

# Transmission Media

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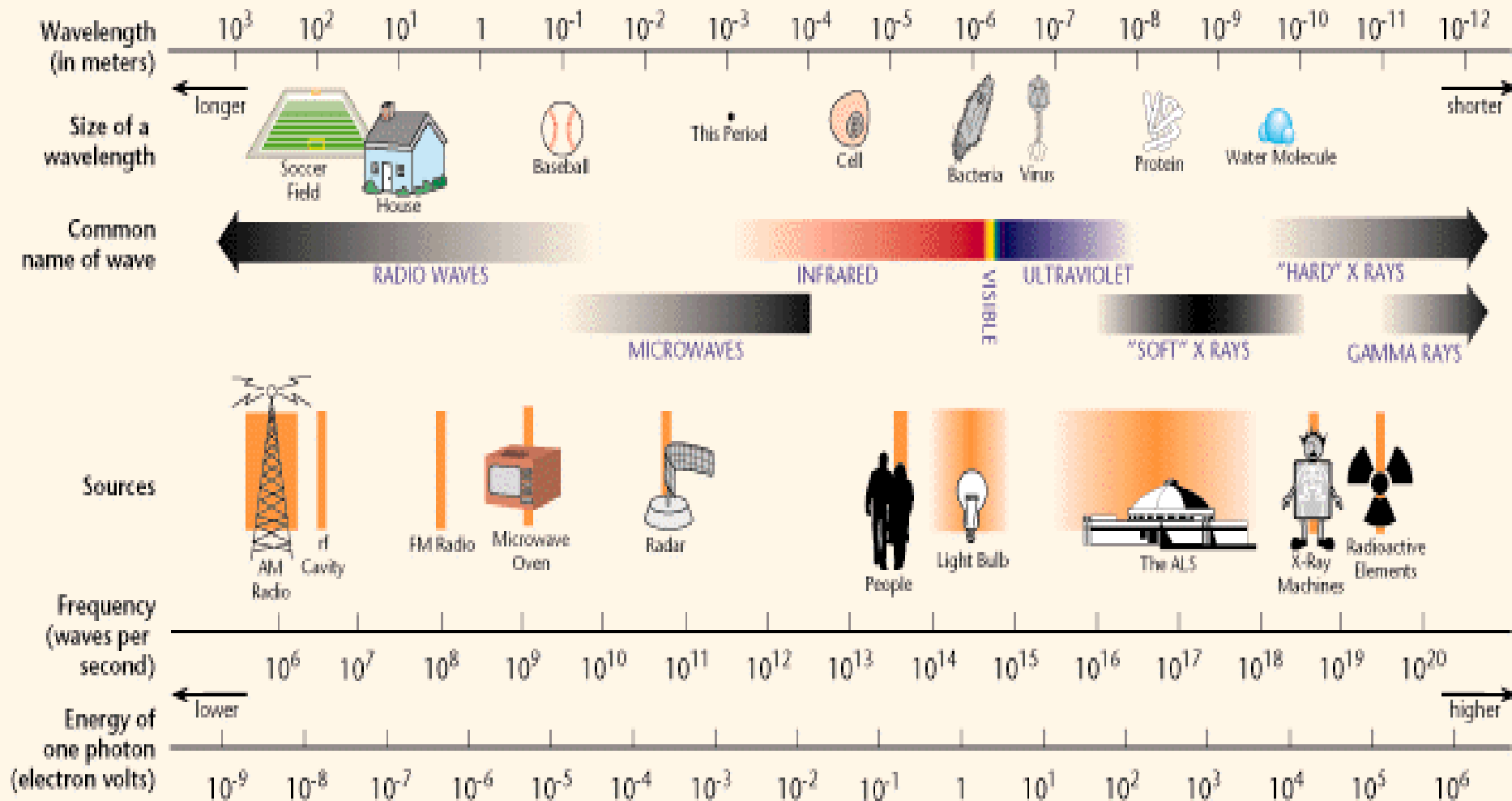
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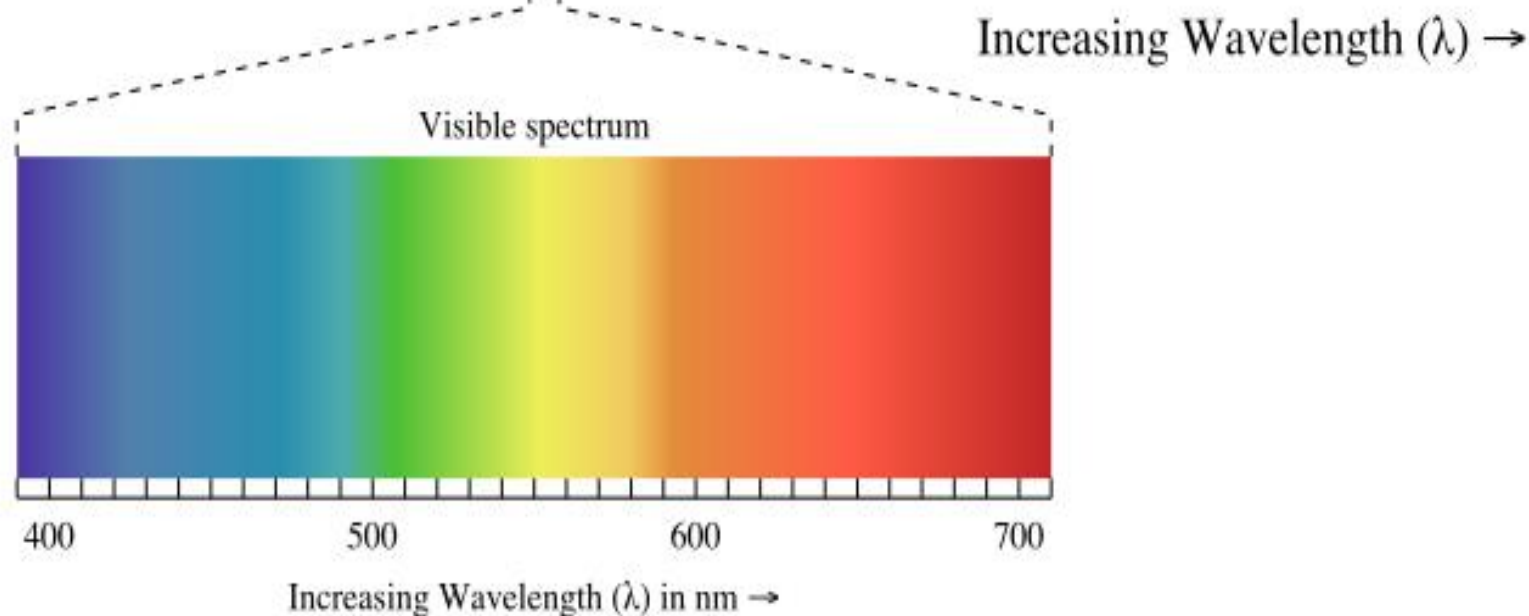
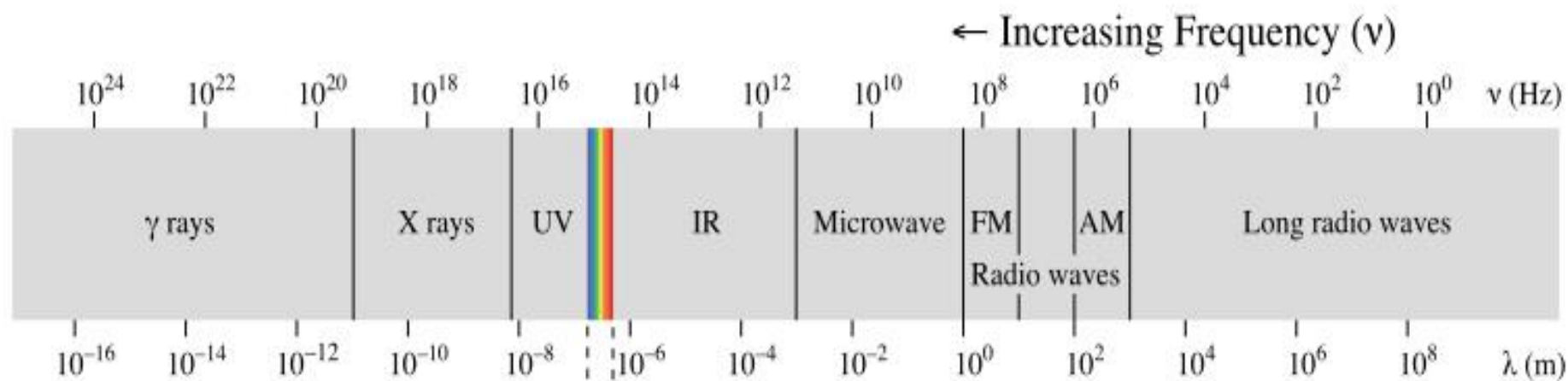
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# THE ELECTROMAGNETIC SPECTRUM



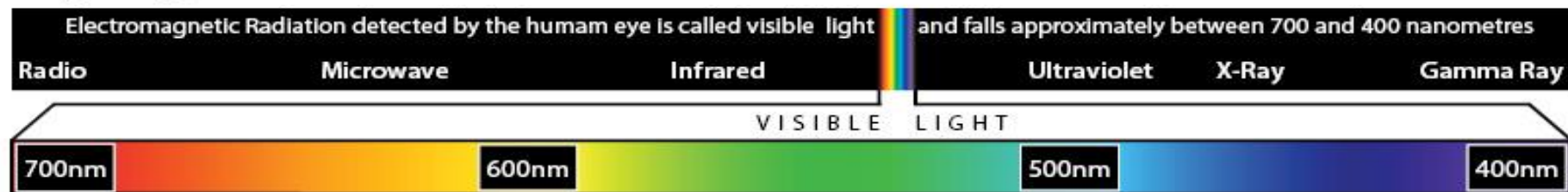
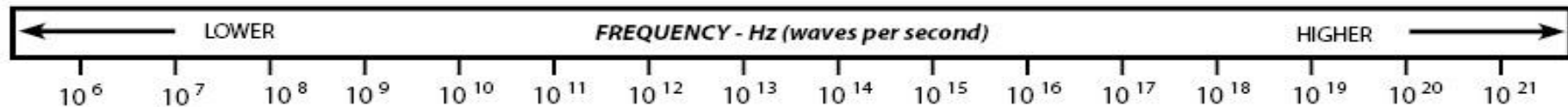
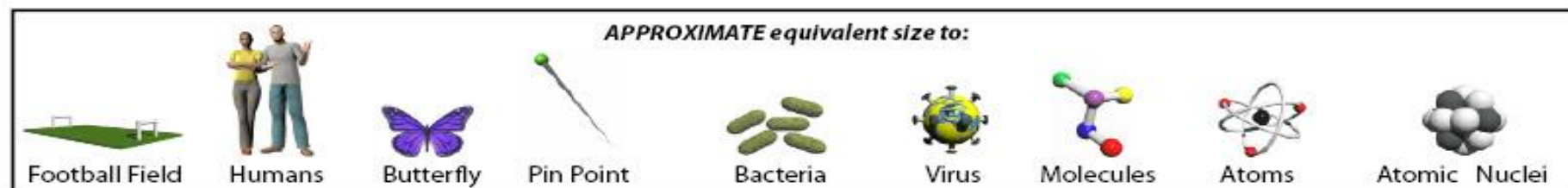
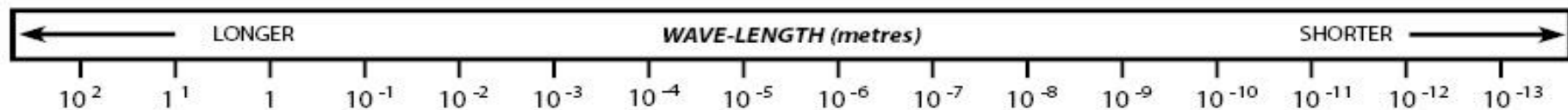
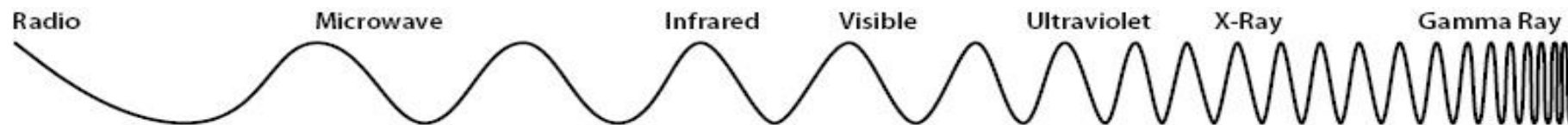


# THE ELECTRO MAGNETIC SPECTRUM

1 metre = 100cm 1 cm = 10mm 1 millimetre = 1000 microns 1 micron = 1000 nanometres (nm) - one nanometre is one billionth of a metre

$$10^{-5} = 0.00001 \quad 10^5 = 100,000$$

**WAVE (type)**



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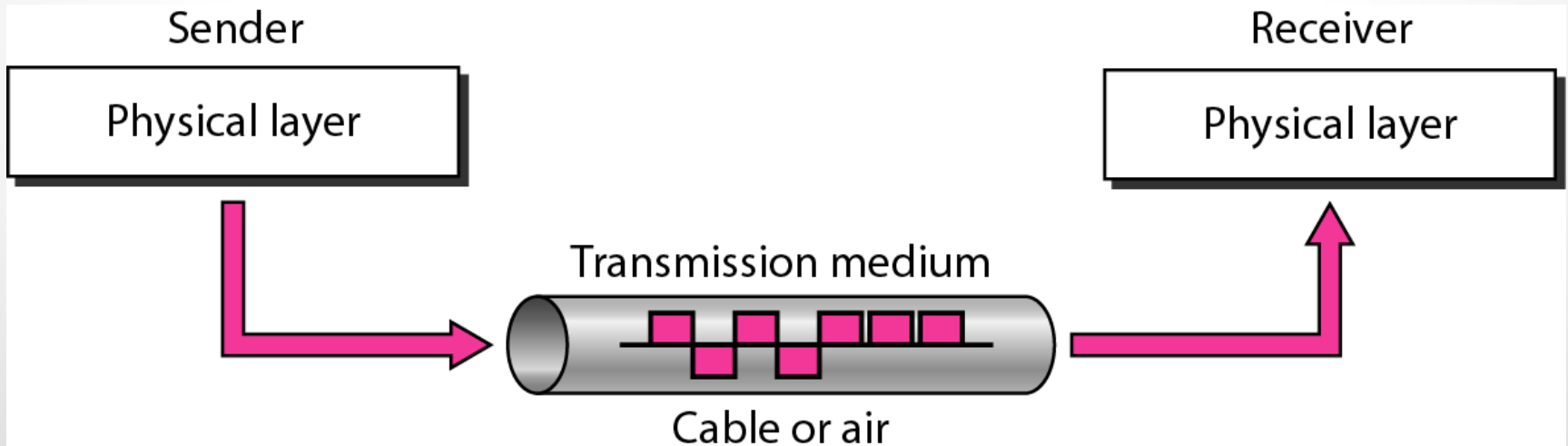
# What is Transmission Media ?

In data communication,

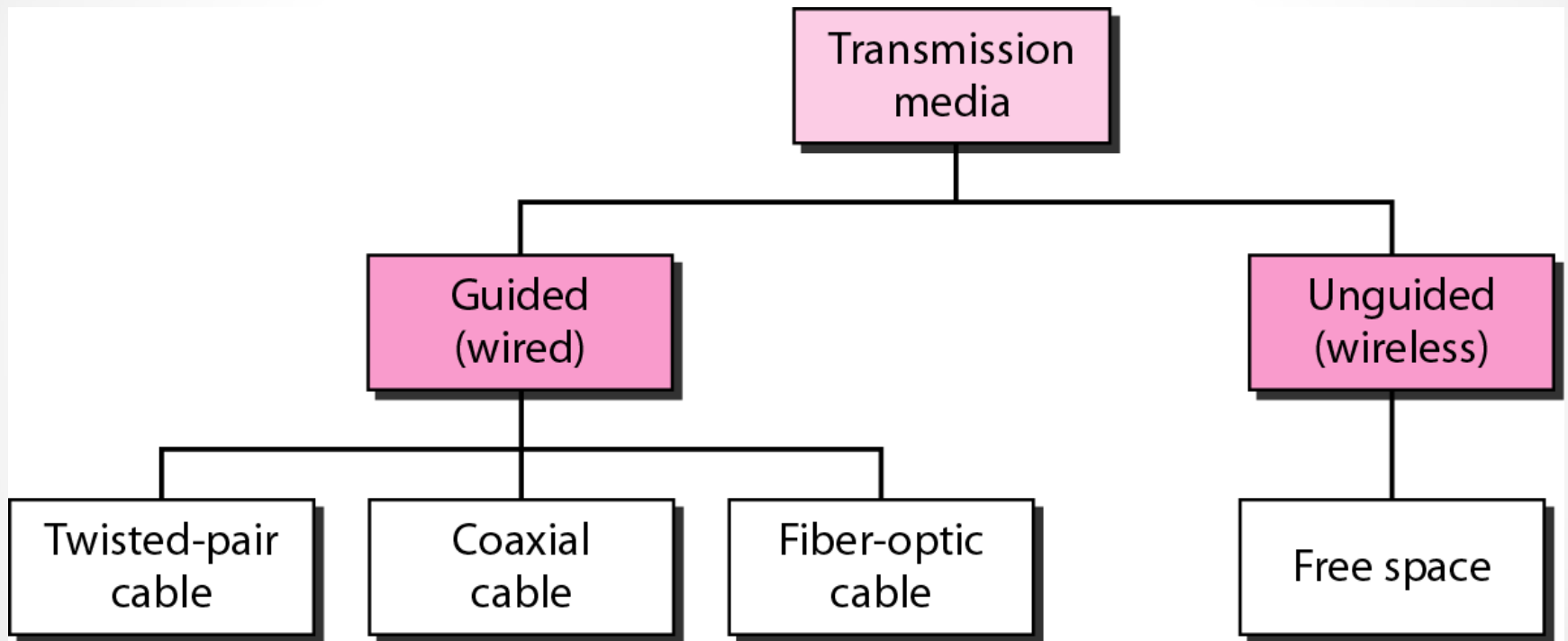
- **Transmission media** is a pathway that carries the information from sender to receiver.
- We use different types of cables or waves to transmit data.
- Data is transmitted normally through electrical or electromagnetic signals.

# Description

- Transmission media are located below the physical layer
- Computers use signals to represent data.
- Signals are transmitted in form of electromagnetic energy.



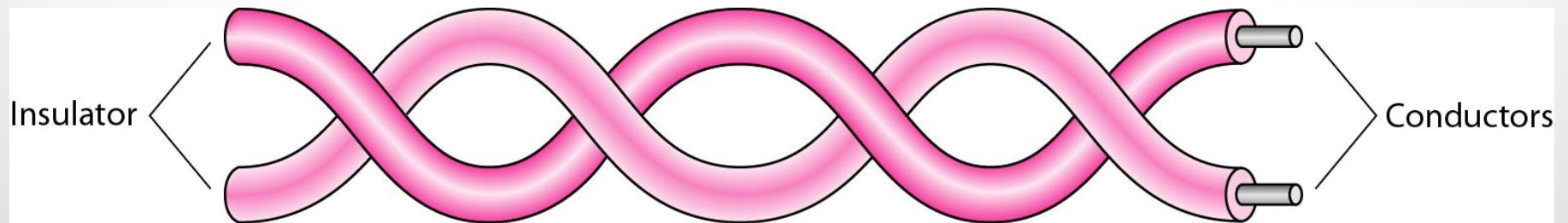
# Classification of Transmission media





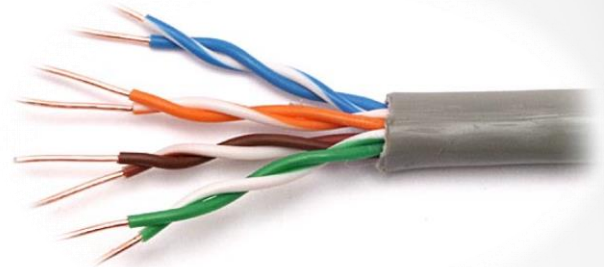
# Twisted-pair cable

- A twisted pair consists of two conductors
- Basically copper based
- With its own plastic insulation, twisted together.



# Twisted Pair Description

- Provide protection against cross talk or interference(noise)
- One wire use to carry signals to the receiver
- Second wire used as a ground reference
- For twisting, after receiving the signal remains same.
- Therefore number of twists per unit length, determines the quality of cable.



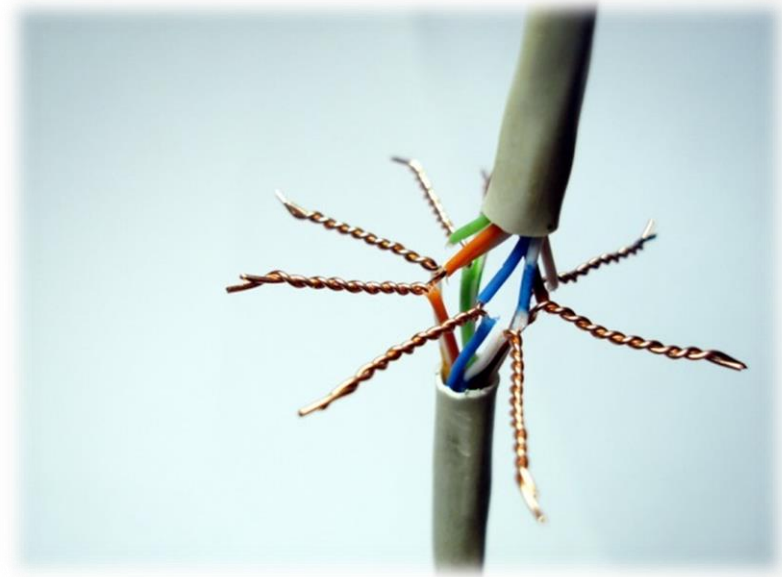
# Twisted Pair

## Advantages:

- Cheap
- Easy to work with

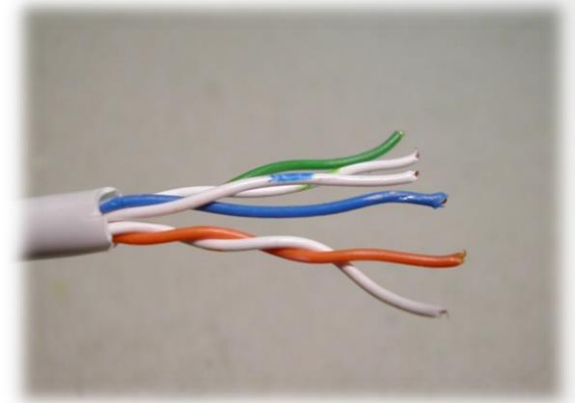
## Disadvantages:

- Low data rate
- Short range

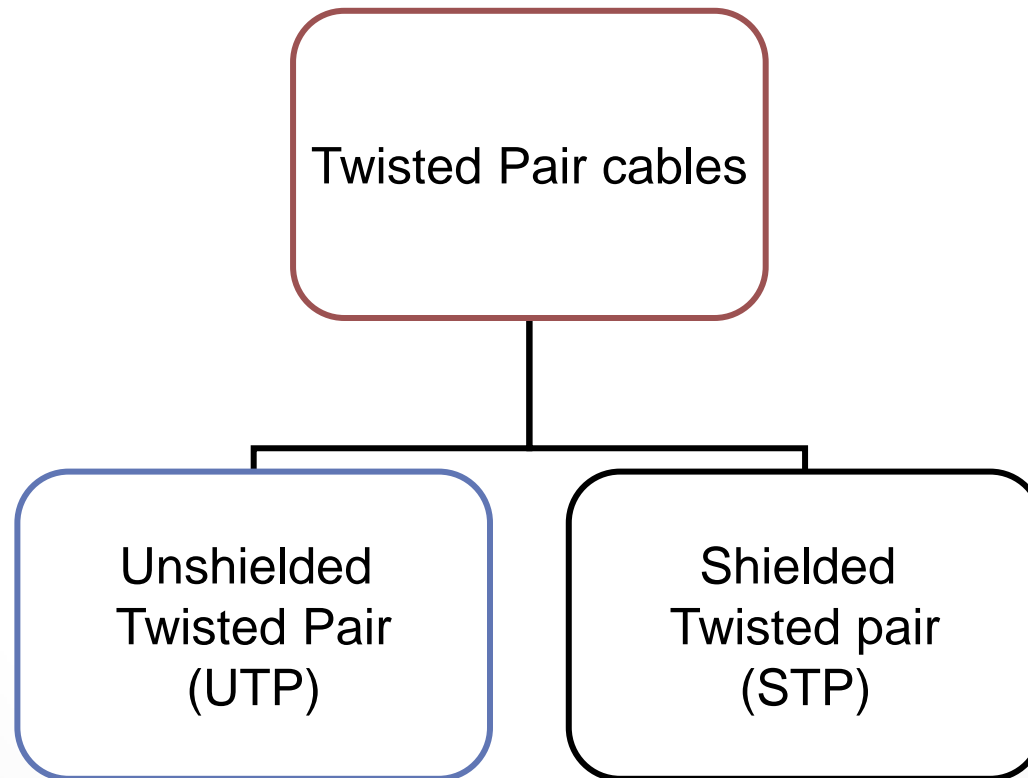


# Twisted Pair - Applications

- Very common medium
- Can be use in telephone network
- Connection Within the buildings
- For local area networks (LAN)



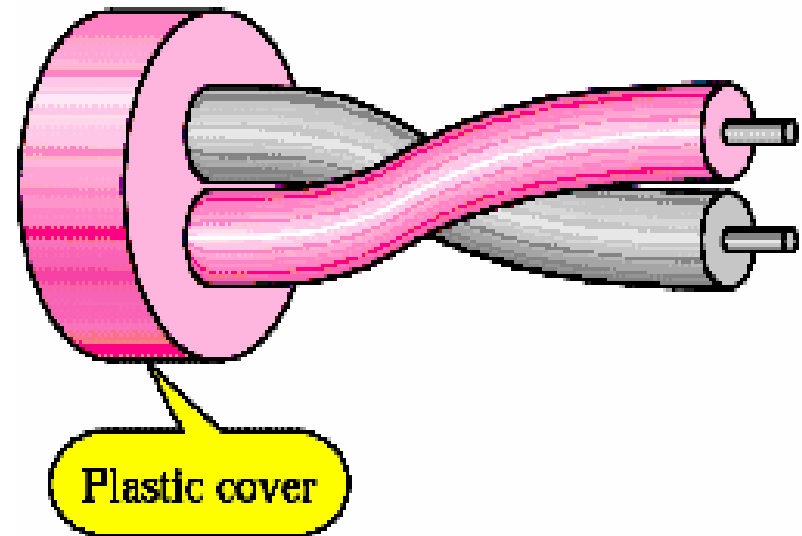
# Twisted Pair Cables



# Unshielded Twisted Pair (UTP):

## Description

- Pair of unshielded wires wound around each other
- Easiest to install



a. UTP

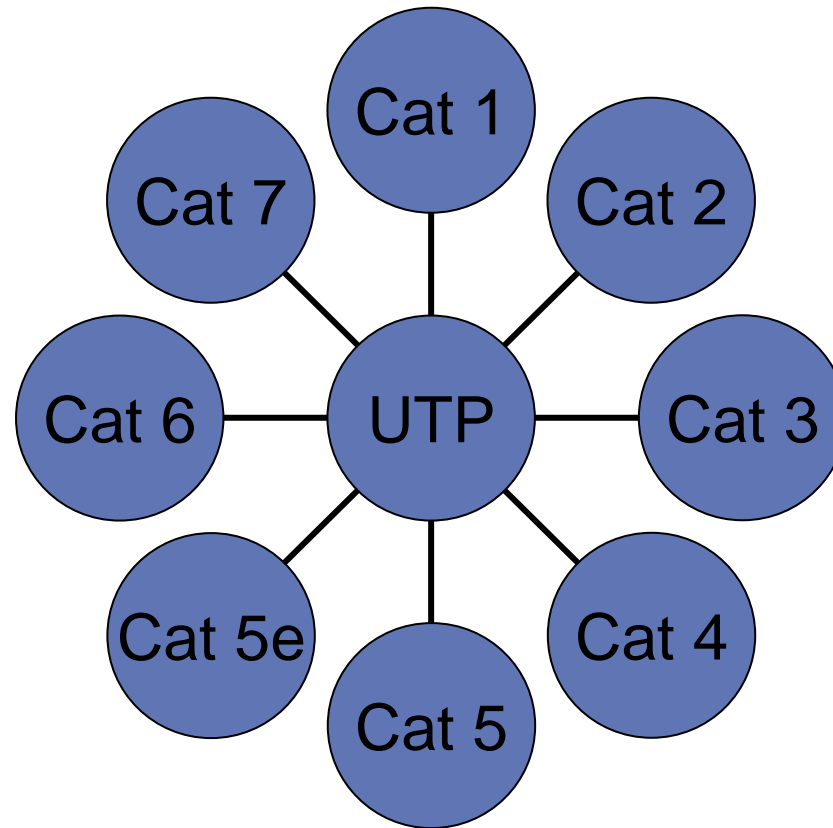
# Applications

## UTP :

- Telephone subscribers connect to the central telephone office
- DSL lines
- LAN – 10Mbps or 100Mbps



# UTP Cable Types



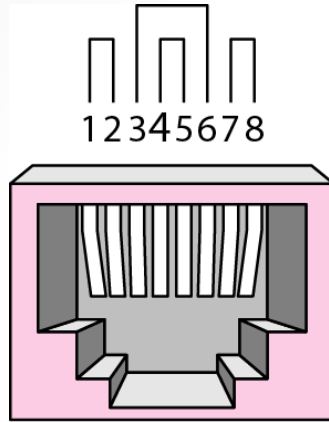
Cat means category according to IEEE standards. IEEE is de jure standard



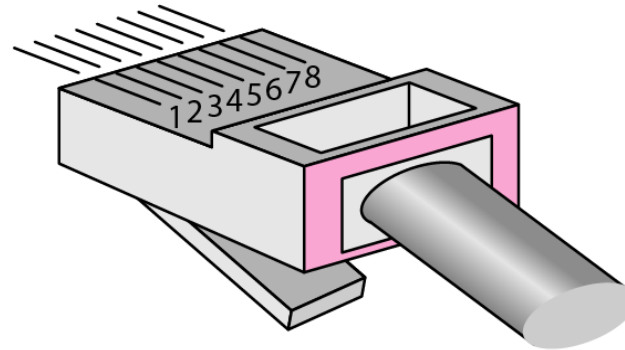
# Categories of UTP cables

| <i>Category</i> | <i>Specification</i>   | <i>Data Rate (Mbps)</i> | <i>Use</i> |
|-----------------|--|-------------------------|------------|
| 1               | Unshielded twisted-pair used in telephone  | < 0.1                   | Telephone  |
| 2               | Unshielded twisted-pair originally used in T-lines   | 2                       | T-1 lines  |
| 3               | Improved CAT 2 used in LANs  | 10                      | LANs       |
| 4               | Improved CAT 3 used in Token Ring networks   | 20                      | LANs       |
| 5               | Cable wire is normally 24 AWG with a jacket and outside sheath   | 100                     | LANs       |
| 5E              | An extension to category 5 that includes extra features to minimize the crosstalk and electromagnetic interference   | 125                     | LANs       |
| 6               | A new category with matched components coming from the same manufacturer. The cable must be tested at a 200-Mbps data rate.  | 200                     | LANs       |
| 7               | Sometimes called SSTP (shielded screen twisted-pair). Each pair is individually wrapped in a helical metallic foil followed by a metallic foil shield in addition to the outside sheath. The shield decreases the effect of crosstalk and increases the data rate. | 600                     | LANs       |

# UTP connector and Tools

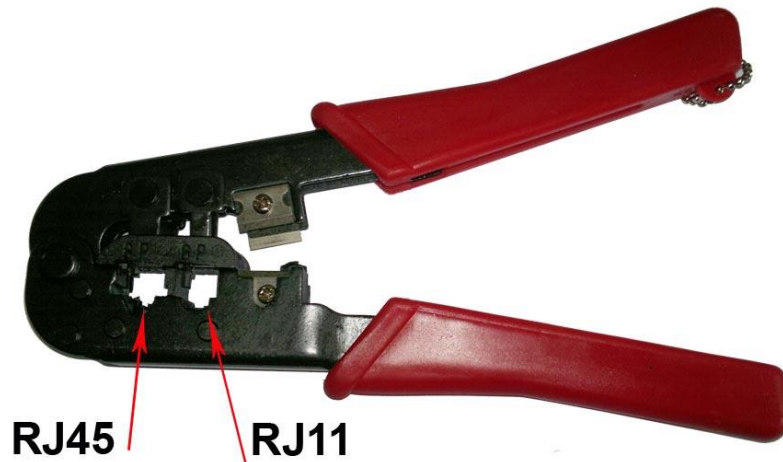


RJ-45 Female



RJ-45 Male

RJ45 (RJ stands for registered jack) is a keyed connector, it means that it can be inserted in only one way



Crimper Tool

## Advantages of UTP:

- Affordable
- Most compatible cabling
- Major networking system

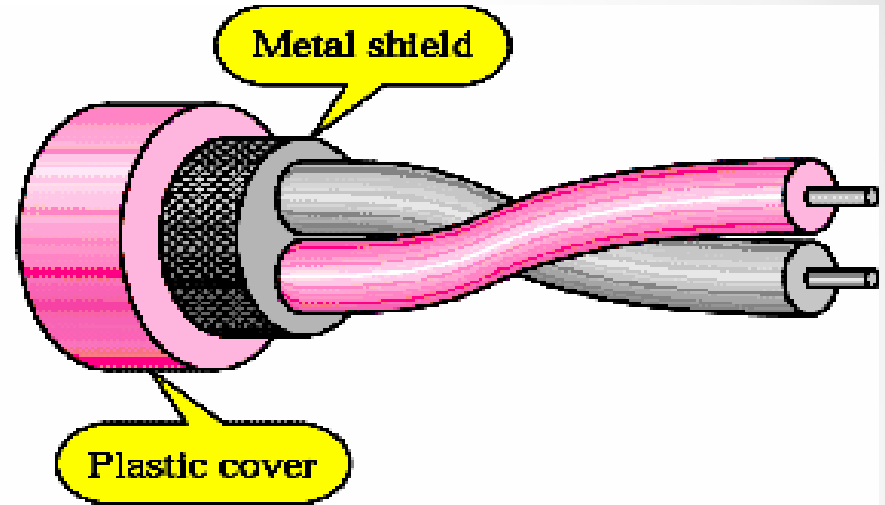


## Disadvantages of UTP:

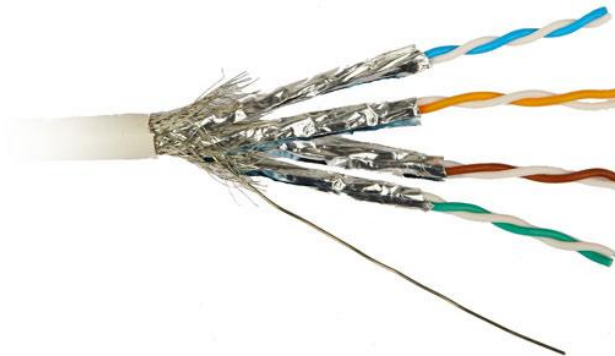
- Suffers from external Electromagnetic interference

# Shielded Twisted Pair (STP)

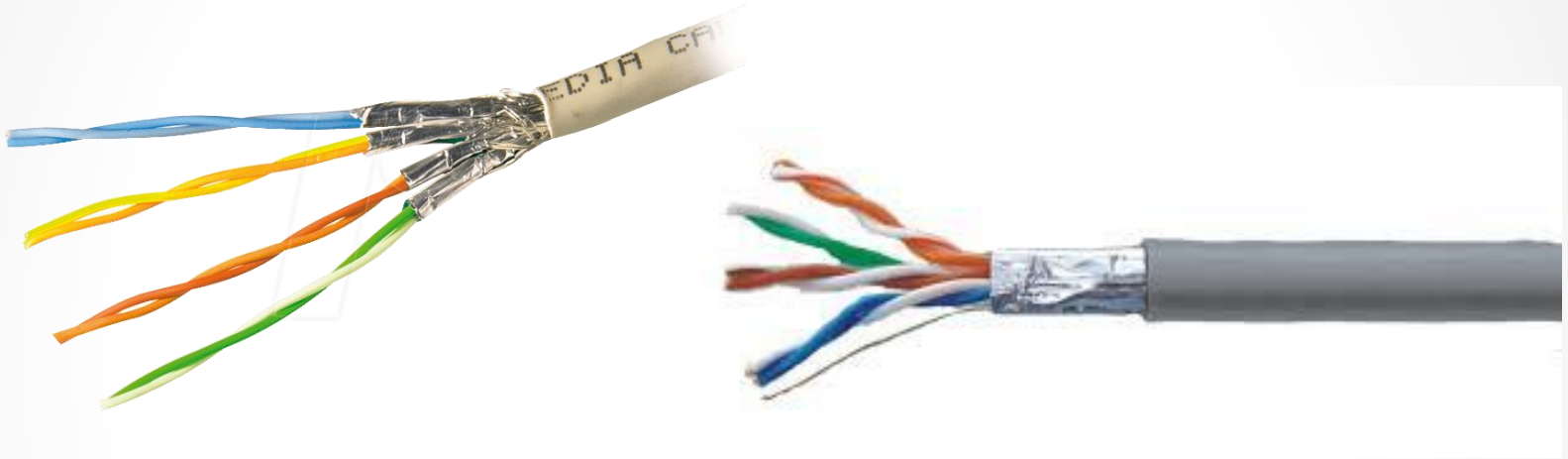
- Pair of wires wound around each other placed inside a protective foil wrap
- Metal braid or sheath foil that reduces interference
- Harder to handle (thick, heavy)



**b. STP**



# STP Application



- STP is used in IBM token ring networks.
- Higher transmission rates over longer distances.

## Advantages of STP:

- Shielded
- Faster than UTP

## Disadvantages of STP:

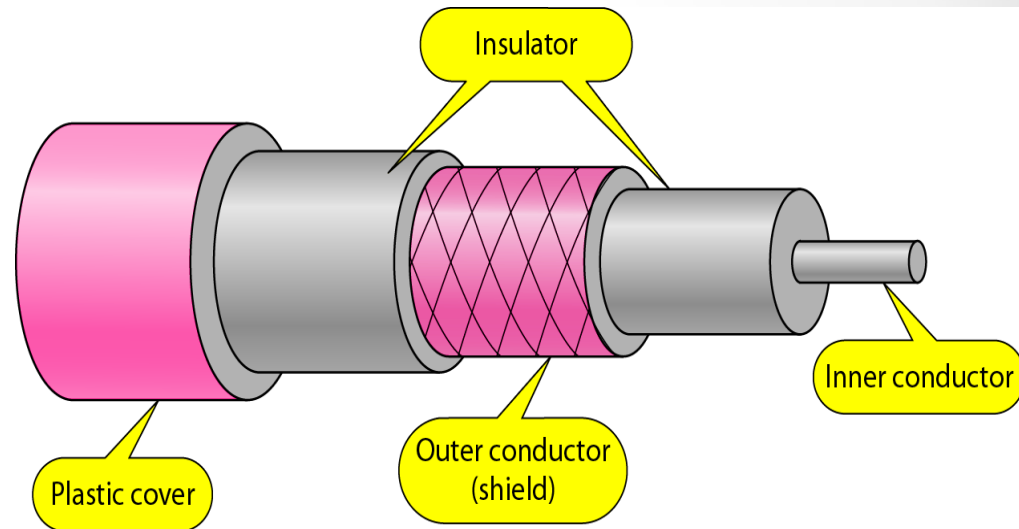
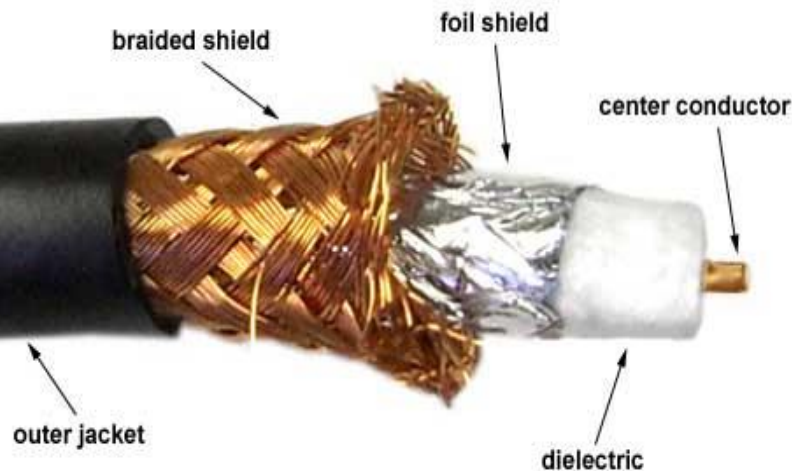
- More expensive than UTP
- High attenuation rate



# Co-axial Cable

Co-axial cable carries signal of higher frequency ranges than twisted pair cable

COAXIAL CABLE



- Inner conductor is a solid wire
- Outer conductor serves as a shield against noise and a second conductor

# Categories of coaxial cables

| <i>Category</i> | <i>Impedance</i> | <i>Use</i>     |
|-----------------|------------------|----------------|
| RG-59           | 75 $\Omega$      | Cable TV       |
| RG-58           | 50 $\Omega$      | Thin Ethernet  |
| RG-11           | 50 $\Omega$      | Thick Ethernet |

Coaxial cables are categorized by Radio Government (RG) ratings, RG is De Jure standards

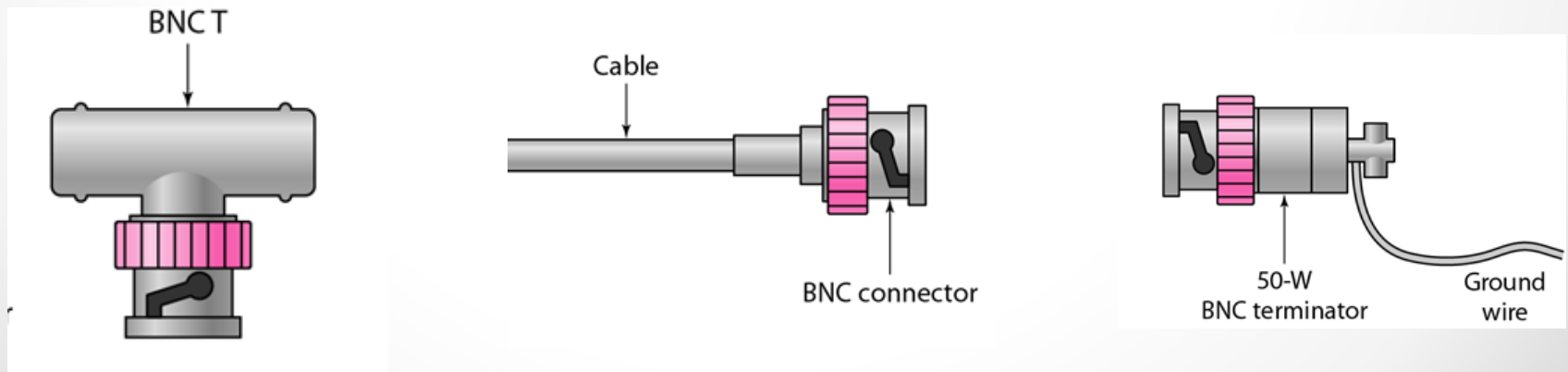


# Coaxial Cable Connectors

## BNC Connectors – Bayone Neil Concelman

To connect coaxial cable to devices we need coaxial connectors

- BNC Connector is used at the end of the cable to a device  
Example: TV set connection
- BNC T connector used to Ethernet networks to branch out connection to computer or other devices
- BNC terminator is used at the end of the cable to prevent the reflection of the signal



# Coaxial Cable Applications

- Most versatile medium
- Television distribution
- Long distance telephone transmission
- Can carry 10,000 voice calls simultaneously
- Short distance computer systems links
- Local area networks



# COAXIAL CABLE

## ADVANTAGES

- Easy to wire
- Easy to expand
- Moderate level of Electro Magnetic Interference



## DISADVANTAGE

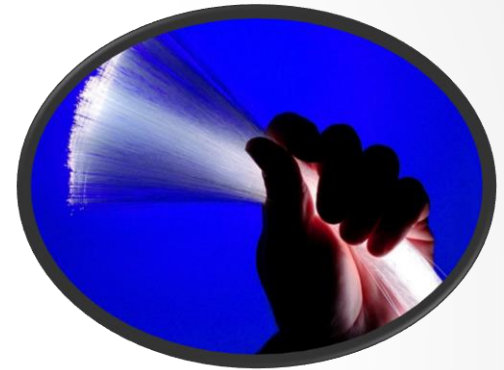
- Single cable failure can take down an entire network
- Cost of installation of a coaxial cable is high due to its thickness and stiffness
- Cost of maintenance is also high

# Fiber-Optic Cable

A fiber optic cable is made of glass or plastic and transmit signals in the form of light.

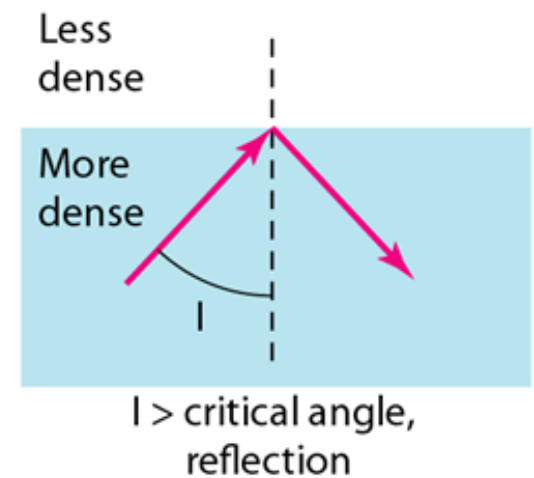
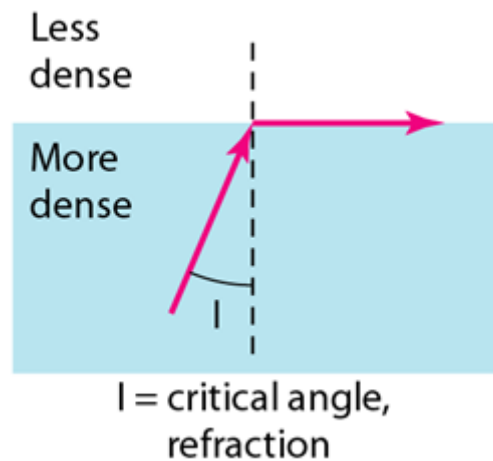
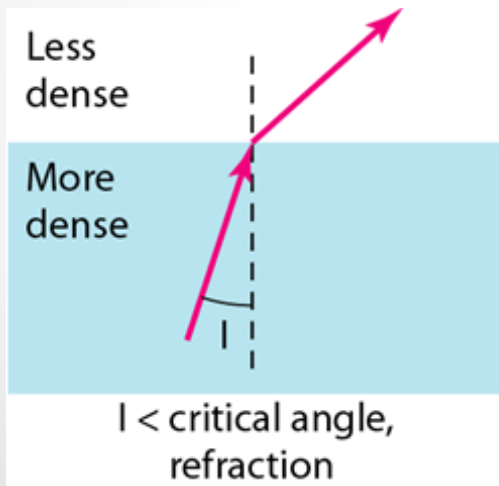
## Nature of light:

- Light travels in a straight line
- If light goes from one substance to another then the ray of light changes direction
- Ray of light changes direction when goes from more dense to a less dense substance



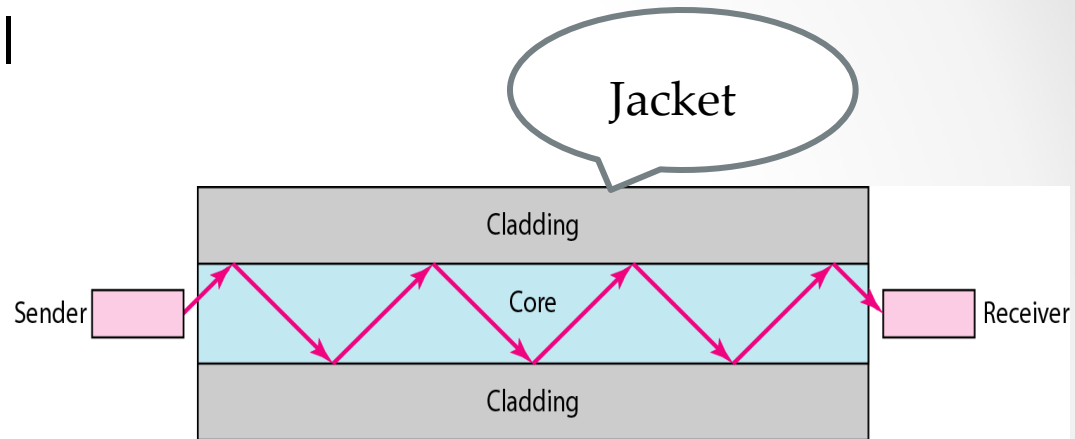
# Bending of light ray

- Angle of Incidence ( $i$ ): the angle the ray makes with the line perpendicular to the interface between the two substances
- Critical Angle: the angle of incidence which provides an angle of refraction of 90-degrees.



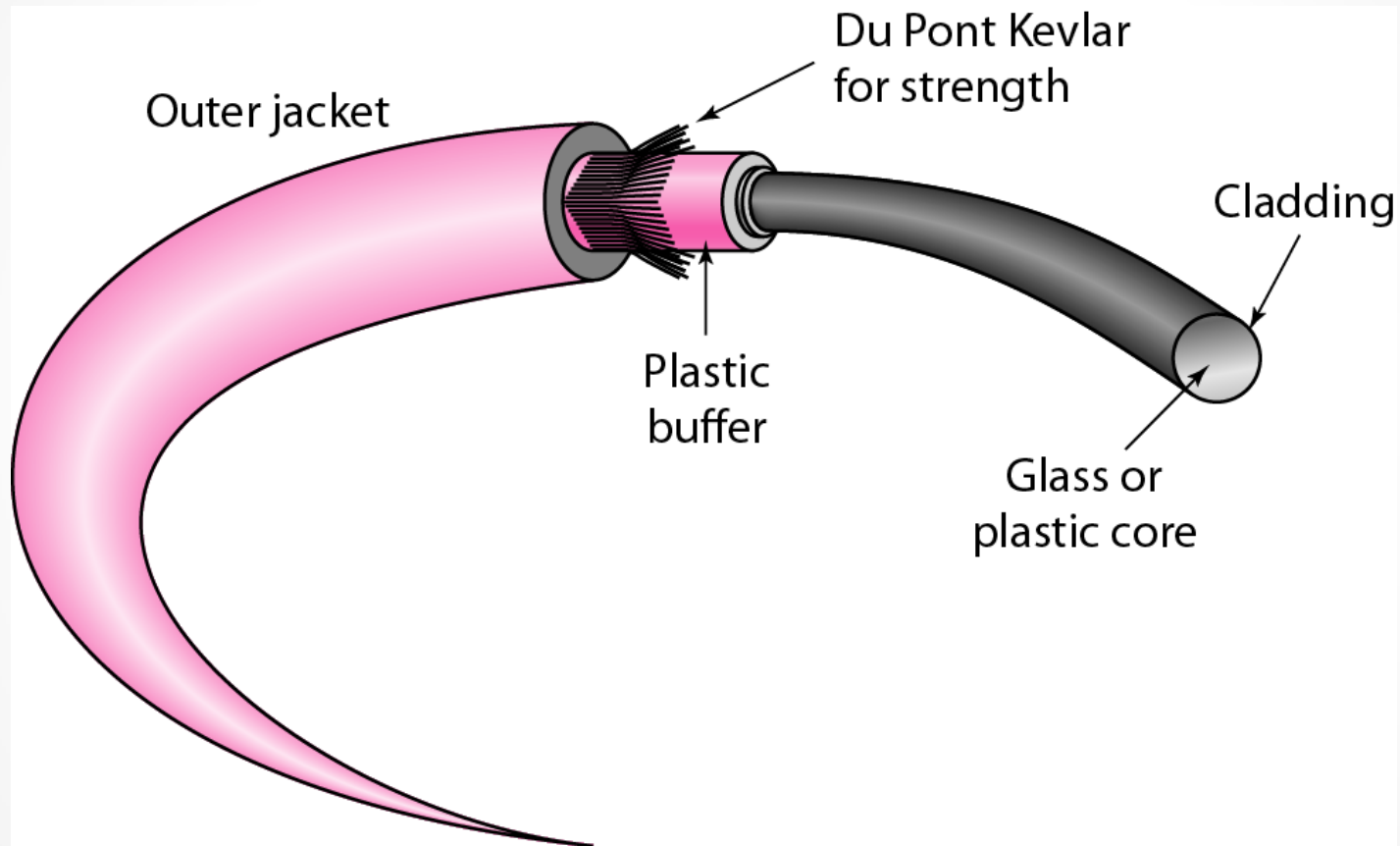
# Optical fiber

- Uses reflection to guide light through a channel
- Core is of glass or plastic surrounded by Cladding
- Cladding is of less dense glass or plastic

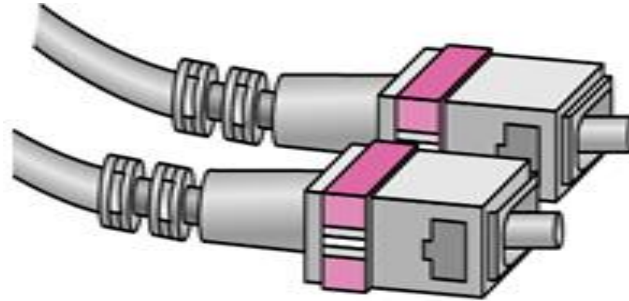


**An optical fiber cable has a cylindrical shape and consists of three concentric sections: the core, the cladding, and the jacket(outer part of the cable).**

# Fiber Construction

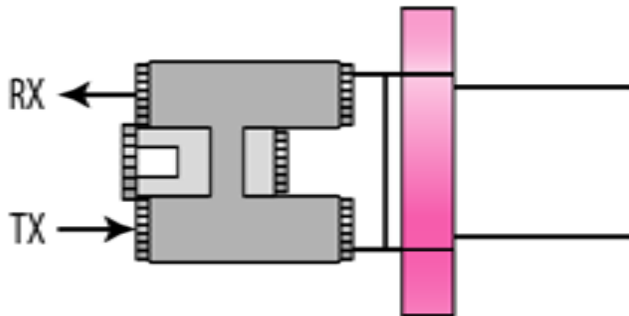


# Fiber – Optic cable Connectors



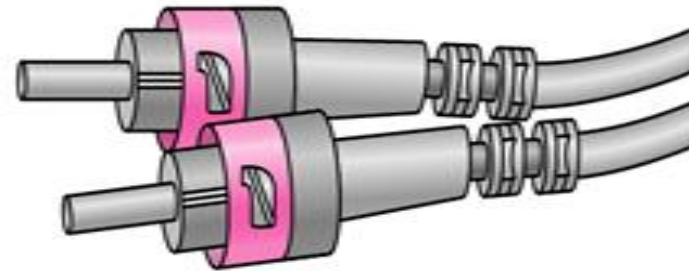
SC connector

Subscriber Channel (SC) Connector



MT-RJ connector

Same size as RJ45 connector



ST connector

Straight-Tip (ST) Connector



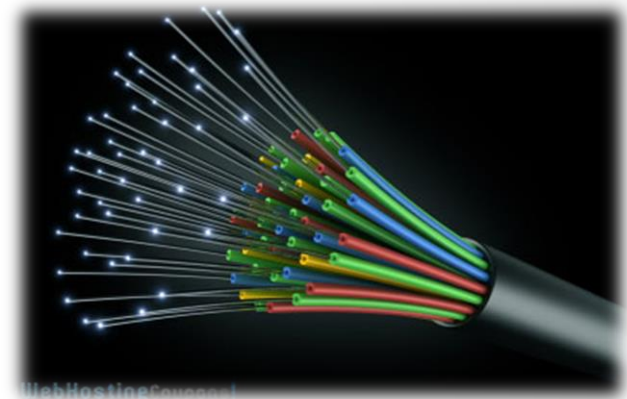
# Areas of Application

- Telecommunications
- Local Area Networks
- Cable TV
- CCTV
- Medical Education



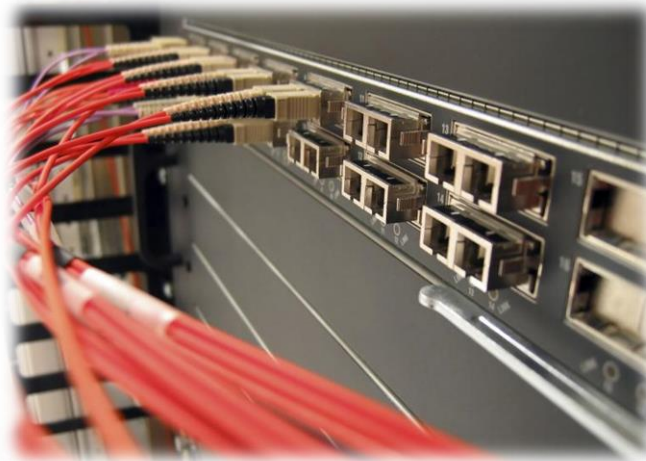
# Optical Fiber Advantages

- Greater capacity  
Example: Data rates at 100 Gbps
- Smaller size & light weight
- Lower attenuation
- Electromagnetic isolation
- More resistance to corrosive materials
- Greater repeater spacing facility  
Example: After every 10s of km at least



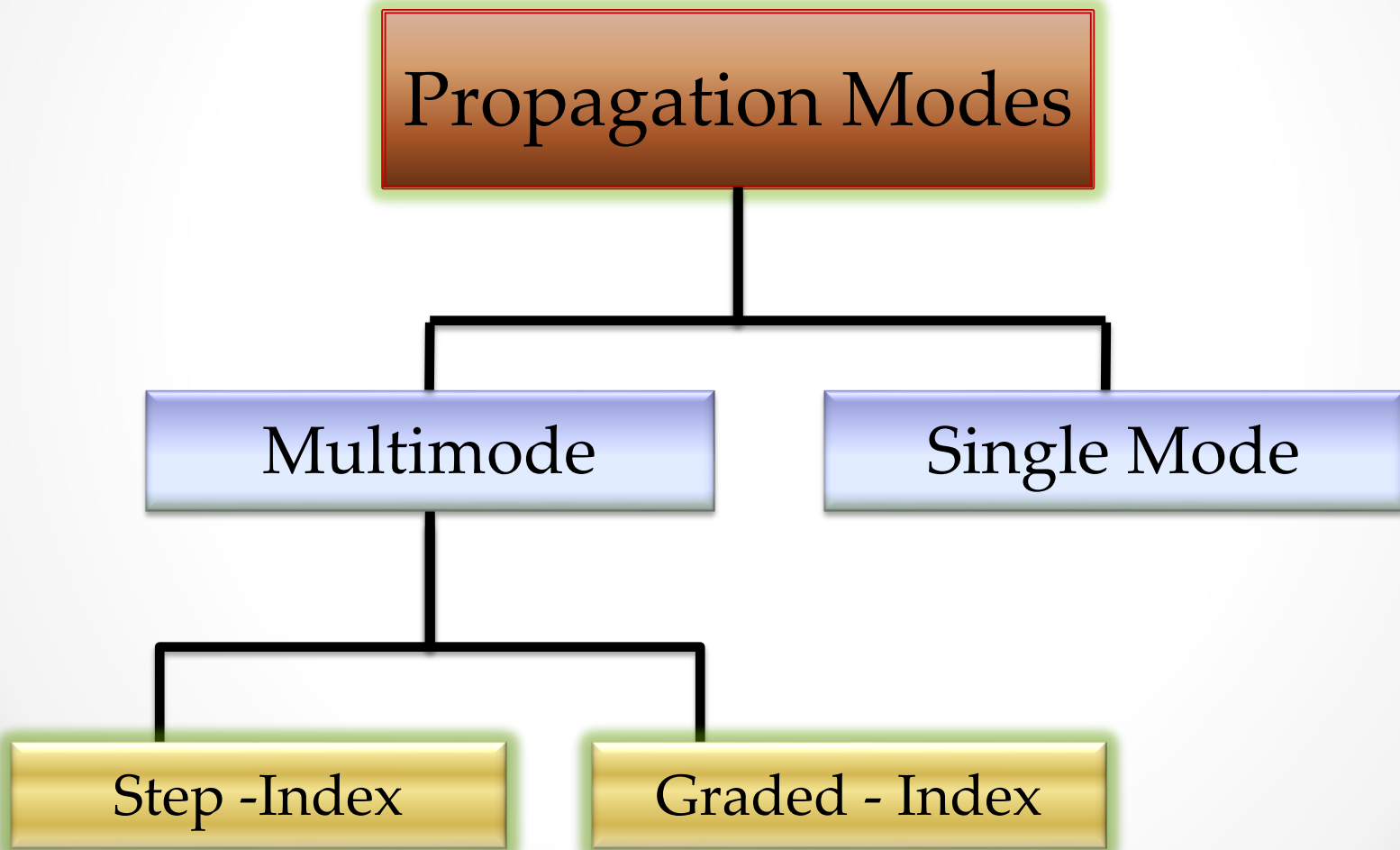
# Optical Fiber Disadvantages

- Installation and maintenance need expertise
- Only Unidirectional light propagation
- Much more expensive

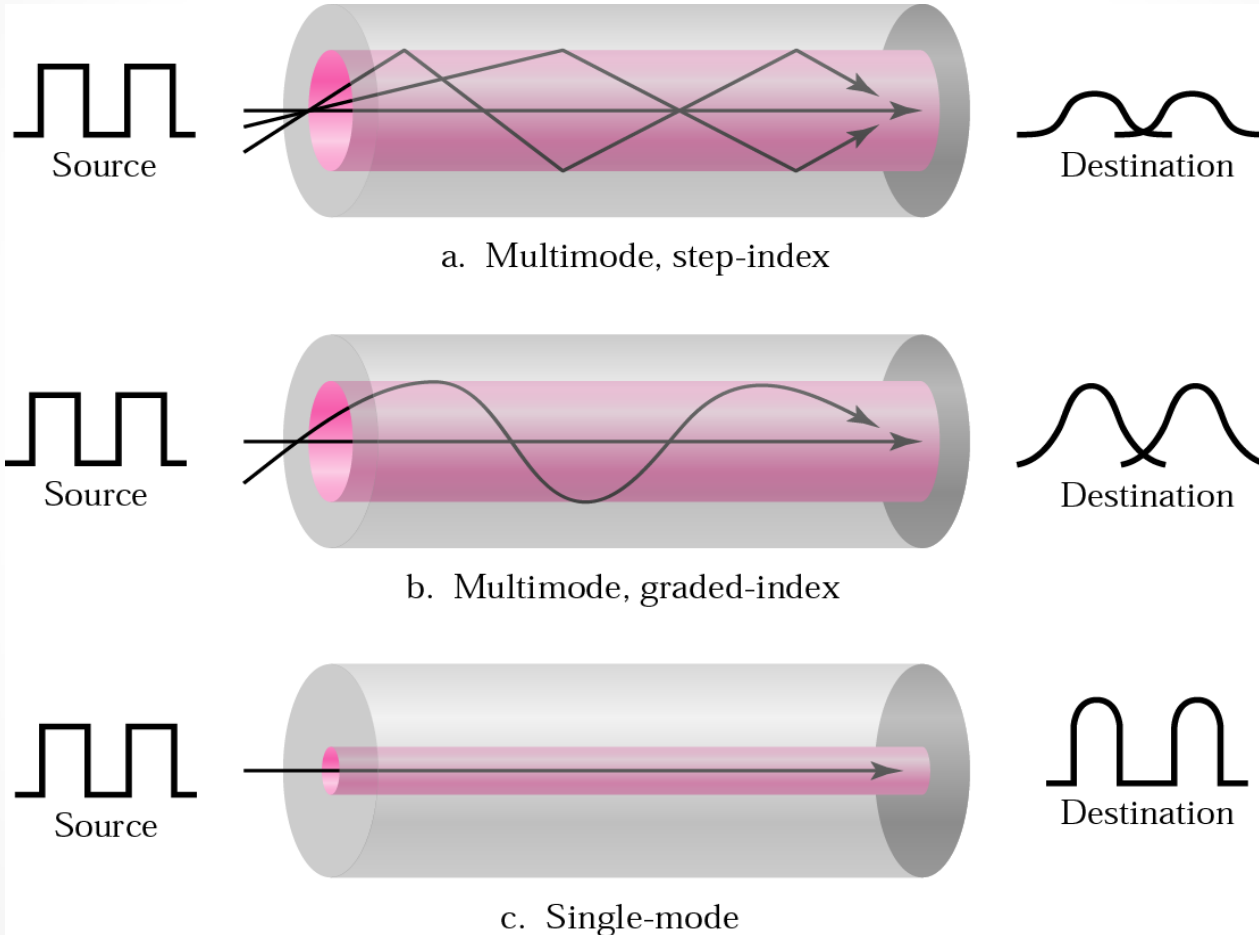


# Propagation Modes

When signal goes from one point to another there are need for propagation modes.

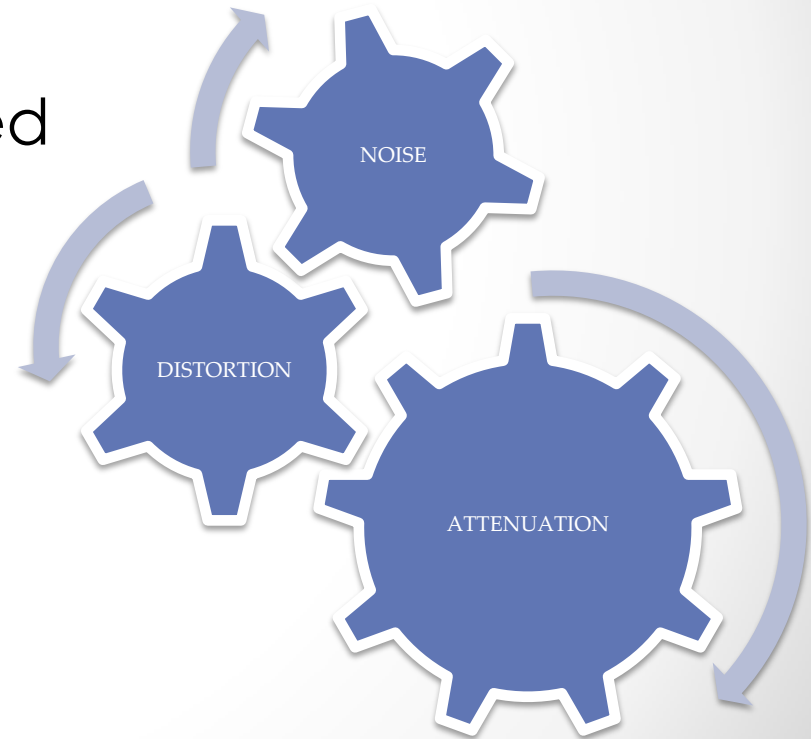


# Propagation Modes



# Transmission Impairment

- The Imperfection in transmission media causes signal impairment
- What is sent is not what is received due to impairment
- Three causes of impairment are
  - 1) Attenuation,
  - 2) Distortion
  - 3) Noise



# Transmission Impairment

- Attenuation means a loss of energy.
- Distortion means that the signal changes its form or shape.
- Noise is another cause of impairment.
- Several types of noise

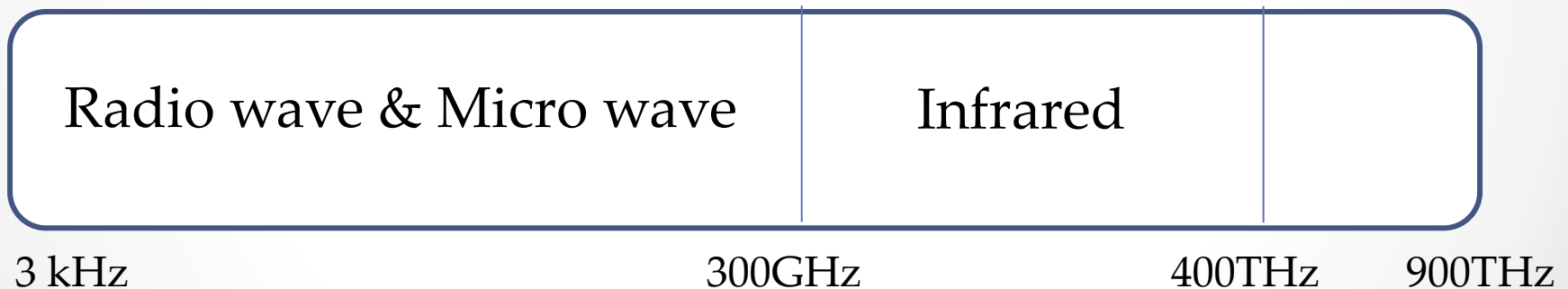
Example: thermal noise, induced noise, crosstalk

# Unguided Media: Wireless Transmission

Unguided media transport electromagnetic waves without using a physical conductor it is known as wireless communication.

Signals broadcast through free space and available to capable receiver

**Electro magnetic spectrum for wireless communication:**



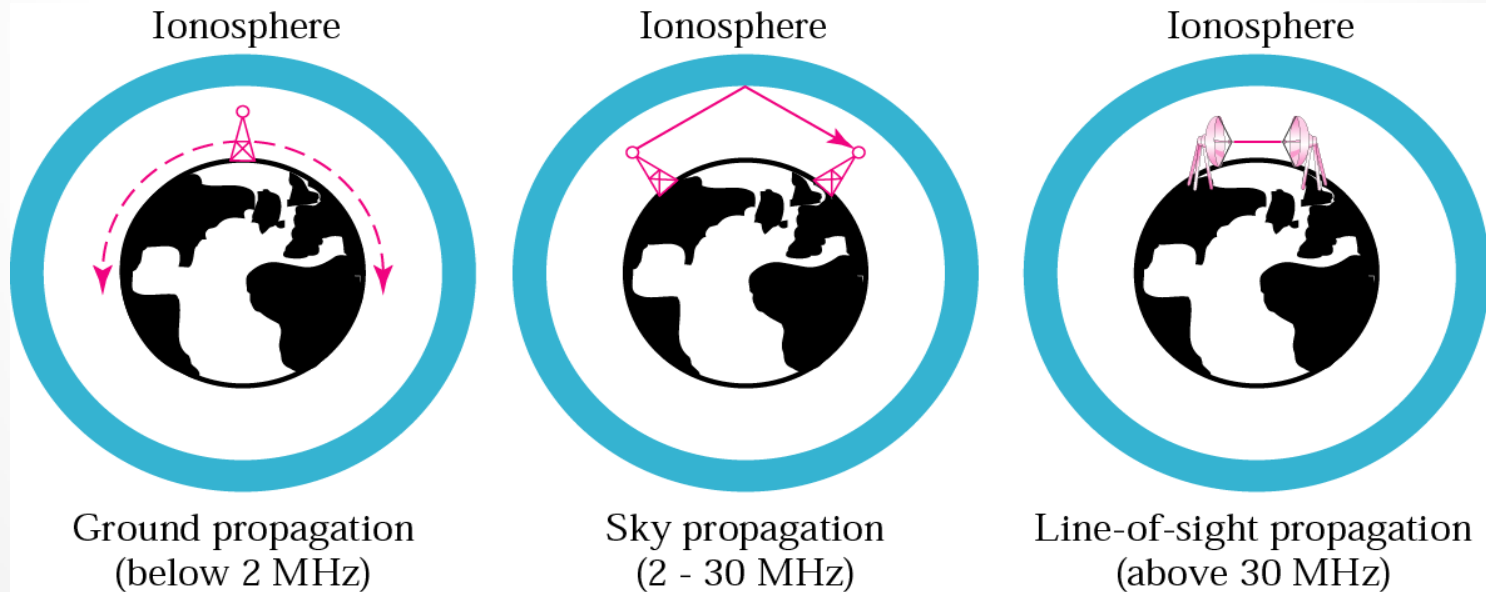


# Propagation methods

Unguided signals travel from the source to destination in several ways it is known as propagation.

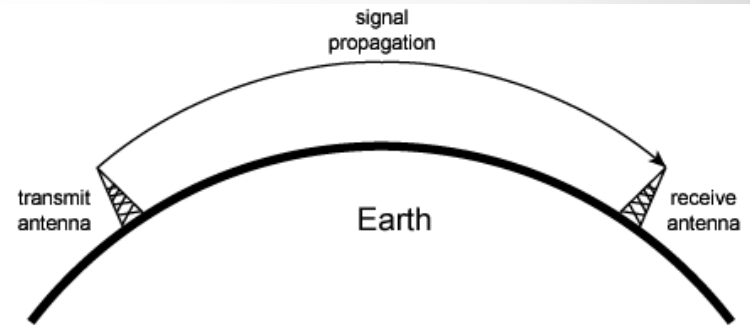
**They are three types:**

- Ground propagation
- Sky propagation
- Line-of-Sight Propagation



## Ground propagation:

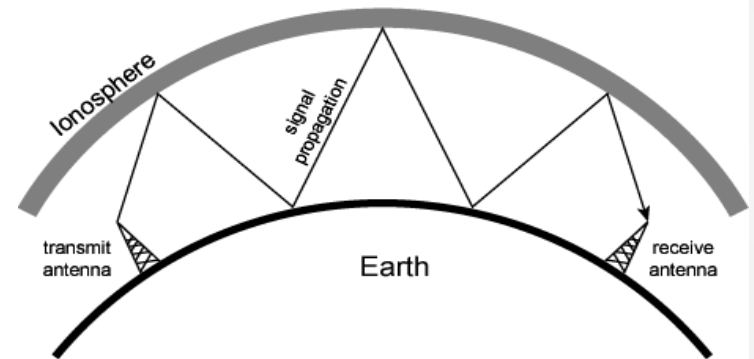
- Radio waves travel through the lowest portion of the atmosphere
- Touching the earth.



(a) Ground-wave propagation (below 2 MHz)

## Sky propagation:

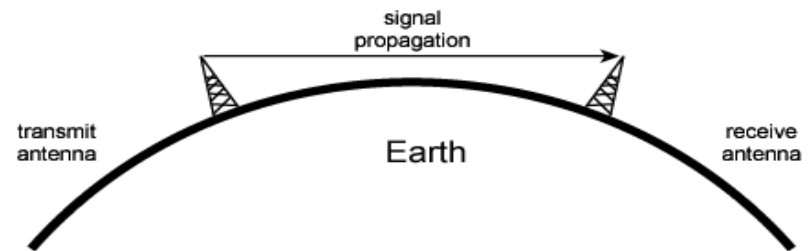
- Radio waves radiate to the ionosphere then they are reflected back to earth.



(b) Sky-wave propagation (2 to 30 MHz)

## Line-of-Sight Propagation:

- In straight lines directly from antenna to antenna.



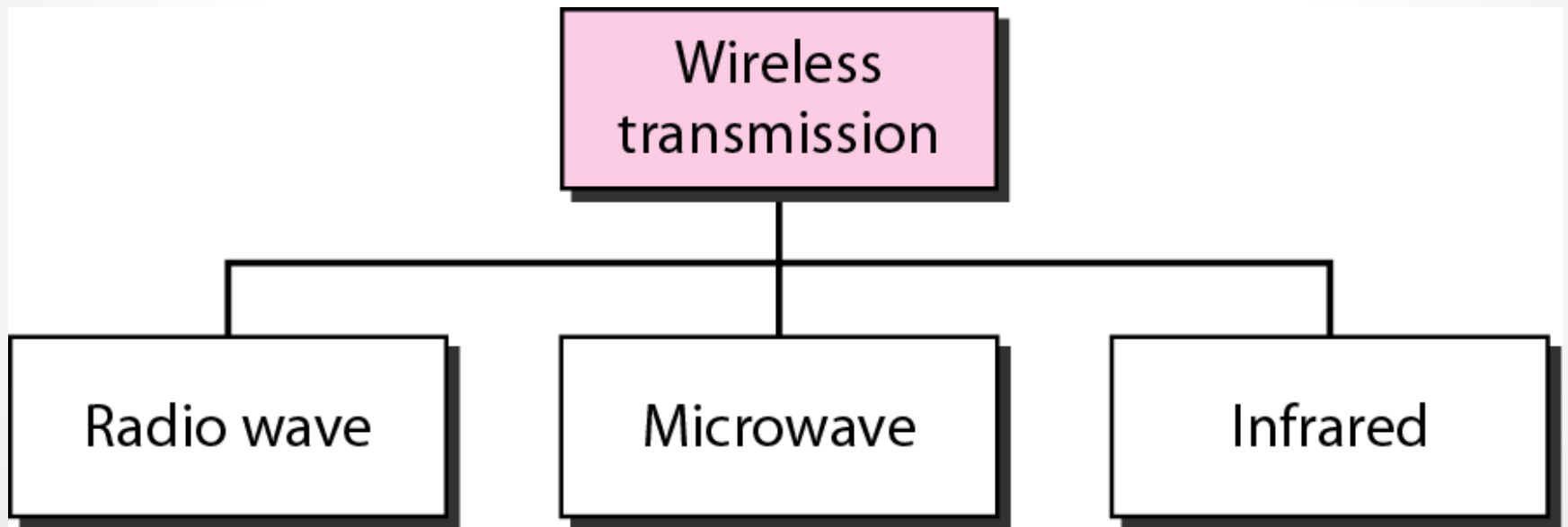
(c) Line-of-sight (LOS) propagation (above 30 MHz)

# Bands using propagation method

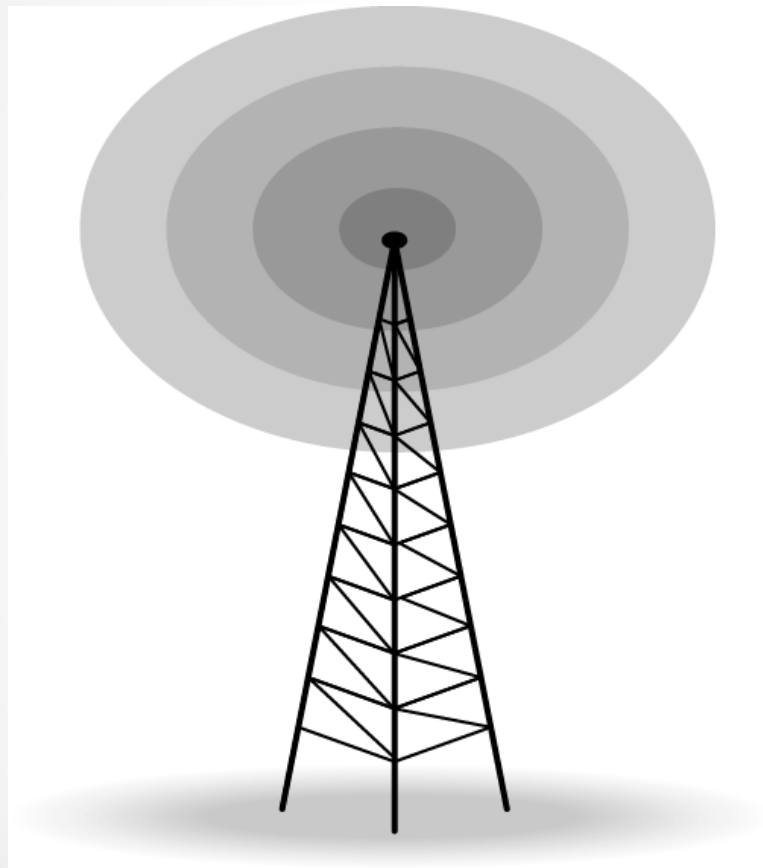
| Band | Range         | Propagation           | Application                                     |
|------|---------------|-----------------------|---|
| VLF  | 3–30 KHz      | Ground                | Long-range radio navigation                     |
| LF   | 30–300 KHz    | Ground                | Radio beacons and navigational locators         |
| MF   | 300 KHz–3 MHz | Sky                   | AM radio  |
| HF   | 3–30 MHz      | Sky                   | Citizens band (CB), ship/aircraft communication |
| VHF  | 30–300 MHz    | Sky and line-of-sight | VHF TV, FM radio                                |
| UHF  | 300 MHz–3 GHz | Line-of-sight         | UHF TV, cellular phones, paging, satellite      |
| SHF  | 3–30 GHz      | Line-of-sight         | Satellite communication                         |
| EHF  | 30–300 GHz    | Line-of-sight         | Long-range radio navigation                     |

# Unguided Media

Wireless transmission waves



# Unguided Media – Radio Waves



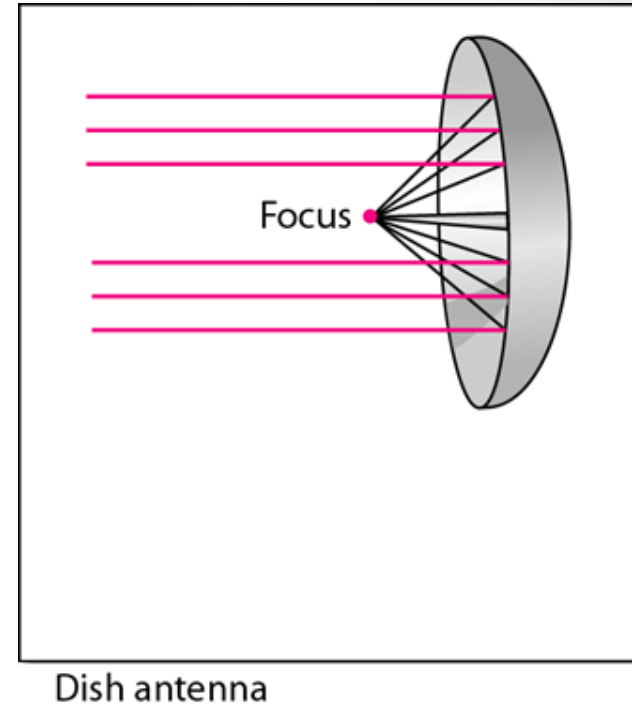
- Omnidirectional Antenna
- Frequencies between 3 KHz and 1 GHz.
- Used for multicasts(multiple way) communications, such as radio and television, and paging system.
- Radio waves can penetrate buildings easily, so that widely use for indoors & outdoors communication.

# Antennas

An Antenna is a structure that is generally a metallic object may be a wire or group of wires, used to convert high frequency current into electromagnetic waves.

Antenna are two types:

- **Transmission antenna**
  - Transmit radio frequency from transmitter
  - Radio frequency then  
Convert to electromagnetic energy by antenna
  - Then, radiate into surrounding environment
- **Reception antenna**
  - Electromagnetic energy get in antenna
  - Then Antenna convert radio frequency to electrical energy
  - Then, Goes to receiver



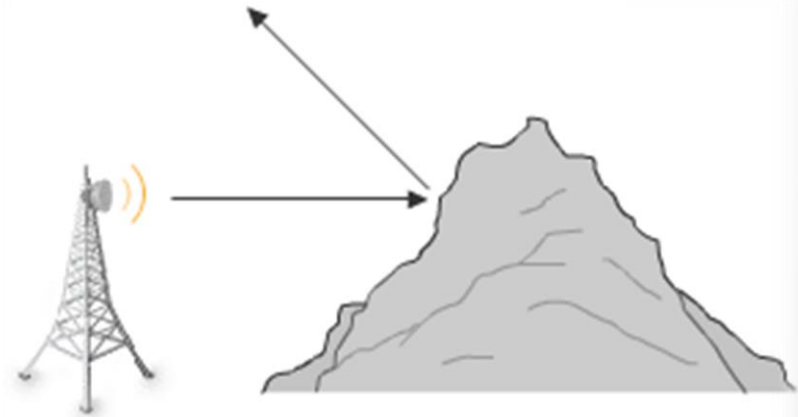
same antenna can be used for both purposes

# Microwaves

Microwaves are ideal when large areas need to be covered and there are no obstacles in the path



**Line of Sight Propagation**



**Ground Reflected Path**

# Micro waves Transmission

- Microwaves are unidirectional
- Micro waves electromagnetic waves having frequency between 1 GHZ and 300 GHZ.
- There are two types of micro waves data communication system : terrestrial and satellite
- Micro waves are widely used for one to one communication between sender and receiver, example: cellular phone, satellite networks and in wireless LANs(wifi), WiMAX, GPS



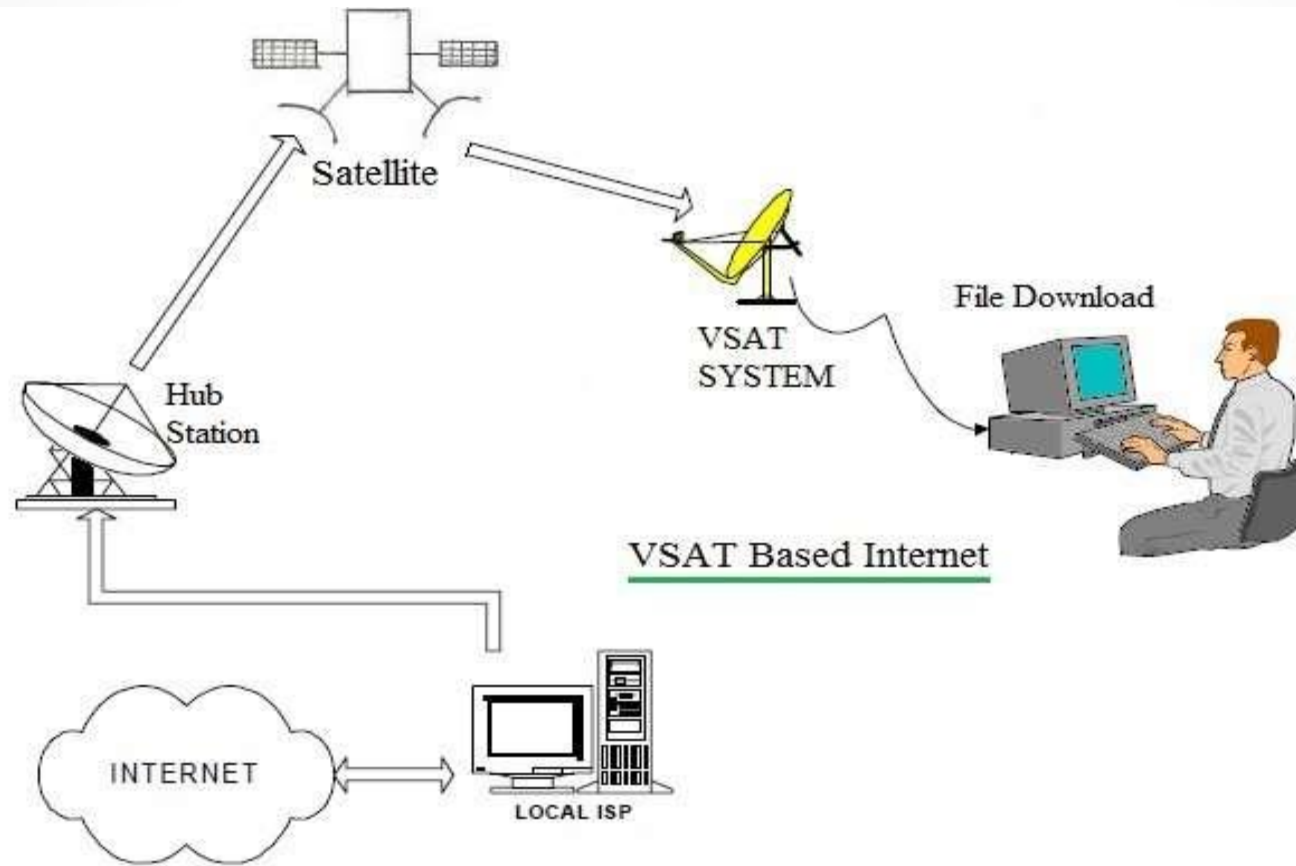


# Infrared

- Frequencies between 300 GHz to 400 THz.
- Used for short-range communication
- Example: Night Vision Camera, Remote control, File sharing between two phones, Communication between a PC and peripheral device,



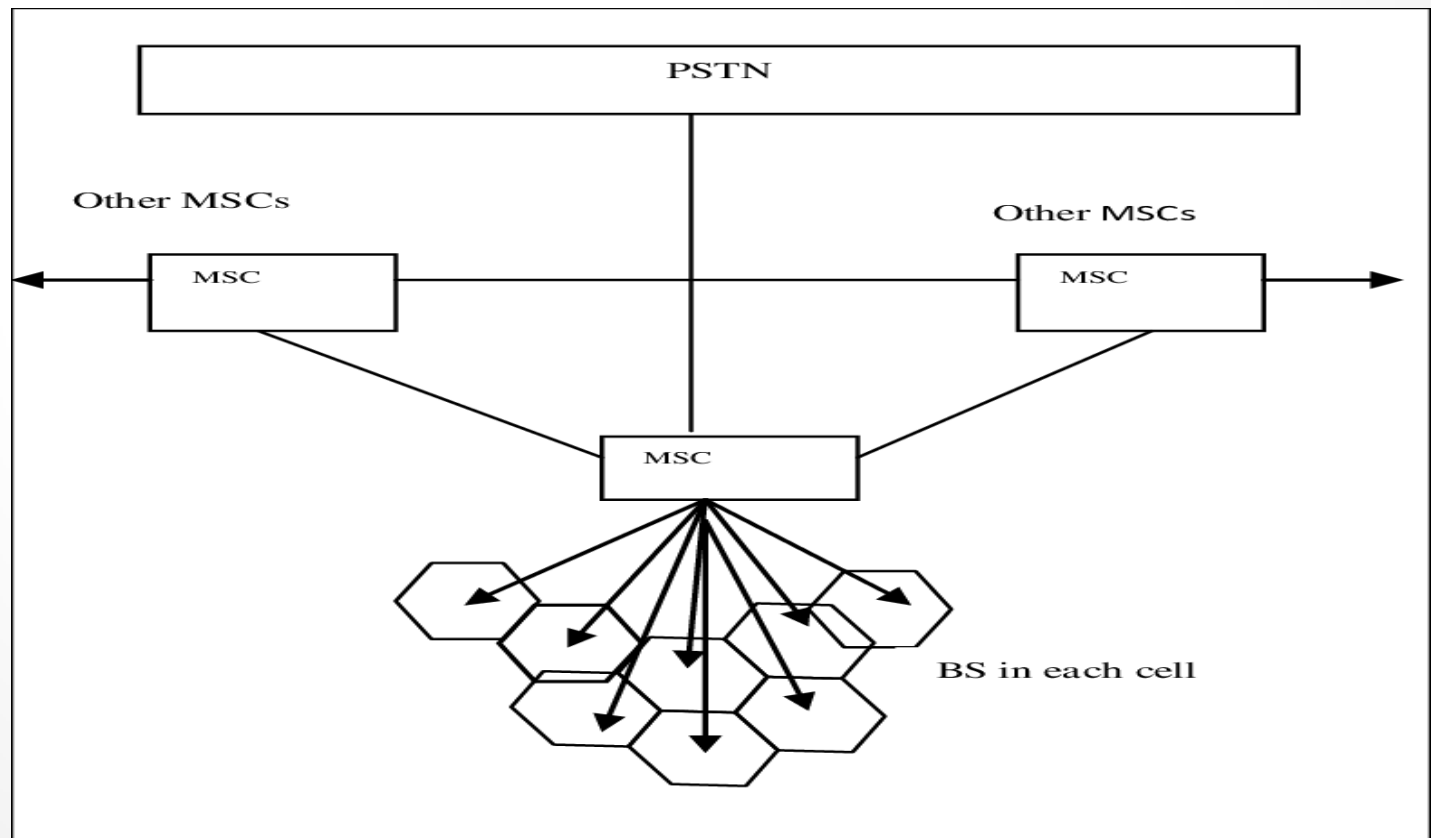
# VSAT(Very Small Aperture terminal)



- Fig

# Cellular Telephony

- To provide communication between two moving units called mobile stations (MSs), between one mobile unit and one stationary unit called land units.



- **Cell:** to make tracking possible divided into small cellular area.
- **Base station:** each cell contains an antenna and is controlled by a solar or AC powered network called as base station.
- **MSC(Mobile switching center):**It coordinates communication between all the base station and the telephone central office.

# Operation of cellular telephony

- Frequency reuse principle
- Transmitting
- Receiving
- Handoff

# References

- Data communication and Networking,  
fourth edition  
By : BEHROUZ A FOROUZAN
- And various relevant websites

Any Question ?



Thank You