Analog and Digital Communication

Part - 2

Transmission Media and its Characteristics

Various physical media can be used for the actual transmission of information from one place to another. Each one has its own niche in terms of bandwidth, delay, cost and ease of installation and maintenance.

Transmission media are roughly grouped into:

- Guided media, such as copper wire and fiber optics and
- Unguided media, such as radio and lasers.

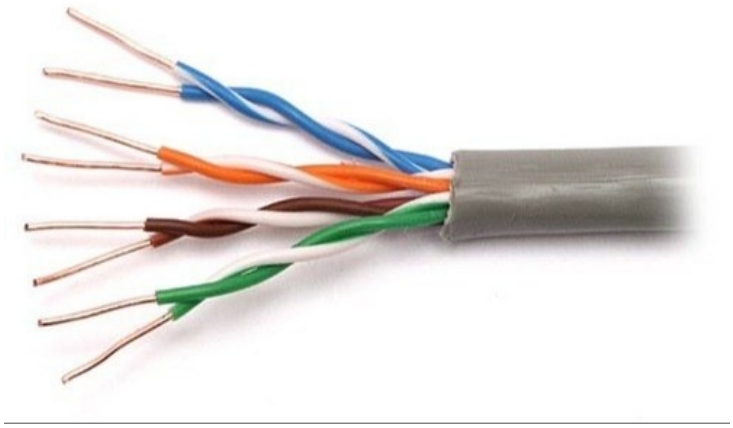
Twisted Pair Cables

A twisted pair cable consists of two insulated copper wires, typically about 1 mm thick. The purpose of twisting the pair is to reduce electrical interference from similar pairs that may be close by.

The most common application of the twisted pair is in the telephone system. Nearly all telephones are connected to the telephone company using twisted pair. Twisted pairs can run several kilometers without amplification but for longer distances, repeaters are needed.

Twisted pairs can be used for either analog or digital transmission. The bandwidth depends on the thickness of the wire and the distance travelled.

Advantages of Twisted Pair Cable are its adequate performance and lowest cost per meter as compared to other cable type and it is also inexpensive to install.



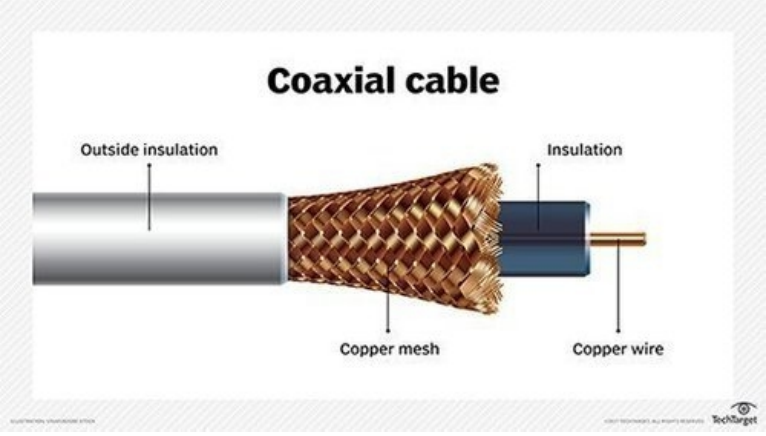
Twisted Pair Cable

Co-axial Cable

Coaxial cable is another common transmission media used for data transmission. It has better shielding than twisted pairs, so it can span longer distances at higher speeds.

A coaxial cable consists of a stiff copper wire as the core, surrounded by an insulating material. The insulator is encased by a cylindrical conductor, often as closely woven braided mesh. The outside conductor is covered with a protective plastic sheath.

The construction and shielding of the coaxial cable gives it a good combination of high bandwidth and excellent noise immunity. Coaxial cables are widely used for long distance telephone system, which is replaced by fiber optic cables in recent times. It is still widely used for cable television and some local area networks.



Optical Fiber

Fiber optic cable is made of fine strands of silicon glass fiber (thinner than a human hair), and is coated with a refractive surface. The signals are converted to light pulses before being sent. When light (provided by laser or LED) is shown into the strand, it travels along the fiber strand and the refractive layer prevents it from escaping.

Each fiber optic strand can support thousand of speech channels and multiple TV channels simultaneously. It is used for long haul telecommunication links, for providing high-speed data communication links for computers and cable TV.

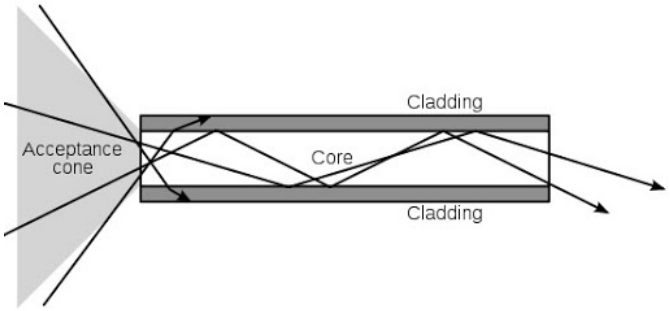
Advantages of Fiber optic cables are:

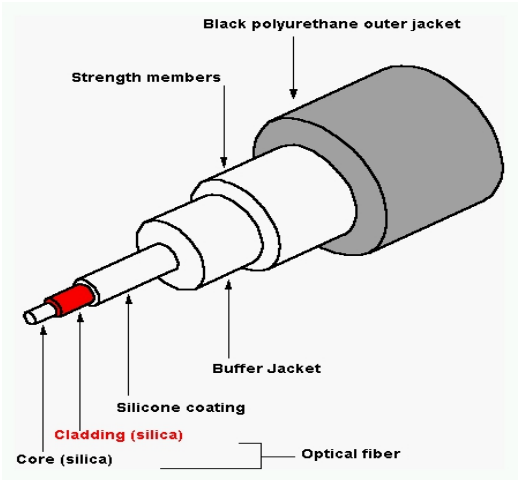
- High capacity, because it has the laser bandwidth.
- It is immune to electromagnetic interference.
- It can go for long distances, due to its low attenuation.

The Disadvantages are:

- It is very much costly.
- It is difficult to join.
- Installation is very expensive and needs greater skills.

An optical fiber transmission system has three components: the light source, the transmission medium and the detector. Conventionally, a pulse of light indicates a 1 bit and the absence of light indicates a 0 bit. The transmission medium is an ultra-thin fiber of glass. The detector is a photo-divider that generates an electrical pulse when light falls on it.





Comparison between Optical Fibers and Copper Wire

- Optical fibers can handle much higher bandwidths than copper wire.
- Due to low attenuation, repeaters are needed only about every 30 km on long lines of optical fiber cables, whereas copper wires require repeaters every 5 km.
- Optical fibers are not being affected by power surges, electromagnetic interference or power failures, which affects copper wires.
- Optical fibers are lighter than copper wires. One thousand twisted pairs, 1 km long weights 8000 kg, whereas two fibers have more capacity and weights only 100 kg.
- Finally, optical fibers do not leak light and are quite difficult to tap. This gives them excellent security against potential wire tappers.

Wireless Transmission

Wireless transmission is also called unbounded media. Here there are no physical connectors between the two communicating devices. Usually the transmission is sent through the atmosphere. The three main types of wireless Media are:

- Radio waves
- Micro waves and
- Infrared rays.

Microwave Transmission

Microwave is a radio system, which uses very high frequencies to send and receive data. Because of the very high frequencies involved, the microwave stations are located about 30 km apart and in line of sight. Microwave systems have sufficient bandwidth capacity to support a large number of voice channels and one or two TV channels.

Above 100 MHz, the waves travel in straight lines and therefore they can be narrowly focused upon, concentrating the energy into a small beam, using parabolic antenna. Since microwaves travel in straight lines, if the towers are too far apart, the earth will get in the way. Consequently, repeaters are needed periodically. The higher the towers are, the further apart they can be. The distance between repeaters increases roughly, with the square root of the tower height.

Microwave communication is so widely used for long-distance telephone communication, cellular telephones, television distribution and other uses, that a severe shortage of spectrum has developed.

Advantages of Microwave Communication

- Medium capacity
- Medium cost and
- Can go long distances.

Disadvantages of Microwave Communication

- Noise interference
- Geographical problems due to line of sight requirements and
- Becoming outdated.

Terrestrial Microwave

Terrestrial microwave employs Earth-based transmitters and receivers. The frequencies used are in low gigahertz range, hence limiting all communication to line of sight.

Microwave transmissions are carried out using parabolic antenna that produces a narrow, highly directional signal. At the receiving site a similar antenna, which is sensitive to signals, only within a narrow focus is placed. As the transmitter and receiver are highly focused, they must be carefully adjusted so that, the transmitted signal is aligned with the receiver.

Terrestrial microwave systems operate in the low-gigahertz range, typically at 2 – 6 GHz and 21 - 23 GHz. They are used as a means of transmitting signals where it would be impractical to run cables.

Satellite Microwave

Satellite Microwave systems relay transmission through communication satellites that operate in geosynchronous orbits (36,000 – 40,000 km) above the Earth.

In order to communicate with satellites, the Earth stations use parabolic antennas. Satellites can retransmit signals in broad or in narrow beams, depending on the location that are to receive the signals. When the destination is on the opposite side of the earth, the first satellite must relay the signal through another satellite, as it cannot directly transmit to the receiver.

Satellite links operate in the low-giga hertz range, typically at 4 – 6 GHz.

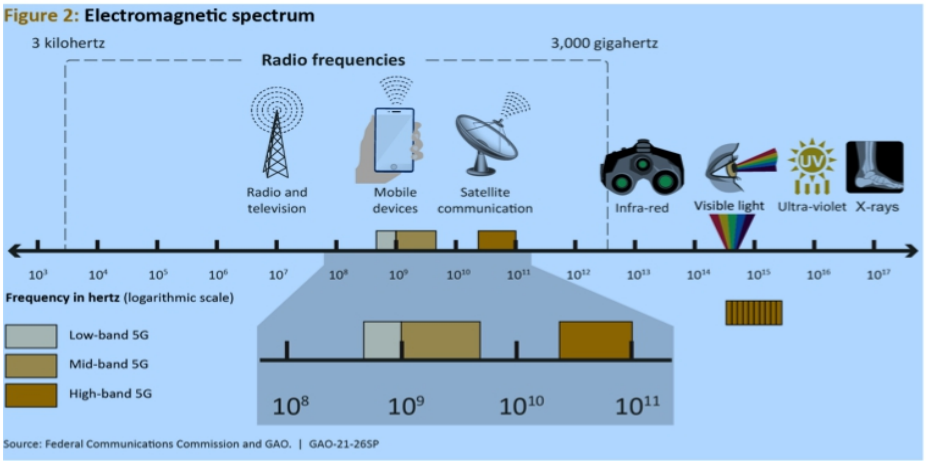
Radio Transmission

The radio portion of the electromagnetic spectrum extends from 10 KHz to 1 GHz. Within this range there are numerous bands or ranges of frequencies that are designated for specific purposes. Some popular frequency bands are:

- Short wave
- VHF (Very High Frequency) used for Television and FM radio.
- UHF (Ultra High Frequency) used for television.

Radio waves are widely used for communication both indoors and outdoors because they are:

- Easy to generate
- They can travel long distances
- They can penetrate buildings easily and
- They are omni directional (travel in all direction from the source)



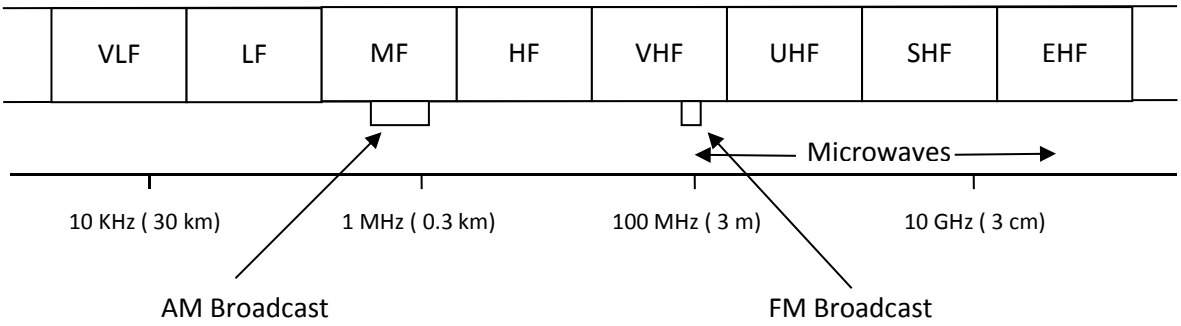
Infrared and Millimeter Waves

Unguided infrared and millimeter waves are widely used for short-range communication. The remote controls used on television, DVD Players and stereos all use infrared communication. The remote control carries coded instruction to the receiver on the TV.

They are relatively directional, cheap and easy to build, but the major drawback is that they cannot pass through solid objects. They do not pass through solid walls and as a result the infrared used in one room do not interfere with a similar system in adjacent rooms. Because of this reason no government license is needed to operate in infrared system, in contrast to radio systems, which must be licensed.

These properties have made infrared suitable for indoor wireless LANs. The computers in offices can be equipped with relatively unfocussed (somewhat omni-directional) infrared transmitters and receivers. In this way, portable computers can also be used in LAN, without a direct physical connection to it.

Frequency Spectrum for Wireless Transmission



Note that:

- AM Radio transmission is assigned a frequency range of 530 KHz to 1700 KHz.
- FM Radio transmission is assigned a frequency range of 88 MHz to 108 MHz, with a min separation of 200 KHz between each station.