Transmission Media

It is the channel through which data is sent from one place to another. Transmission Media is broadly classified into the following types: Guided and unguided media.

1. Guided Media:

It is also referred to as Wired or Bounded transmission media. Signals being transmitted are directed and confined in a narrow pathway by using physical links.

Features:

- High Speed
- Secure
- Used for comparatively shorter distances

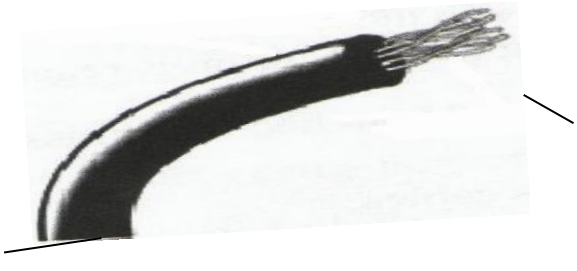
There are 3 major types of Guided Media:

(i) Twisted Pair Cable –

It consists of 2 separately insulated conductor wires wound about each other. Generally, several such pairs are bundled together in a protective sheath. They are the most widely used Transmission Media. Twisted Pair is of two types:

1. Unshielded twisted pair (UTP) cables.

UTP cables do not have a shield that prevents electromagnetic interference (also called '***Electric noise***') from the environment.

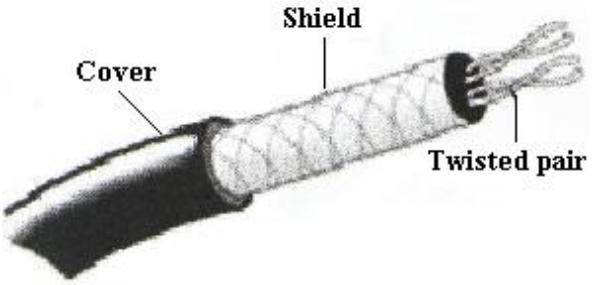


UTP cable is prone to noise & signal interference, and therefore, not suitable for environments that are electrically 'noisy'.

Noise may come from lightening sparks, radio signal, or radiations from spark plugs in motor vehicles.

2.Shielded twisted pair (STP) cables.

In STP cables, a braided shield is wrapped around the wires to protect them from noise.



Twisted pair cables are grouped into 5 categories according to the type of data transmitted, and the maximum rate of transmission.

Categories of Twisted Pair Cables.

CATEGORY	NETWORK TYPE	MAXIMUM NETWORK SPEED	DESCRIPTION
Category 1(CAT 1)	Voice Transmission	1 Mbps	It's not suitable for networking.
CAT 2	For digital telephone an low-speed networks	4 Mbps	Its commonly not used on networks.
CAT 3	Ethernet	10 Mbps	This category is currently used for telephone wiring.
CAT 4	IBM token ring	10 Mbps	It may also be used for 10Mbps Ethernet.
CAT 5	Fast Ethernet Connection	100 Mbps	
CAT 5e	Gigabit Ethernet	350 Mbps	
CAT 6	Gigabit Ethernet	1 Gbps	It does supports a signaling rate of 250 megahertz (MHz).

CAT 6a	Gigabit Ethernet	1 Gbps	It also supports a signaling rate of 500 megahertz (MHz).
CAT 7	Gigabit Ethernet	1+ Gbps	It support a signaling rate of 2 gigahertz (GHz).

Advantages of Twisted pair cables.

1. Can support high data rates (bandwidth) of up to 100 Mbps.
2. Telephone systems use UTP, which is present in most buildings. Therefore, it is easier to setup network media because; connection is readily available.
3. Installation equipment is cheap & readily available.
4. It is cheap because; of mass production for telephone use.

Disadvantages of Twisted pair cables.

1. They suffer from high attenuation. Therefore, for every cable length of 90m, a "**Repeater**" is needed to amplify (restore) the signal.
2. It is sensitive to electromagnetic interference & eavesdropping.
3. It has low data transmission rates as compared to other cables.

(ii) Coaxial cables.

A Coaxial cable resembles the cable that is used to connect television antenna to a television set.

The cable has;

1. A central *copper core* (which is either solid or stranded wires).

The diameter of the centre core determines the attenuation rate. If the core is thin, then the attenuation rate will be higher.

2. An *insulator* (a dielectric material) surrounding the copper core.

3. A hollow *braid* (mesh conductor) surrounding the insulator. The braid is made of copper or aluminium, and serves as the ground for the carrier wire.

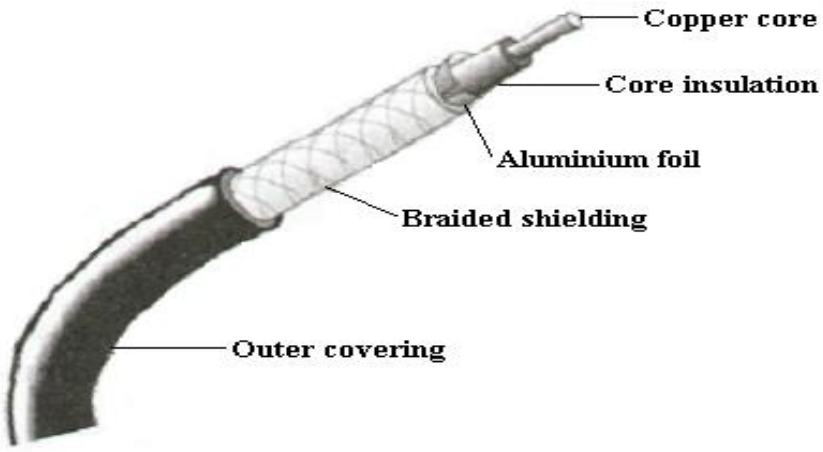
4. A *shield* which covers the braid making the core more resistant to electromagnetic interference.

The braid together with the insulator & the foil shield protects the carrier wire from Radio Frequency Interference (RFI) and Electromagnetic Interference (EMI).

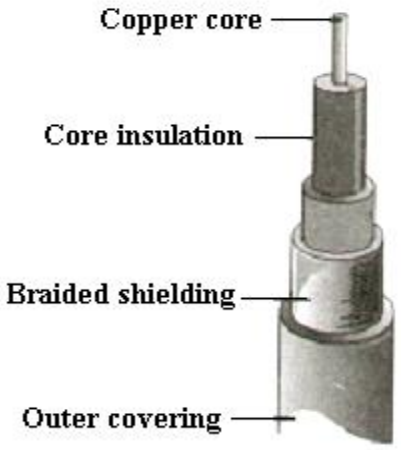
Coaxial cables have bandwidths of up to *1 Gbps* (Gigabits per second). Hence, they can be used to link/connect different networks between buildings, and route trunk calls in telecommunication companies.

The Two types of coaxial cables.

(i). <u>*Thin coaxial cable (Thinnet)*</u>: - it has 1 dielectric insulator around the core.



(ii). *Thick coaxial cable (Thicknet)*: - it has 2 dielectric insulators around the core, and is thicker than the thinnet.



Advantages of coaxial cables.

1. They are very stable even under high loads.
2. They have a large bandwidth (up to 1Gbps) compared to twisted pair cables.
3. They can carry voice, data and video signals simultaneously.
4. They are more resistant to radio and electromagnetic interference than twisted pair cables.

Disadvantages of coaxial cables.

1. Thick coaxial cable is hard to work with.
2. They are relatively expensive to buy & install compared to twisted pair cables.

(iii) Fibre optic cables.

A fibre optic cable uses light to transmit data signals from one point to another on the network.

A ***Light Emitting Diode*** (***LED***) is used at the source/transmitter (sending computer) to convert electrical signals to light signals which are then send along the cable. At the receiving computer, a ***photosensitive*** device is then used to convert the light signals back to electric signals that can be processed by the computer.

A fibre optic cable is made up of;

1. **The Core**.

This is the central part of the cable, and is made of a hollow transparent plastic or glass.

2. **Cladding**.

This is a single protective layer surrounding the core.

The Cladding is able to bend light rays, (i.e., when light tries to travel from the core to the cladding, it is redirected back to the core).

3. **Buffer**.

It surrounds the cladding. Its main function is to strengthen the cable.

4. **The Jacket**.

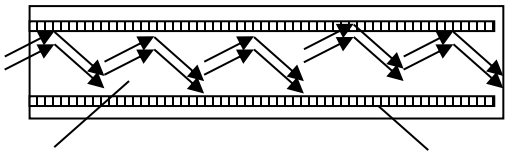
It is the outer covering of the cable.

Light transmission along a fibre optic cable.

The light signal travels along the core through a process referred to as ***Total internal reflection***.

The process that causes total internal reflection is called **Refraction**. *Refraction* is the bending of light when it crosses the boundary of two mediums that have different densities.

Therefore, when light signal is inserted into the cable, it tries to cross from the core to the cladding. The light is bent back into the core, hence spreads along the length of the cable.



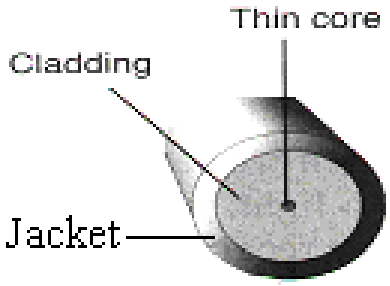
Light rays

Core Cladding

Types of fibre optic cables.

(i). <u>Single mode fibre optic cable</u>.

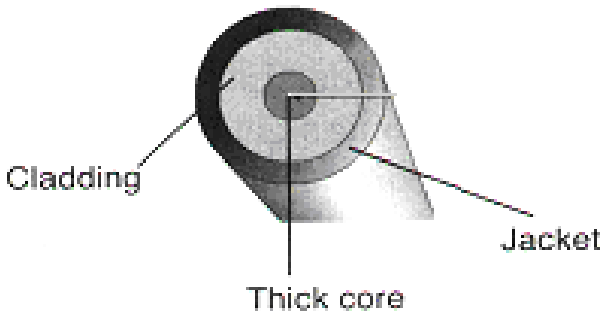
The single mode fibre has a very narrow centre core. This implies that, the light in the cable can take only one path through it.



- It has a very low attenuation rate, and is preferred for long distance transmission.
- It has a very high bandwidth of 50 Gigabits per second.
- It is very expensive, and requires very careful handling during installation.

(ii). <u>Multimode fibre optic cable.</u>

A multimode fibre has a thicker centre core than the single mode fibre.



- It allows several light signals (rays) to be sent through the cable at the same time. Hence, there are high chances of the signal being distorted.
- It has a high attenuation rate, and is usually used for shorter distance transmission.

Advantages of fibre optic cable.

1. It is immune to electromagnetic interference, and eavesdropping.
2. It is fast and supports high bandwidth.
3. It has low attenuation; hence, a long distance can be covered.
4. It does not generate electrical signals; hence can be used in dangerous (highly flammable) places.
5. It is smaller & lighter than copper cables; hence, suitable for situations where space is limited.

Disadvantages of fibre optic cable.

1. Requires expensive connectivity devices and media.
2. Installation is difficult because the cable must be handled carefully.
3. It is relatively complex to configure.
4. A broken fibre optic cable is difficult & expensive to repair.

Review questions.

1. Define the term Transmission media.
2. (a). Give two advantages of coaxial cables.

(b). Explain the importance of the wire braid in coaxial cable.

3. Distinguish between Thinnet and Thicknet coaxial cables.
4. Define the term Pitch as used in twisted pair cabling.

5. (a). Give two advantages of fibre optic media.

(b). Differentiate between single mode and multimode fibre optic cables.

Wireless communication (unbounded media)

Wireless (*unbounded*) *media* is a type of media that is used to transmit data from one point to another *without using physical connections*.

It is also referred to as Wireless or Unbounded transmission media. No physical medium is required for the transmission of electromagnetic signals.

Features:

- The signal is broadcasted through air
- Less Secure
- Used for larger distances

In this case, a transmitting *antenna* & a receiver *aerial* are used to facilitate the communication.

Examples of wireless communication media include:

1. Microwaves.

2. Radio waves.

3. Infrared transmission.

All these waves use different frequencies of the electromagnetic spectrum, and travel at the speed of light.

Microwave transmission

Microwave frequencies have a small wavelength, and can easily release their energy in water as heat. This is why they are used in making domestic kitchen appliances, e.g., microwave ovens.

In networking, microwaves are suitable for *point-to-point* transmissions, whereby a signal is directed through a focused beam from the transmitter to the receiver station.

Satellite communication

A Satellite is a microwave relay station. The microwave earth stations have parabolic dishes with an antenna fixed on them in order to focus a narrow beam towards the satellite in space.

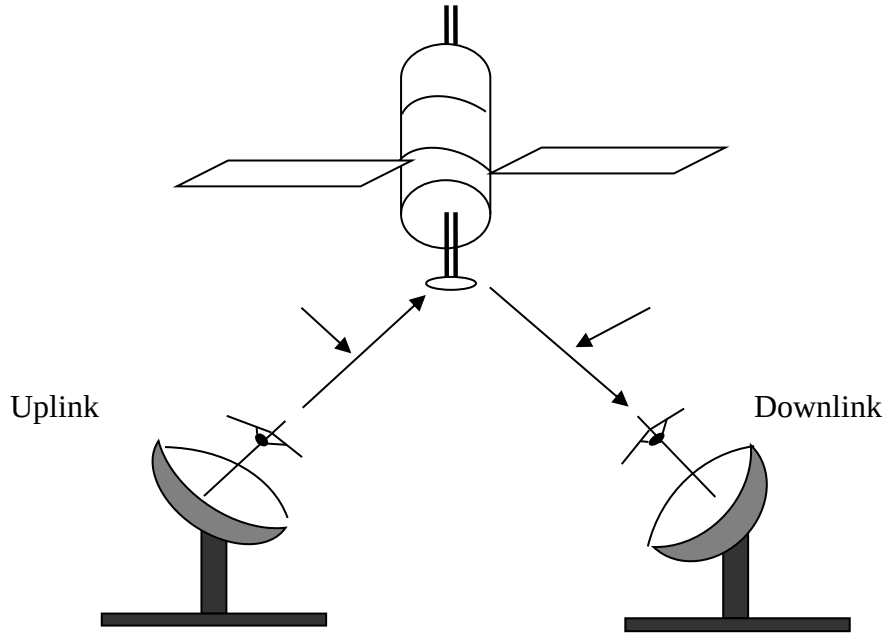
A satellite transmission system has 3 main components:

1. ***Transmitter earth station*** - it sets up an *uplink* to the satellite in order to transmit data.
2. A ***Satellite*** that is somewhere in an orbit. It receives, amplifies, and retransmits the signal to a receiving earth station through a *downlink* frequency.

The downlink & the uplink frequency are usually different. This is to prevent the downlink signal from interfering with the uplink signal.

3. ***Receiving earth station*** - receives the signal sent by the satellite on the other side of the globe.

Satellite in space



Transmitter earth station

Receiving earth station

A communication satellite is usually launched into space about 36,000 km above the earth in such a manner that its speed is almost equal to the rotation speed of the earth. This makes the satellite appear as if it is stationary in space. Such types of satellites are called ***geostationary*** satellites.

Advantages of using satellites

1. A satellite is convenient because; it provides a large constant line of sight to earth stations. This means that, there is no need to keep on moving the parabolic dish so as to track the line of sight.
2. The satellite transmits the signal to many recipient earth stations. This is because; the transmitted signal spreads out in all directions to form a *Point to Multipoint* transmission.

Very Small Aperture Terminal (**VSAT**)

A *VSAT* is a very small satellite dish used both in data, radio, and TV communication.

It can be set up at home or in a small business. It enables direct access to satellite communication instead of having to go through state-owned or licensed satellite gateways.

The dish has an antenna that receives the satellite signals. The signals are decoded using a *decoder* which is plugged directly to a television set or a computer.

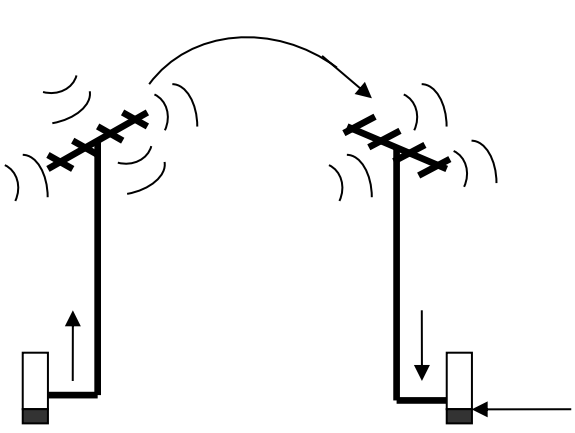
Radio communication

Radio waves are used in radio and television broadcasts.

Radio waves travel just like surface water waves, i.e., they start from a central point and spread outwards in all directions.

As they travel outwards, their energy spreads outwards over the covered area. The waves are radiated into the atmosphere by a radio frequency antenna at constant velocity.

The figure below shows a typical radio waves link between two separate geographical locations.



Transmitting Receiving

antenna antenna Power supply

TRANSMITTER RECEIVER

Fig.: A typical radio transmitter and receiver link

Radio waves can be of:

- High frequency (HF).
- Very high frequency (VHF).
- Ultra-high frequency (UHF).

<u>High frequency (HF) radio waves</u>

The *High frequency* radio wave signal is transmitted by directing it to the *ionosphere* of the earth. The ionosphere reflects it back to the earth's surface, and the receiver then picks the signal.

Disadvantage of HF communication

– The signal can be intercepted by unauthorized parties.

<u>Very High frequency (VHF) radio waves</u>

They are transmitted along the earth's surface. However, since the earth is somehow curved, the signal tends to attenuate at the horizons of mountains and buildings. This means that, *repeater stations* have to be built on raised areas in order to receive, amplify, and propagate the signal from one area to another.

Note. The range of VHF is limited; however, it is preferred to HF because; it is possible to make a VHF wave follow a narrower & more direct path to the receiver.

Ultra-High frequency (UHF) radio waves

The UHF radio waves use the *line of sight principle* used by the VHF waves. This means that, there should be no barrier between the sending & the receiving aerial. However, they require smaller aerials.

For example;

The Television aerial for VHF is bigger than the one for UHF radio waves. This is because; UHF radio waves can be made to follow a narrower & a more direct path to the receiver than VHF radio waves.

The Bluetooth technology

This is a worldwide and short-range radio transmission technology that allows all personal, hand-held devices to be able to communicate with each other through wireless technology.

It enables people to use hand-held communication devices such as mobile phones & Personal Digital Assistants (PDA's) to access the Internet.

The main component in Bluetooth is a small *low power* two-way radio transceiver, which can be inserted in small devices.

Bluetooth enabled devices use a network called the *Wireless personal area network* (*WPAN*) or *piconet*.

Infrared transmission

Communication through infrared waves (signals) is achieved by having infrared transmitters & receivers (*transceivers*) within a line of sight in the same room. This is because; infrared signals cannot penetrate obstacles like walls and ceilings. However, the signal can be reflected off these surfaces until they reach their destination.

For example;

A tv remote should not encounter any barriers between it and the receiver if barricade the signal from the remote will not reach the receiver.

Most mobile phones have an infrared transceiver. Once activated, two people in the same room can send messages to each other on their mobile phones without going through the mobile service provider; hence avoid being charged.

In computer networking environment, infrared technology can be used to connect devices in the same room to each other without the need for cables, e.g., a computer and a printer. However, the computer's infrared transceiver must maintain a line of sight with the one for the printer.

Advantages of wireless communication.

1. Wireless medium is flexible in operation, i.e., devices can be moved around without losing access to the network.
2. Wireless networks can span large geographical areas easily.
3. Wireless communication can take place via satellite even in very remote areas that do not have high cost physical infrastructure like telephone lines.

Disadvantages of wireless communication.

1. The initial cost is very high.
2. It is relatively difficult to establish or configure.

Review questions.

1. Distinguish between radio and microwave transmission.

2. Describe an electromagnetic spectrum.

3. State two advantages of satellite communication.

4. Give one application area of Infrared transmission.

5. Describe the VSAT technology.

6. Explain the concept of a geostationary satellite.

7. Explain the *line of sight principle* in wireless communication.

Factors to consider when selecting a data transmission system

1. Cost of each type of data transmission method.
2. Distance between the computer (server) & the terminal (clients).
3. Whether data should be transmitted direct to the computer online.
4. Type of data transmission system to be used, i.e., whether the data transmission will be 1-way or 2-way.
5. Volume of data to be processed; and whether it is batched at particular times, or whether it is collected individually and required to be processed immediately.
6. Speed of transmission required.
7. Accuracy and reliability required.