

## Chapter 3: Transmission Media

Marks- 20

## Transmission Media

- ◆ **Transmission media** carries the information from sender to receiver.
- ◆ Different **types of cables or waves to transmit data.**
- ◆ Data is transmitted through **electrical or electromagnetic signals.**
  - An **electrical signal** is in the form of **current.**
  - An **electromagnetic signal** is series of electromagnetic energy pulses at various frequencies.
- ◆ These signals can be transmitted through **copper wires, optical fibers, atmosphere, water and vacuum.**
- ◆ It is also called **Communication channel.**

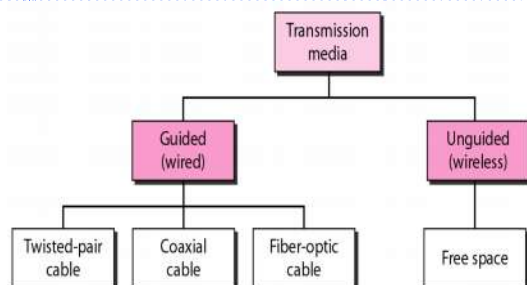
## Criteria for selection of media

- ◆ **Type of Media (Wired or Wireless).**
- ◆ **Flexibility-** In order to expand network.
- ◆ **Bandwidth-**
  - **Data carrying capacity** of a channel or medium.
  - **Higher bandwidth** communication channels support **higher data rates.**
- ◆ **Reliability.**
  - The consistency of transmission media (effect of weather conditions).
- ◆ **Radiation.**
  - It refers to the **leakage of signal.**

## Criteria for selection of media

- ◆ **Noise Absorption.**
  - **Exposure of the media to external electrical noise** that **can cause distortion of data signal.**
- ◆ **Attenuation.**
  - It refers to loss of energy as signal propagates outwards.
- ◆ **Number of receivers-**
  - The number of users to be connected.
- ◆ **Transmission Rate.**
- ◆ **Cost and Ease of Installation.**
- ◆ **Distances,** etc.

## Types of Transmission Media



## Types of Transmission Media

- ◆ **Wired or guided media**
  - use a **conductor such as a wire or a fiber optic cable** to move the signal from sender to receiver.
- ◆ **Wireless or unguided media**
  - use **radio waves of different frequencies** and do not need a wire or cable conductor to transmit signals.

## Guided Transmission Media

- ◆ Transmission capacity depends on
  - The **distance** and
  - On whether the medium is **point-to-point or multipoint**.
- ◆ Examples
  - **Twisted Pair Wires**
  - **Coaxial Cables**
  - **Optical Fiber**

## Selection of Guided Media

- ◆ Cost
- ◆ Connectivity
- ◆ Bandwidth
- ◆ Performance in presence of noise
- ◆ Geographical coverage.

## Twisted Pair Wires

- ◆ Consists of **two insulated copper wires** arranged in a regular **spiral pattern**.
- ◆ To **minimize the electromagnetic interference (EMI)** between adjacent pairs.
- ◆ Often used to **carry voice as well as data communications**
- ◆ Low frequency transmission medium.



## Advantages and Disadvantages

- It is the most commonly used medium of **telephone network**.
- Much **less expensive** than the other guided media.
- **Easy to work** with (install and debug)
- **Low data rate**; comparing with other guided transmission medium.
- Short range.

## Types of Twisted Pair

- ◆ **UTP (Unshielded Twisted Pair)**
  - Each wire is insulated with **plastic wrap**, but the pair is encased in an outer covering.
- ◆ **STP (Shielded Twisted Pair)**
  - the pair is wrapped with metallic foil or braid to insulate the pair from electromagnetic interference

## UTP- Unshielded Twisted Pair

- ◆ Usually consists of two copper wires wrapped in individual plastic insulation.



- ◆ The frequency range of the twisted pair cables enable **both voice and data transmission** hence used for telephone.

### UTP- Unshielded Twisted Pair

- ◆ 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.



### Categories of UTPs

- ◆ **Category 1:-** used only for **voice communication** and supports low data rates.
- ◆ **Category 2:-** Suitable for Voice and Data, speed **4 mbps**
- ◆ **Category 3:-** It is suitable for **Computer network**.
  - Support data rate of up to **16mbps**.
- ◆ **Category 4:-** It offers data rate up to **20mbps**.
- ◆ **Category 5:-** It offers data rate of **100mbps**. Can be used for fast **Ethernet**. It requires more insulation and more twist per foot.

### Advantages

- Installation is easy
- Flexible and light weight
- Cheap
- It has high speed capacity,
- Higher grades of UTP are used in LAN technologies like Ethernet.

### Disadvantages

- ◆ Bandwidth is low.
- ◆ Suffers from external electromagnetic interference
- ◆ Attenuation problem
  - For analog, repeaters needed every 5-6km
  - For digital, repeaters needed every 2-3km

### STP- Shielded Twisted Pair

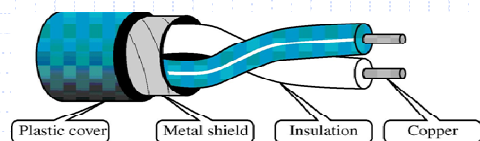
- ◆ The only difference between STP and UTP is that STP cables have a **shielding of aluminum or polyester material between the outer jacket and wire**.



- ◆ The shield makes STP less vulnerable to EMI because the shield is electrically grounded

### STP- Shielded Twisted Pair

- ◆ An alternative to UTP
- ◆ The metal mesh around the insulated wires eliminates **crosstalk**.
- ◆ **Crosstalk** occurs when one line picks up some of the other signals traveling down another line.



- ◆ STP shares the same standards as UTP.

### Advantages

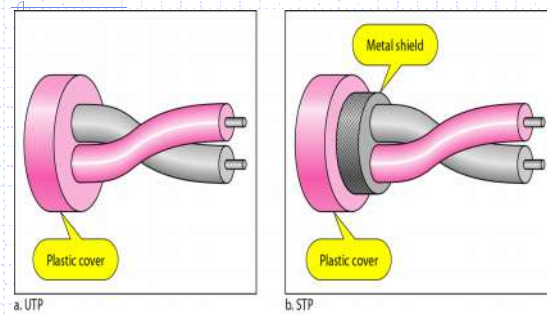
- ◆ Easy to install
- ◆ Performance is adequate
- ◆ Can be used for Analog or Digital transmission
- ◆ Increases the signaling rate
- ◆ Higher capacity than unshielded twisted pair
- ◆ Eliminates crosstalk

### Disadvantages

- ◆ Difficult to manufacture
- ◆ Heavy
- ◆ Expensive than UTP.

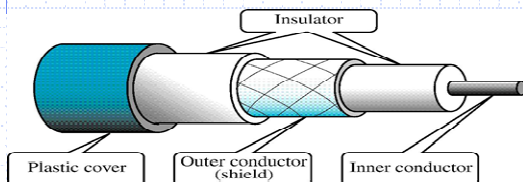
### Difference UTP vs STP

Factors	UTP	STP
Bandwidth	<b>1-155Mbps</b>	<b>1-155Mbps</b>
Node capacity per segment	<b>2</b>	<b>2</b>
Attenuation	<b>High</b>	<b>Low</b>
EMI	<b>Very High</b>	<b>High</b>
Installation	<b>Easy</b>	<b>Fairly Easy</b>
Cost	<b>Low</b>	<b>Moderate</b>



### Coaxial Cable (or Co-ax)

- ◆ Has an inner conductor surrounded by a braided mesh.
- ◆ Both conductors share a common center axial, hence the term "co-axial"



### Coax

- Coax cables operate at **higher frequency range**.
- Due to the construction it is **more noise resistant** and is **very durable and reliable**.
- Able to transfer more information than standard telephone cables.
  - Can **carry 10,000 voice calls** simultaneously
- Was primarily used to connect **cable television**.
- Now, coaxial cables are used as backbones of bus topologies.

## Coax Advantages

- ◆ Bandwidth is high
- ◆ Used in long distance telephone lines.
- ◆ Transmits digital signals at a very high rate of 10-100Mbps.
- ◆ Much higher noise immunity.
- ◆ Data transmission without distortion.
- ◆ Minimum attenuation.

## Coax Disadvantages

- ◆ Single cable failure can fail the entire network.
- ◆ Difficult to install.
- ◆ **Expensive** when compared with twisted pair.
- ◆ If the shield is imperfect, it can lead to grounded loop.
- ◆ **Bulky**

Table 8-1 Comparison of physical media

Media	Throughput Potential	Cost of Installation and Maintenance	Security	Scalability	Noise Immunity
Coaxial cable	Up to 10 Mbps	More expensive than twisted-pair cable, but less expensive than fiber	Fair security	In most cases, can extend longer than twisted-pair, but not as long as fiber optic cable before requiring repeaters (depending on transmission method used)	More noise-resistant than twisted-pair, but less noise-resistant than fiber
Shielded twisted-pair (STP)	Up to 1 Gbps, though typically used for up to 100 Mbps	Less expensive than coaxial cable or fiber, but more expensive than UTP	Fair security (not as good as coaxial cable, but better than twisted-pair)	Can extend farther than unshielded twisted-pair networks, but not as far as fiber optic networks	More noise-resistant than UTP, but less noise-resistant than coaxial cable or fiber

## Fiber Optic Cable

- ◆ Relatively new transmission medium used by telephone companies in place of long-distance trunk lines
- ◆ Also used by private companies in implementing local data communications networks
- ◆ Require a light source with injection laser diode (ILD) or light-emitting diodes (LED)

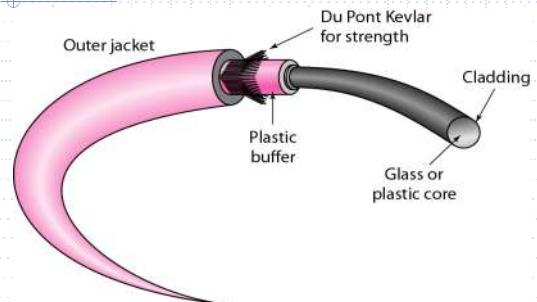
## Fiber Optical Cable

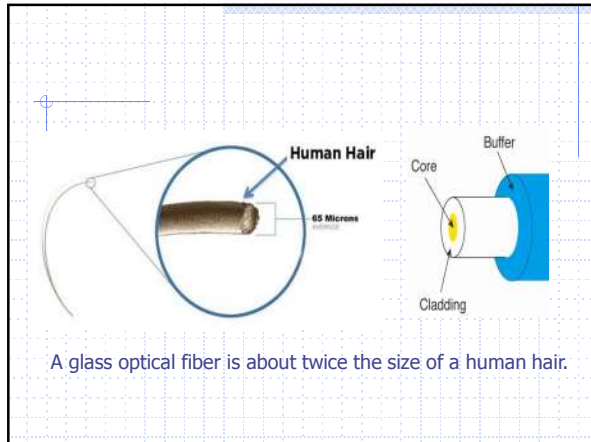
- ◆ Transmitting communications signals over **hair thin strands of glass or plastic.**

Fiber is the **least expensive, most reliable** method for **high speed** and **long distance** communications



## Close look to Fiber Optics





### Fiber Optic Layers

- ◆ consists of three concentric sections

- ◆ The **core** is the innermost section and consists of **one or more very thin strands, or fibers**.
- ◆ The core diameter is in the range of **8 to 50 μm**.

### Fiber Optics cable

- ◆ Each fiber is surrounded by **cladding**, a **glass or plastic coating** a diameter of **125 μm**.
- ◆ The cladding acts as a **reflector to light** that would otherwise escape the core.
- ◆ The outermost layer, surrounding one or a bundle of cladded fibers, is the **jacket**.
- ◆ The jacket is made of plastic and other material.
- ◆ To protect against **moisture, cut, crushing**, and other **environmental dangers**.

### Optical Fiber Communication

- ◆ A **transmitter (Light Source)** at senders end sends a Light across the fiber.
- ◆ A receiver at the other end makes use of **Light Sensitive transistor** to detect the **absence or presence of light** to indicate 0 or 1.

### Bending of light ray

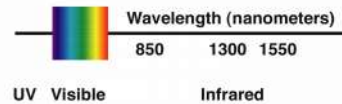
- ◆ **Angle of Incidence (I)**: the angle the ray makes with the line perpendicular to the interface between the two substances
- ◆ **Critical Angle**: the angle of incidence which provides an angle of refraction of 90-degrees.

## Light Source

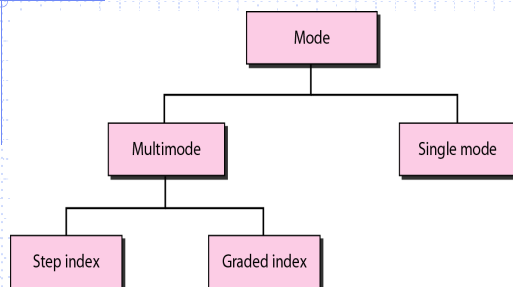
1. **The Light Emitting Diode (LED)**
  2. **Injection Laser Diode (ILD)**
- ◆ Both are semiconductor devices that **emit a beam of light** when voltage is applied.
  - ◆ **Led** is **less costly** than **ILD** used for **short distance**.
  - ◆ **ILD** which operates on **laser principle** and is **more efficient** and can **sustain greater data rate**.

## Light Used In Fiber Optics

- ◆ Fiber optic systems transmit using **infrared light**, invisible to the human eye.
- ◆ because it goes further in the optical fiber at those wavelengths.

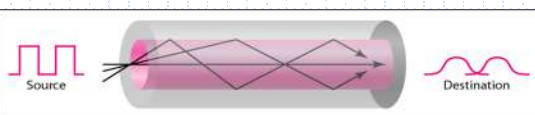


## Propagation Modes

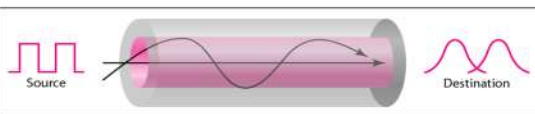


## Fiber Optic Types

- ◆ multimode **step-index fiber**
  - the reflective walls of the fiber move the light pulses to the receiver
- ◆ multimode **graded-index fiber**
  - acts to refract the light toward the center of the fiber by variations in the density
- ◆ **single mode fiber**
  - the light is guided down the center of an extremely narrow core



a. Multimode, step index



b. Multimode, graded index



c. Single mode

## Fiber Optic Advantages

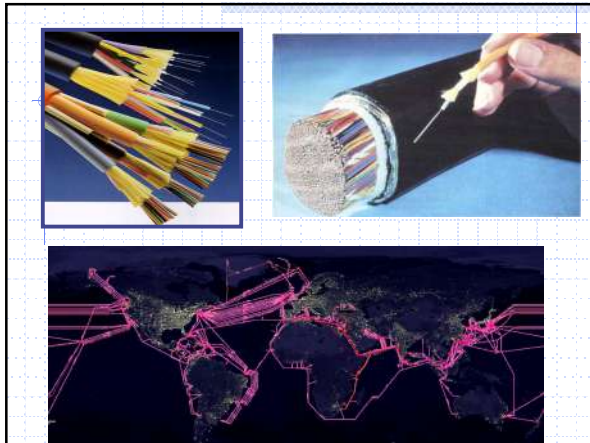
- ◆ **Greater capacity**(bandwidth of upto **2Gbps**)
- ◆ **Smaller size** and **light weight**
- ◆ **lower attenuation**
- ◆ **highly secure** due to tap difficulty and lack of signal radiation
- ◆ These are not affected by **electromagnetic interference**, so **noise and distortion** is very less.
- ◆ Used for both analog and digital signals.

## Fiber Optic Disadvantages

- ◆ **Expensive** over short distance
- ◆ Difficult to install - requires **highly skilled installers**
- ◆ **adding additional nodes** is difficult
- ◆ **Maintenance** is expensive and difficult.

## Applications

- ◆ Telephones, including cellular wireless
- ◆ Internet
- ◆ LANs - local area networks
- ◆ CATV - for video, voice and Internet connections
- ◆ Utilities - management of power grid
- ◆ Security - closed-circuit TV and intrusion sensors
- ◆ Transportation – smart lights and highways
- ◆ Military – everywhere!



Factor	UTP	STP	Co-axial	Fiber optics
Cost	Low	Moderate	Moderate	Highest
Installation	Easy	Fairly easy	Fairly easy	Difficult
Data rate	1 to 155 mbps	1 to 155 mbps	500 mbps	2 GBPS
Node capacity	2	2	30-100	2
Attenuation	High(100's of meter)	High(100's of meter)	Lower (range of few km's)	Lowest (10 Km's)
EMI	Most vulnerable	Less vulnerable than UTP	Less vulnerable than UTP	Not effected by EMI
Bandwidth	Low	Moderate	Moderately high	Very high
Signals	Electrical	Electrical	Electrical	Light