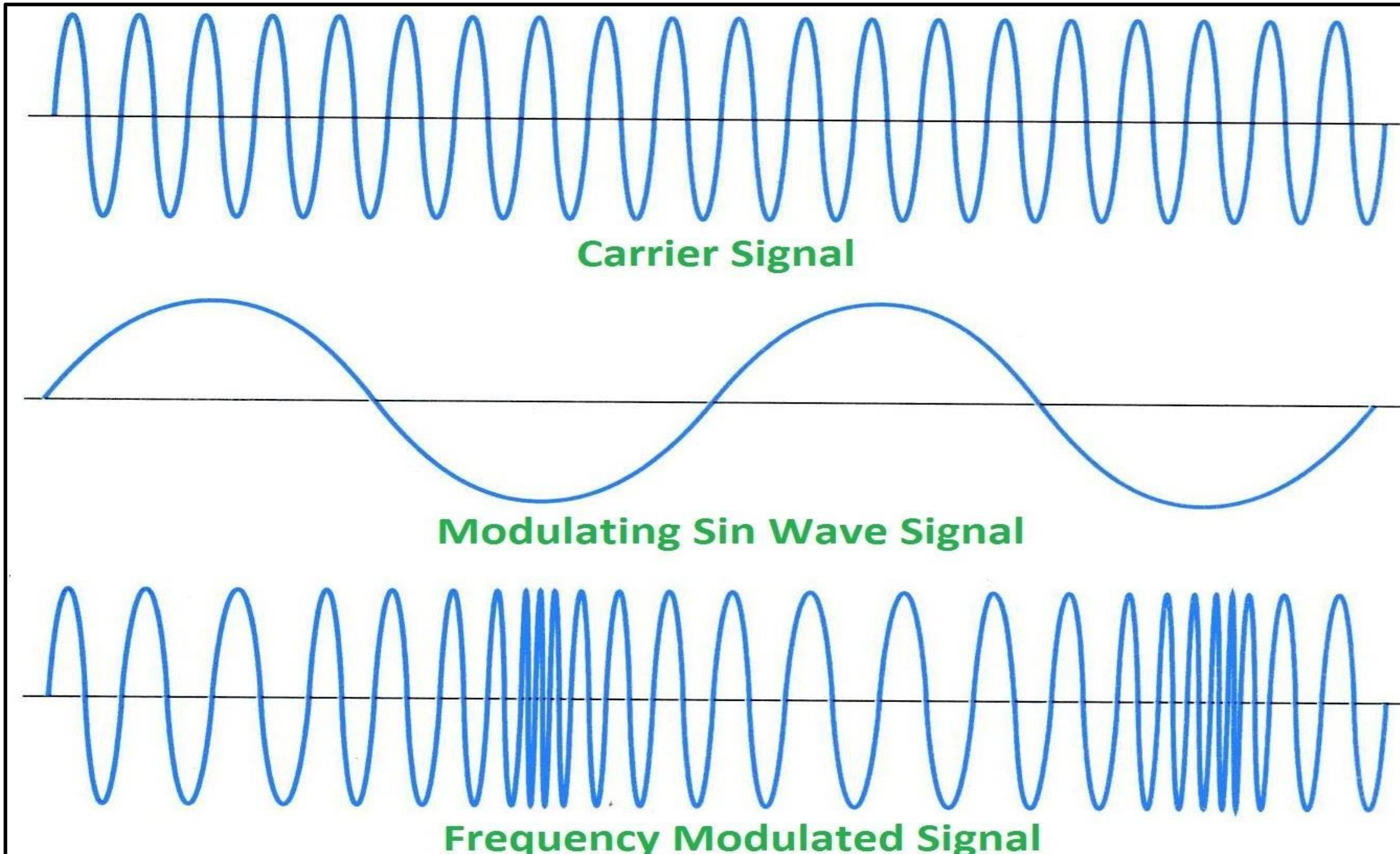
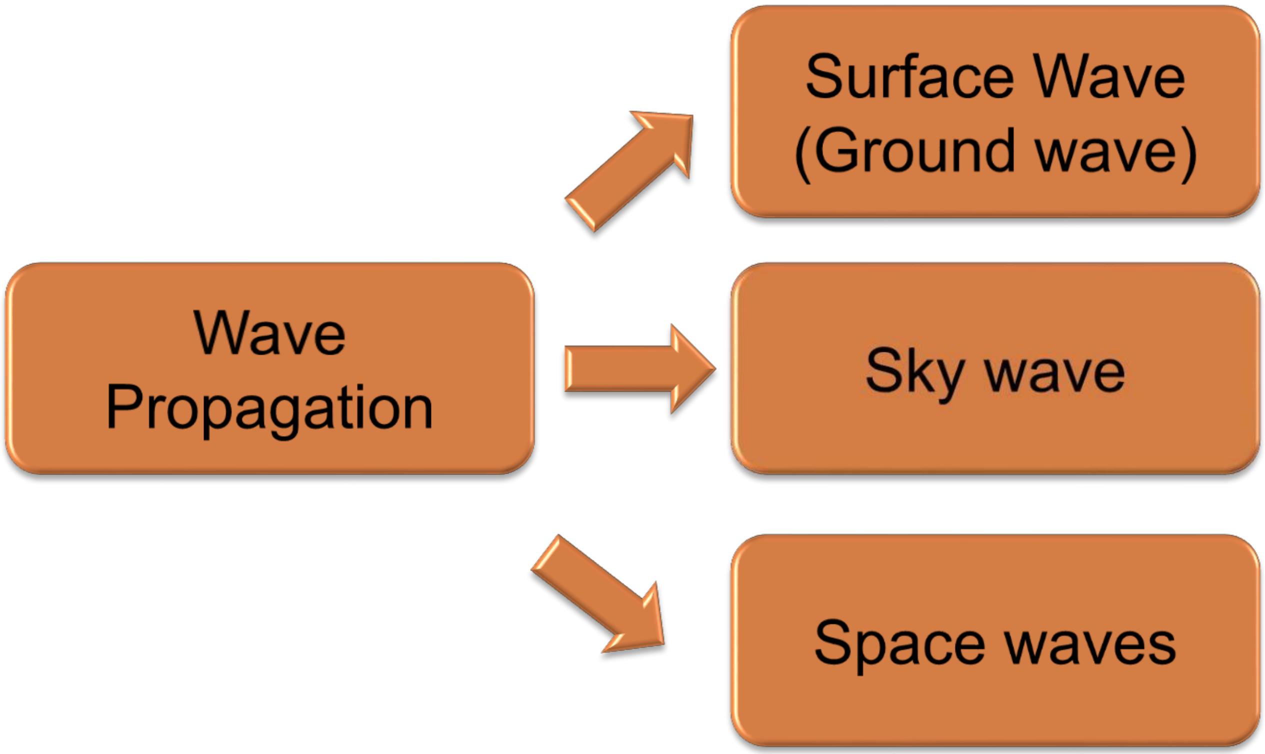
FREQUENCY MODULATION



RADIO WAVE PROPAGATION

RADIO WAVE PROPAGATION

- There are three principle paths which radio waves may follow over the earth between the transmitter and the receiver



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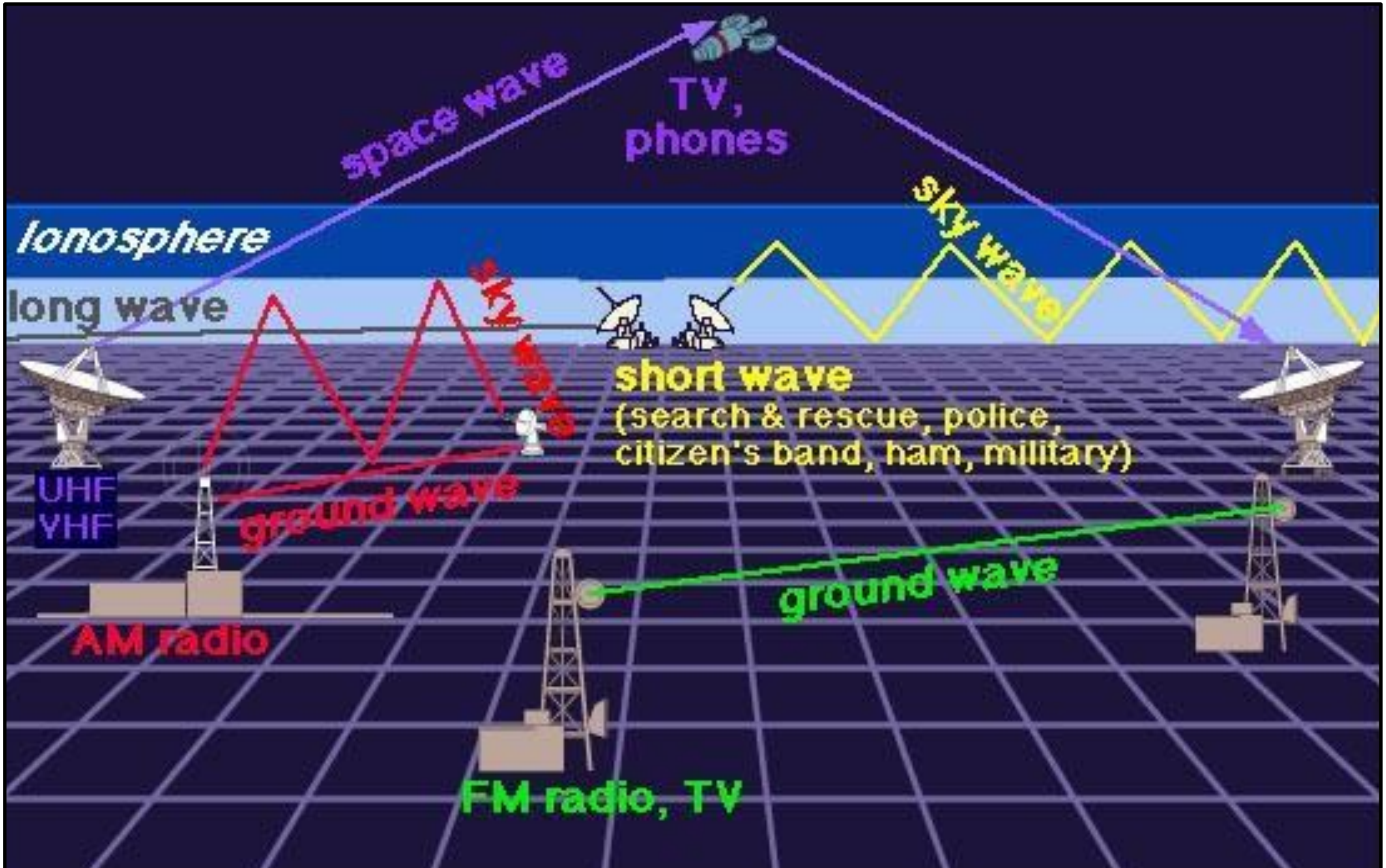
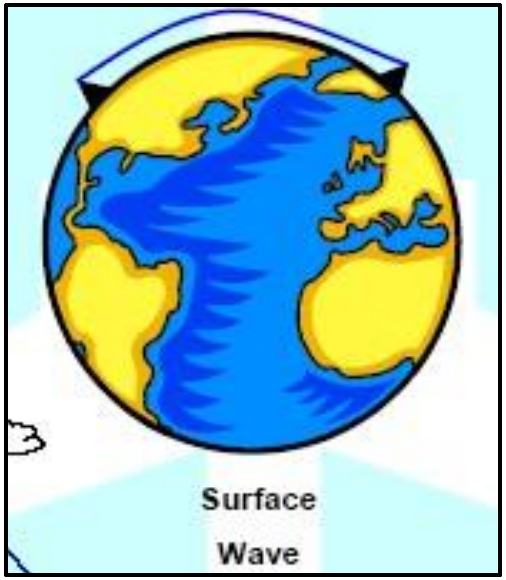
RADIO WAVE PROPAGATION



RADIO WAVE PROPAGATION



Follows the contour of the Earth

Line of Sight: Clear path between transmitting and receiving antennas

RECAP

- Types of Transmission Media
- Radio Principles
- Basic Terminologies
- Basic Equation
- Modulation
- Radio Wave Propagation


Thank You