Signals

When data is sent over physical medium, it needs to be first converted into electromagnetic signals. Data itself can be analog such as human voice, or digital such as file on the disk. Both analog and digital data can be represented in digital or analog signals.

- **Digital Signals**

  Digital signals are discrete in nature and represent sequence of voltage pulses. Digital signals are used within the circuitry of a computer system.

- **Analog Signals**

  Analog signals are in continuous wave form in nature and represented by continuous electromagnetic waves.

Transmission Impairment

When signals travel through the medium they tend to deteriorate. This may have many reasons as given:

- **Attenuation**

  For the receiver to interpret the data accurately, the signal must be sufficiently strong.When the signal passes through the medium, it tends to get weaker.As it covers distance, it loses strength.

- **Dispersion**

  As signal travels through the media, it tends to spread and overlaps. The amount of dispersion depends upon the frequency used.

- **Delay distortion**

  Signals are sent over media with pre-defined speed and frequency. If the signal speed and frequency do not match, there are possibilities that signal reaches destination in arbitrary fashion. In digital media, this is very critical that some bits reach earlier than the previously sent ones.

- **Noise**

  Random disturbance or fluctuation in analog or digital signal is said to be Noise in signal, which may distort the actual information being carried.

Transmission Media

The media over which the information between two computer systems is sent, called transmission media. Transmission media comes in two forms.

- **Guided Media**

  All communication wires/cables are guided media, such as UTP, coaxial cables, and fiber Optics. In this media, the sender and receiver are directly connected and the information is send (guided) through it.

- **Unguided Media**

Wireless or open air space is said to be unguided media, because there is no connectivity between the sender and receiver. Information is spread over the air, and anyone including the actual recipient may collect the information.

The transmission of this bits over the physical media depends on the following:

- The type of medium and its connectors
- The form of representation of the bits; either electrical, light or wave signals
- The data encoding and the control information
- The types of transmitters and receivers in the networks

During communication, the user data has undergone several processes; segmentation at the transport layer, packets in the network layer, encapsulation into frames at the data link layer and finally, the data is converted into one of the three forms that can be transmitted over the physical media; electrical, light signals or microwaves in the physical layer.

The three main forms of transmission media that we use in networks are:

1. Copper cable
2. Fiber
3. Wireless

Multiplexing

Multiplexing is a technique to mix and send multiple data streams over a single medium. This technique requires system hardware called multiplexer (MUX) for multiplexing the streams and sending them on a medium, and de-multiplexer (DMUX) which takes information from the medium and distributes to different destinations.

Ethernet

The standards at the layer 1 and 2 of the OSI model are defined as Ethernet standards. The different standards used in Ethernet define the different layer 1 and layer 2 protocols, however, the format of the frame does not change.

As we mentioned in the previous sections, the data link layer provides mechanisms for converting packets to frames while the physical layer converts frames to bits which are then transmitted over the physical media.

Hub

In the yester years, the main Ethernet standards in many Local area networks was the HUB. The hub used a technique known as the CSMA/CA (Carrier Sense Multiple Access/ Collision Avoidance) and CSMA/CD (Carrier Sense Multiple Access/ Collision Detection). This was implemented using either the bus or hub technologies.

Like the name suggests, the hub was at the heart of communication in a network segment and devices could only transmit data one at a time.

The HUB operates at layer 1, this means that when data is received by a hub, it floods this information to all the devices in the network. This is a major performance issue since there may be congestion, network failure among others.

NOTE: the area in which the Hub is the center of communication is refer to as a collision domain. This is because there is a high possibility of collisions.
The communication in a collision domain such as the one by a hub has the following characteristics.

- Flooding – where frames are sent to all devices in connected to the hub.
- Only one device can communicate at any instance
- Communication is only one way
- One collision domain

Switch

The problems associated with hubs, such as high failure rate due to collisions were a major hindrance to growth of networks. As a result, a new solution to combat this was introduced. The switch, changed communication in networks in many ways, each port on a switch acted as a single collision domain, therefore, the switch had as many collision domains as it had ports. This meant that the likelihood of collisions was reduced. The switch worked at layer 2 as opposed to layer one which meant that the switch could learn of the devices on its network and instead of flooding frames, unicast communication was possible.

Further development lead to bidirectional communication, instead of only one way communication as seen in hubs, also with switches many devices can communicate simultaneously.

The area where a switch is center of communication is known as a broadcast domain. In this type of communication, each port is its own collision domain therefore, there are as many collision domains as there are switch ports.

Some of the other characteristics of a switch include:

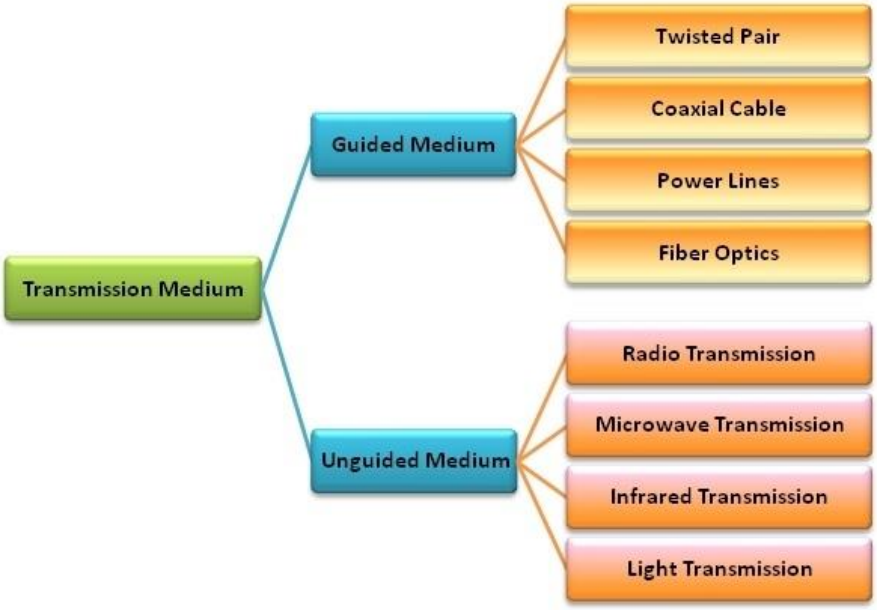
- Communication at data-link layer instead of the physical layer
- Full duplex communication
- Broadcast domains instead of a single collision domain

The transmission medium can be defined as a pathway that can transmit information from a sender to a receiver. Transmission media are located below the physical layer and are controlled by the physical layer. Transmission media are also called communication channels.

Transmission media are of two types −

- Guided Transmission Medium
- Unguided Transmission Medium

The following chart categorizes transmission media −

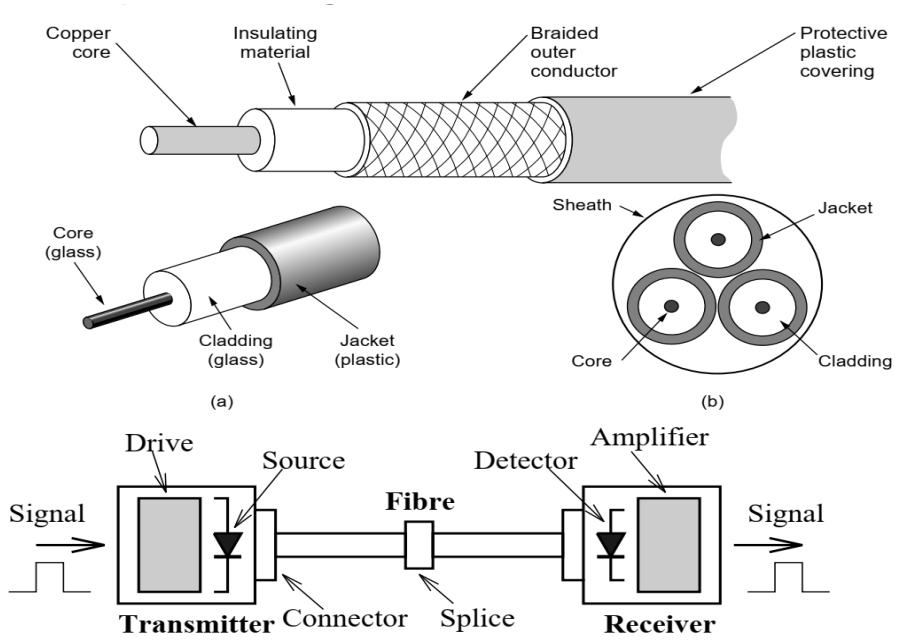


Guided Transmission Medium

Guided transmission media are also called **bounded media** or **wired media**. They comprise cables or wires through which data is transmitted. They are called guided since they provide a physical conduit from the sender device to the receiver device. The signal traveling through these media are bounded by the physical limits of the medium.

The most popular guided media are −

- Twisted pair cable
- Coaxial cable
- Power lines
- Fiber optics



Unguided Transmission Medium

Unguided transmission media are also called wireless media. They transport data in the form of electromagnetic waves that do not require any cables for transmission. These media are bounded by geographical boundaries. These type of communication is commonly referred to as wireless communications.

Unguided signals can travel in three ways −

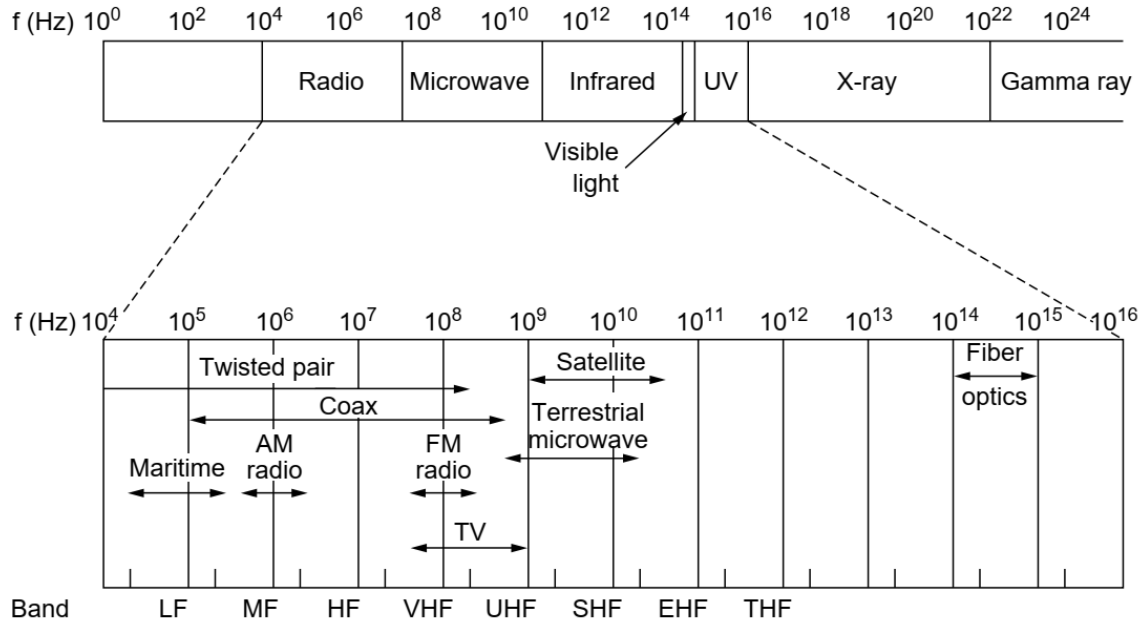
- Ground propagation
- Sky propagation
- Line – of – sight propagation

The commonly used unguided transmissions are −

- Radio transmission
- Microwave transmission
- Infrared transmission
- Light transmission

Examples of unguided media include radio and microwave, infrared

Electromagnetic spectrum:



- Wireless media are very hostile environments for communication and at present have restricted data rates (The 3G system, UMTS, only offers 2 Mbps for indoor and local area coverage).
- Infrared: short range communications (as your TV remote control), small network for one room (regular reflectors at ceiling form “transmitters” array)
- Radio and microwave: most widely used, various air interface standards Infrared: unlicenced "free" bandwidth
- Mobile communications