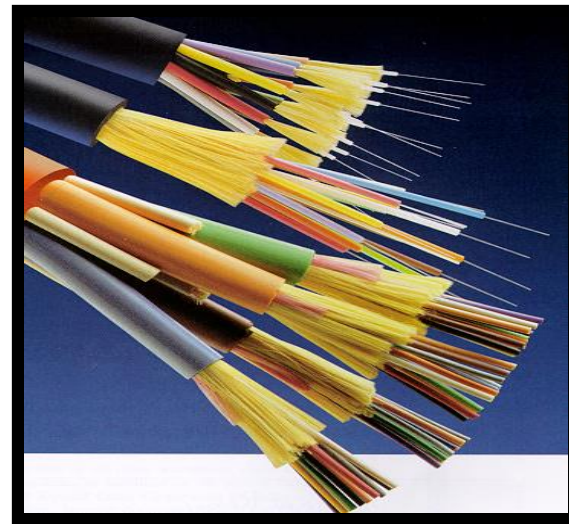
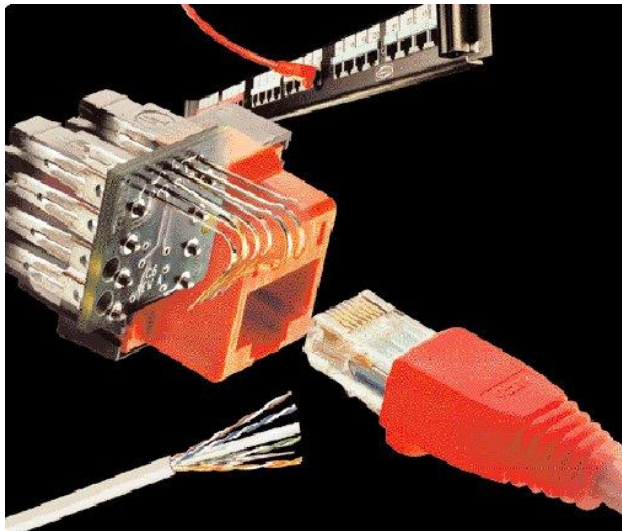
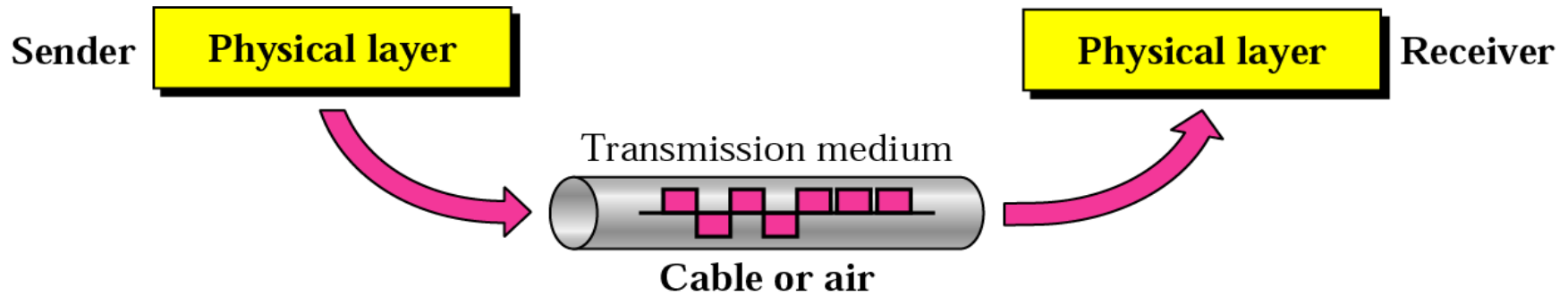


## PHYSICAL MEDIA



# Physical Media



# Physical Media

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## **Copper**

- ❑ Coaxial Cable - Thick or Thin
- ❑ Unshielded Twisted Pair - CAT 3,4,5,5e&6

## **Optical Fiber**

- ❑ Multimode
- ❑ Singlemode

## **Wireless**

- ❑ Short Range
- ❑ Medium Range (Line of Sight)
- ❑ Satellite

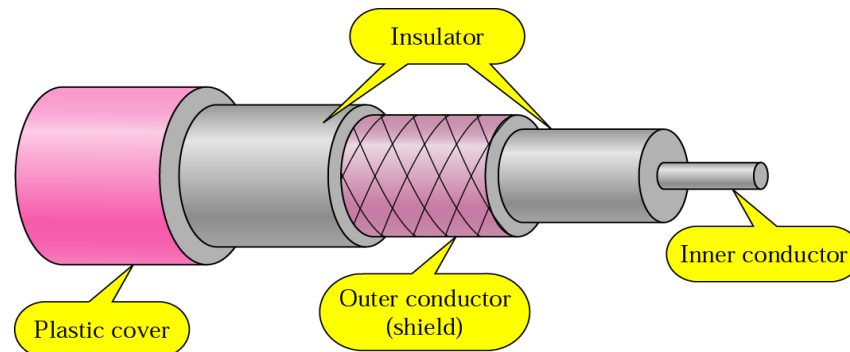
## Copper Media: Coaxial Cable

Coaxial cable is a copper-cored cable surrounded by a heavy shielding and is used to connect computers in a network.

Outer conductor shields the inner conductor from picking up stray signal from the air.

High bandwidth but lossy channel.

Repeater is used to regenerate the weakened signals.



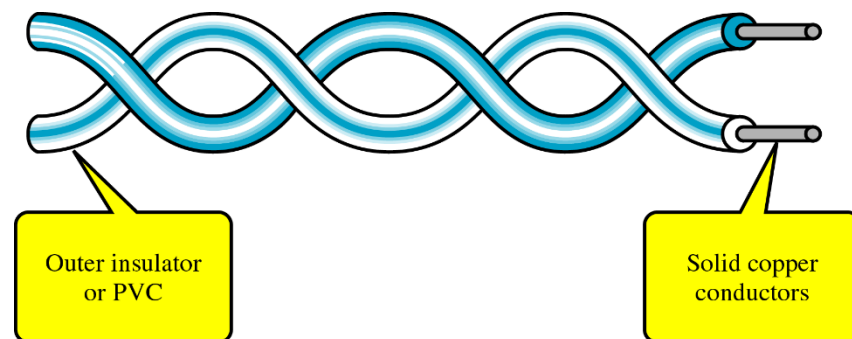
Category	Impedance	Use
RG-59	75 $\Omega$	Cable TV
RG-58	50 $\Omega$	Thin Ethernet
RG-11	50 $\Omega$	Thick Ethernet

# Copper Media: Twisted Pair

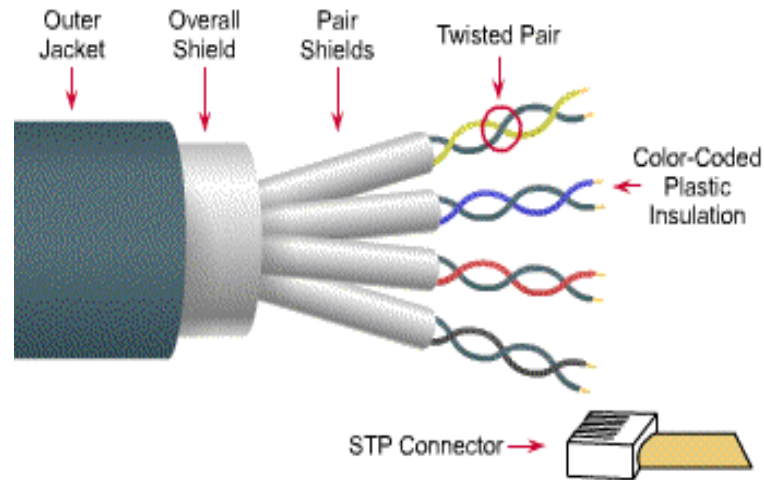
Twisted-pair is a type of cabling that is used for telephone communications and most modern Ethernet networks.

A pair of wires forms a circuit that can transmit data. The pairs are twisted to provide protection against crosstalk, the noise generated by adjacent pairs.

There are two basic types, shielded twisted-pair (STP) and unshielded twisted-pair (UTP).

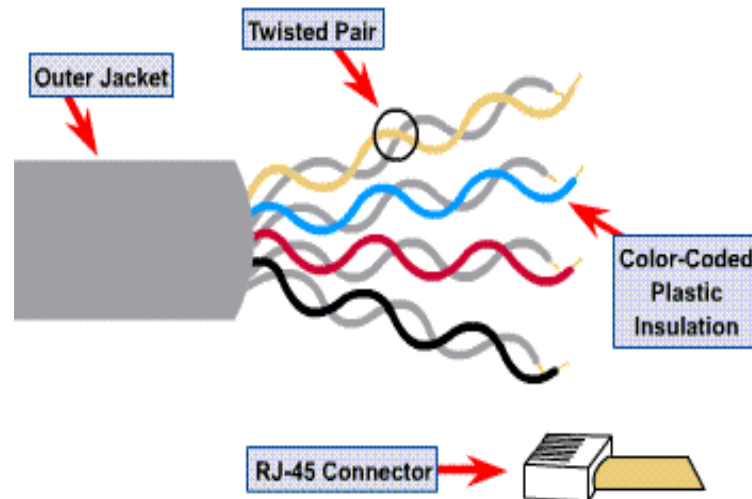


# Shielded Twisted Pair (STP)



- Speed and throughput: 10-100 Mbps
- Cost per node: Moderately expensive
- Media and connector size: Medium to Large
- Maximum cable length: 100m (short)

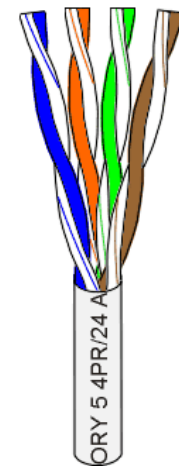
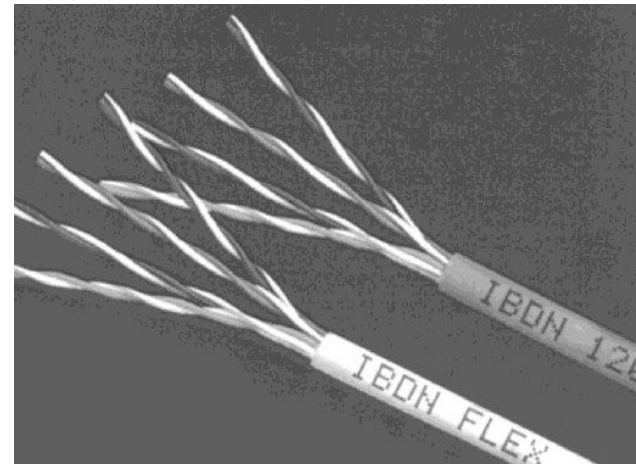
# Unshielded Twisted Pair (UTP)



- Speed and throughput: 10-100 Mbps
- Cost per node: Least Expensive
- Media and connector size: Small
- Maximum cable length: 100m (short)

# Unshielded Twisted Pair (UTP)




- Consists of 4 pairs (8 wires) of insulated copper wires typically about 1 mm thick.
- The wires are twisted together in a helical form.
- Twisting reduces the interference between pairs of wires.
- High bandwidth and High attenuation channel.
- Flexible and cheap cable.
- Category rating based on number of twists per inch and the material used
- CAT 3, CAT 4, CAT 5, Enhanced CAT 5 and now CAT 6.





## Categories of UTP

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-  UTP comes in several categories that are based on the number of twists in the wires, the diameter of the wires and the material used in the wires.
-  Category 3 is the wiring used primarily for telephone connections.
-  Category 5e and Category 6 are currently the most common Ethernet cables used.





## Categories of UTP: CAT 3

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- Bandwidth 16 Mhz
- 11.5 dB Attenuation
- 100 ohms Impedance
- Used in voice applications and 10baseT (10Mbps) Ethernet

## Categories of UTP: CAT 4

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-  **20 MHz Bandwidth**
-  **7.5 dB Attenuation**
-  **100 ohms Impedance**
-  **Used in 10baseT (10Mbps) Ethernet**






## Categories of UTP: CAT 5

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- 100 MHz Bandwidth
- 24.0 dB Attenuation
- 100 ohms Impedance
- Used for high-speed data transmission
- Used in 10BaseT (10 Mbps) Ethernet & Fast Ethernet (100 Mbps)

## Categories of UTP: CAT 5e

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-  150 MHz Bandwidth
-  24.0 dB Attenuation
-  100 ohms Impedance
-  Transmits high-speed data
-  Used in Fast Ethernet (100 Mbps), Gigabit Ethernet (1000 Mbps) & 155 Mbps ATM

## Categories of UTP: CAT 6

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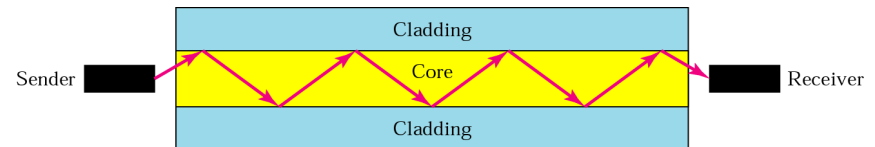
- 250 MHz Bandwidth
- 19.8 dB Attenuation
- 100 ohms Impedance
- Transmits high-speed data
- Used in Gigabit Ethernet (1000 Mbps) & 10 Gig Ethernet (10000 Mbps)

# Fiber Media

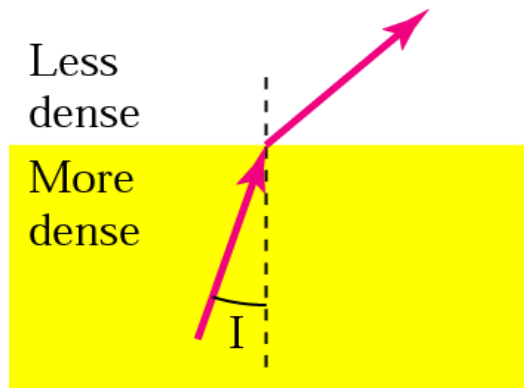
Optical fibers use light to send information through the optical medium.

It uses the principal of total internal reflection.

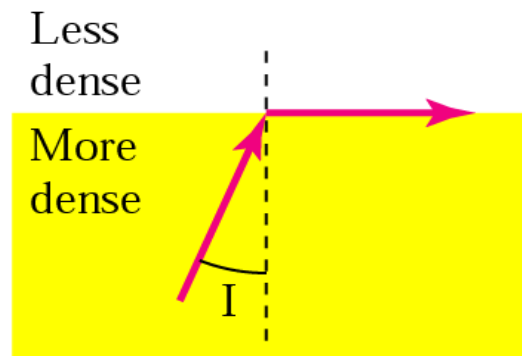
Modulated light transmissions are used to transmit the signal.



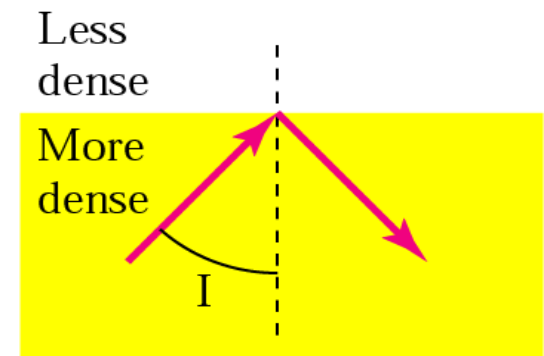
# Total Internal Reflection



$I < \text{critical angle,}$   
refraction



$I = \text{critical angle,}$   
refraction



$I > \text{critical angle,}$   
reflection



## Fiber Media

- Light travels through the optical media by the way of total internal reflection.
- Modulation scheme used is intensity modulation.
- Two types of Fiber media :
  - Multimode
  - Singlemode
- Multimode Fiber can support less bandwidth than Singlemode Fiber.
- Singlemode Fiber has a very small core and carry only one beam of light. It can support Gbps data rates over > 100 Km without using repeaters.

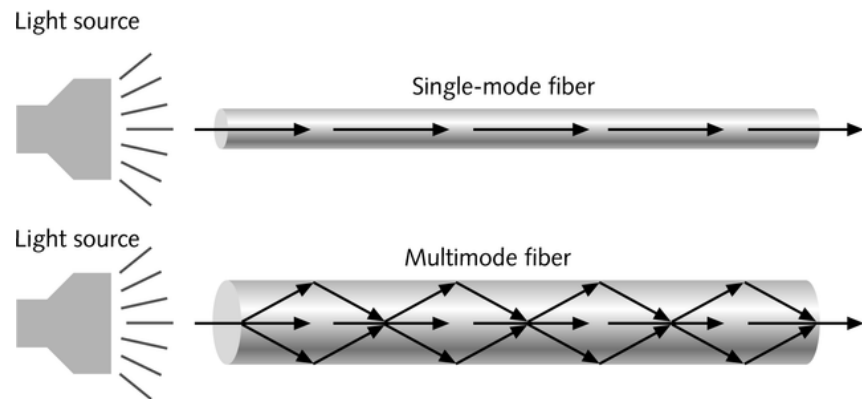
# Single and Multimode Fiber

## Single-mode fiber







- Carries light pulses along single path
- Uses Laser Light Source

## Multimode fiber

- Many pulses of light generated by LED travel at different angles

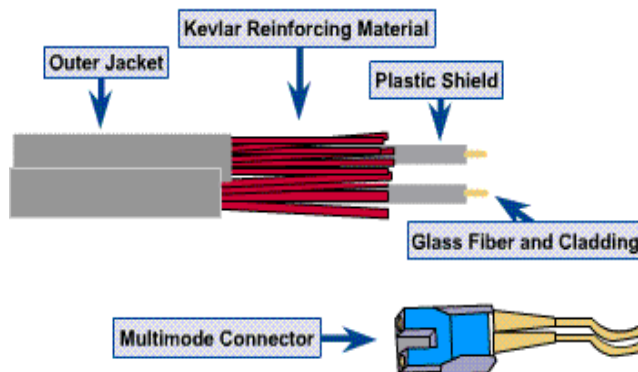
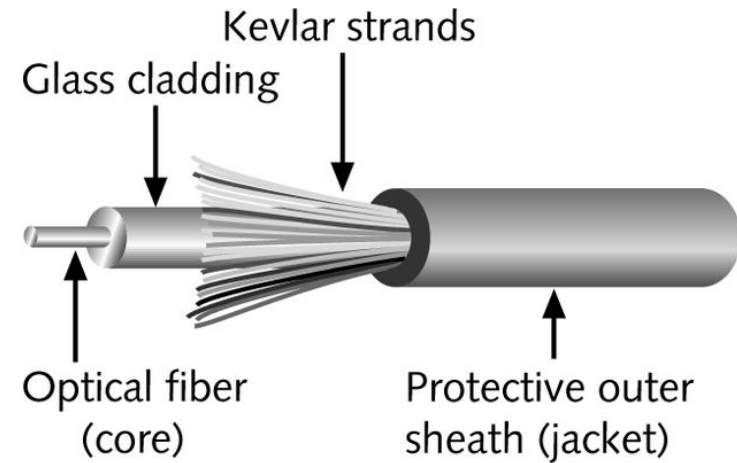


## Fiber Media

-  The bandwidth of the fiber is limited due to the dispersion effect.
-  Distance Bandwidth product of a fiber is almost a constant.
-  Fiber optic cables consist of multiple fibers packed inside protective covering.
-  62.5/125  $\mu\text{m}$  (850/1310 nm) multimode fiber
-  50/125  $\mu\text{m}$  (850/1310 nm) multimode fiber
-  10  $\mu\text{m}$  (1310 nm) single-mode fiber

## Fiber-Optic Cable

- Contains one or several glass fibers at its core
- Surrounding the fibers is a layer called cladding

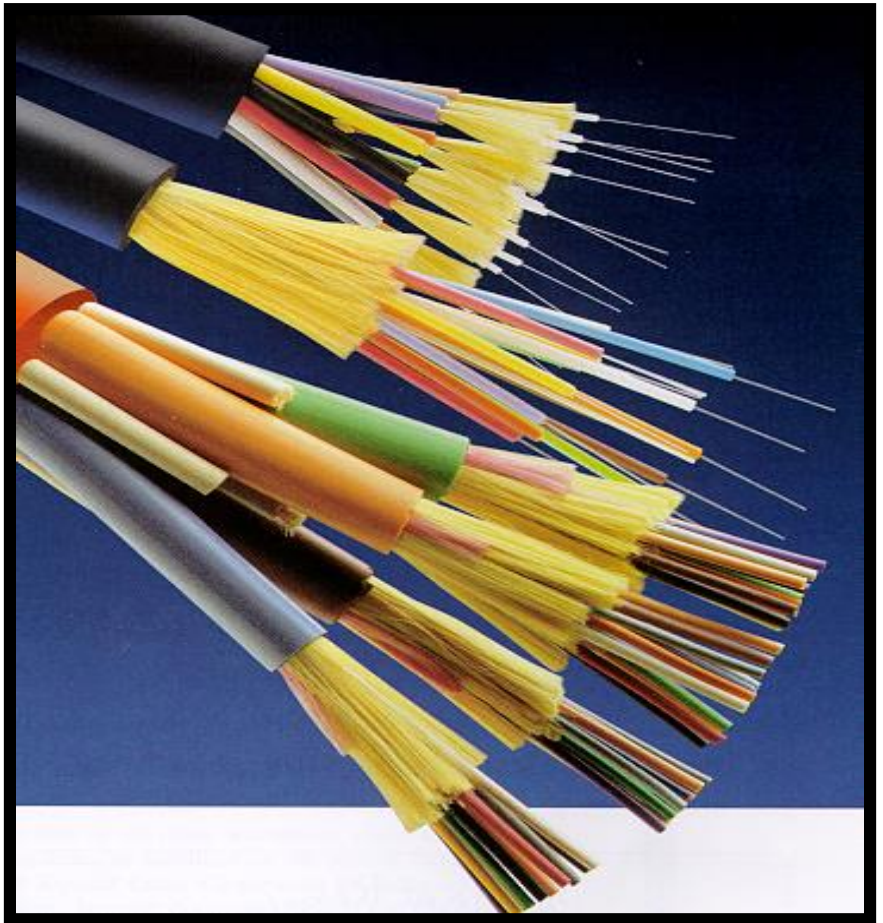


- Speed and throughput: 100+ Mbps
- Cost per node: Most Expensive
- Media and connector size: Small
- Single mode, maximum cable length: Up to 3000m
- Multimode mode, maximum cable length: Up to 2000m
- Single mode: One stream of laser-generated light
- Multimode: Multiple streams of LED-generated light

# Fiber Optic Cable

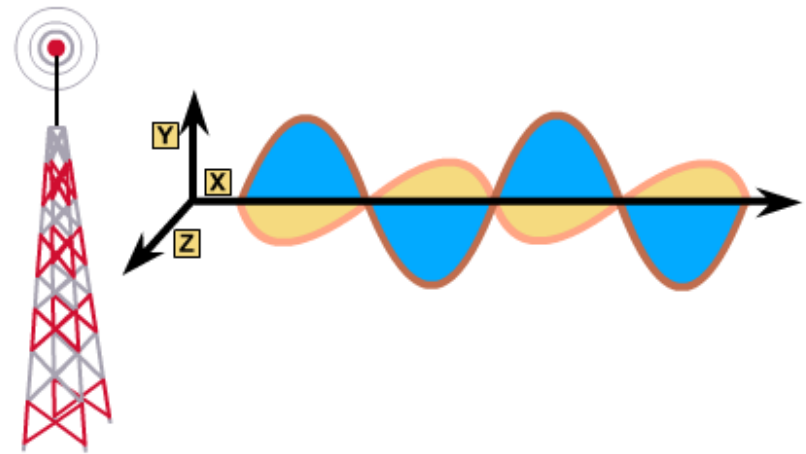


FO Cable may have 1 to over 1000 fibers



# Wireless Media

- Very useful in difficult terrain where cable laying is not possible.
- Provides mobility to communication nodes.
- Right of way and cable laying costs can be reduced.
- Susceptible to rain, atmospheric variations and Objects in transmission path.



## Wireless Media

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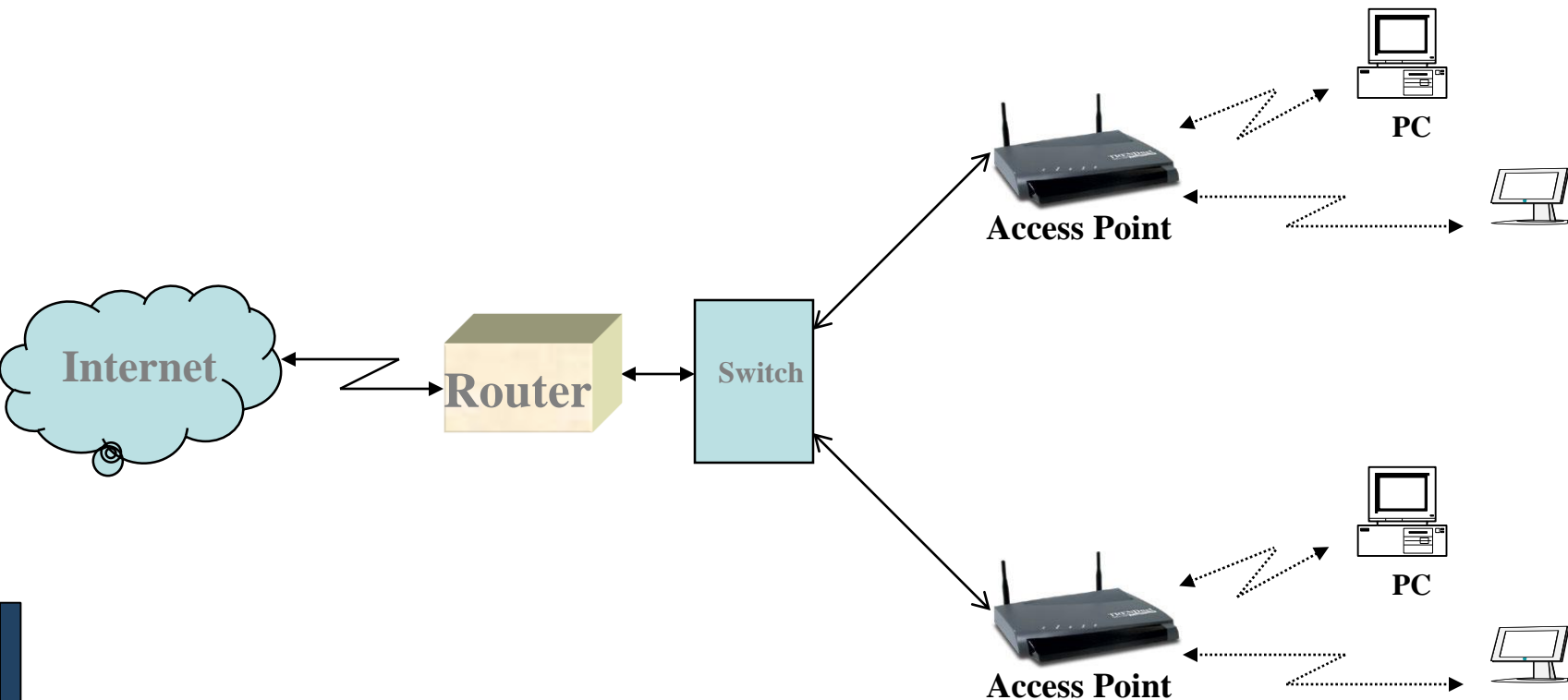
- ❏ Indoor : 10 – 50m : Bluetooth, WLAN
- ❏ Short range Outdoor : 50 – 200m: WLAN
- ❏ Mid Range Outdoor : 200m – 5 Km : GSM, CDMA, WLAN Point-to-Point, Wi-Max
- ❏ Long Range Outdoor : 5 Km – 100 Km : Microwave Point-to-Point
- ❏ Long Distance Communication : Across Continents : Satellite Communication

# Frequency Bands

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



# Wireless LAN



# Terrestrial Microwave

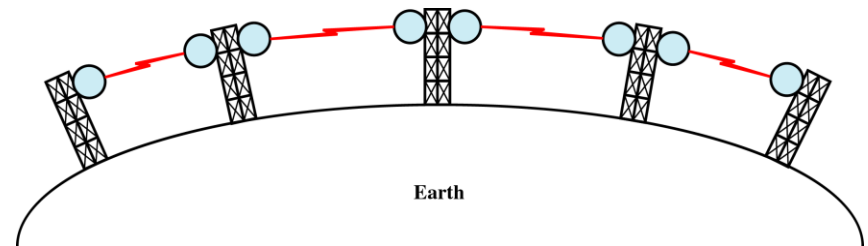
- ❑ Microwaves do not follow the curvature of earth

- ❑ Line-of-Sight transmission

- ❑ Height allows the signal to travel farther

- ❑ Two frequencies for two way communication

- ❑ Repeater is used to increase the distance Hop-by-Hop



# Satellite Communication

