Data Communications and Computer Network

PART IIC: INTRODUCTION TO COMPUTER NETWORK DEVICES and COMPONENTS

What are internetworking devices?

- Internetworking devices are products used to connect networks. As computer networks grow in size and complexity, so do the internetworking devices used to connect them.

The purposes of having devices

- First, they allow a greater number of nodes to be connected to the network.
- Second, they extend the distance over which a network can extend.
- Third, they localize traffic on the network.
- Fourth, they can merge existing networks.
- Fifth, they isolate network problems so that they can be diagnosed more easily.

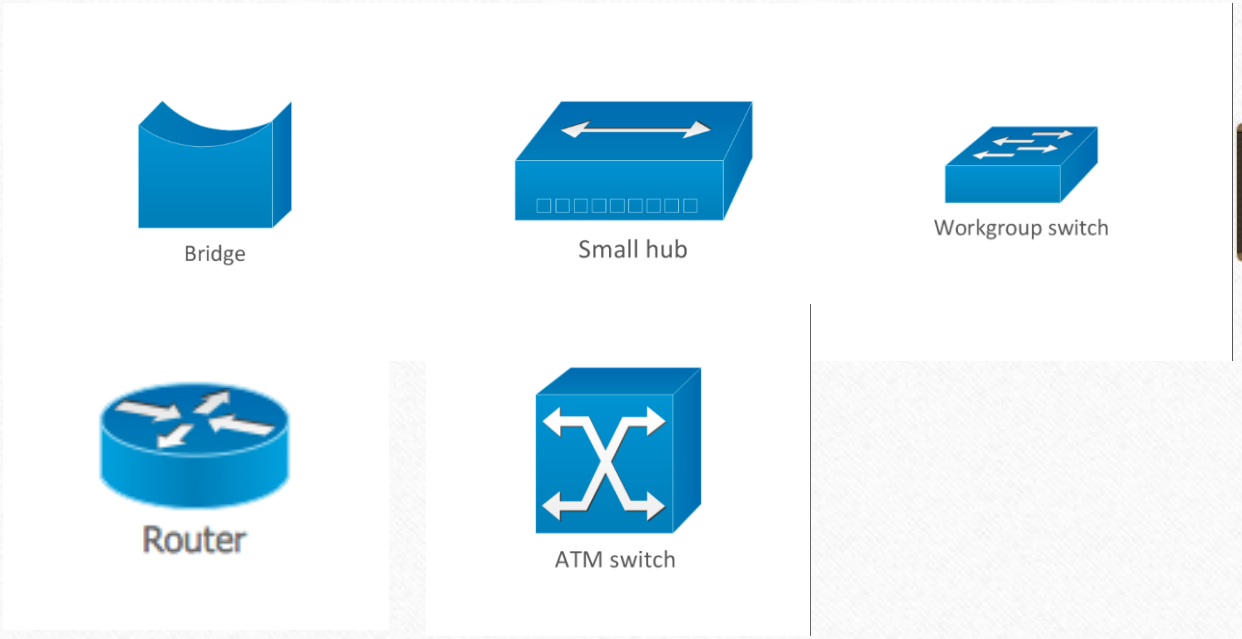
LAN Devices

LAN Devices are designed to:

- Operate within a limited geographic area
- Allow multi-access to high-bandwidth media
- Control the network privately under local administration
- Provide full-time connectivity to local services
- Connect physically adjacent devices

LAN Devices

- BRIDGE
- HUB
- ETHERNET SWITCH
- ROUTER
- ATM SWITCH



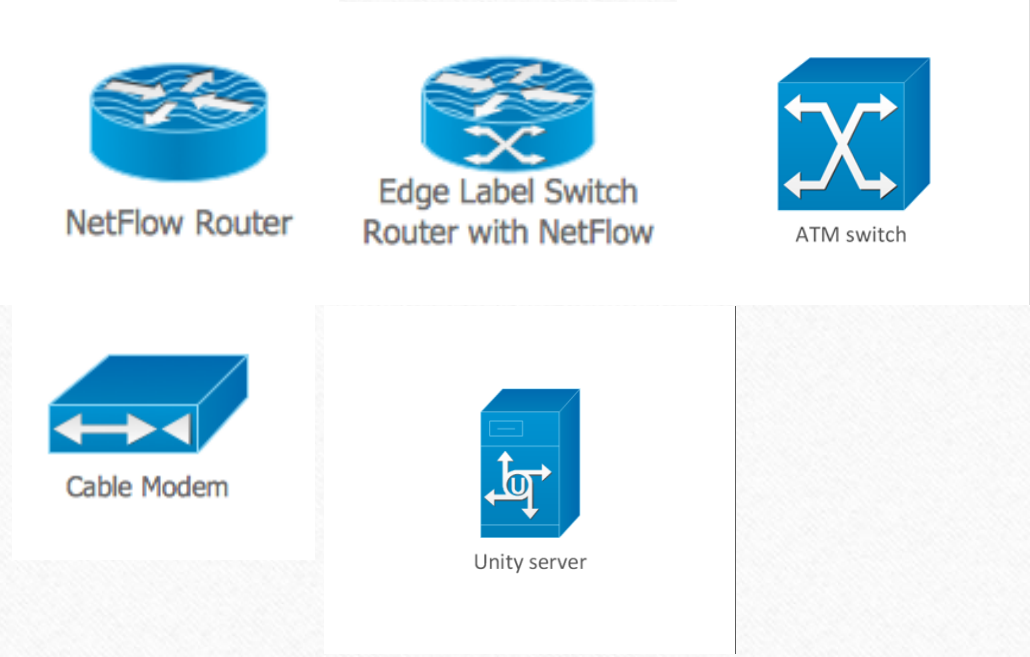
WAN Devices

WAN devices are designed to:

- Operate over geography of telecommunications carriers
- Allow access over serial interfaces operating at lower speeds
- Control the network subject to regulated public services
- Provide full-time and part-time connectivity
- Connect devices separated over wide, even global areas

WAN Devices

- Router
- ATM Switch
- Modem
- Servers



Repeater?

- A repeater operates at the physical layer. Its job is to regenerate the signal over the same network before the signal becomes too weak or corrupted so as to extend the length to which the signal can be transmitted over the same network. An important point to be noted about repeaters is that they do not amplify the signal. When the signal becomes weak, they copy the signal bit by bit and regenerate it at the original strength. It is a 2 port device.
- When signals first leave a transmitting station, they are clean and easily recognizable. However, the longer the cable length, the weaker and more deteriorated the signals become as they pass along the networking media.
- **Degradation** usually refers to reduction in quality of an analog or digital **signal**. When a **signal** is being transmitted or received, it undergoes changes which are undesirable. These changes are called **degradation**.

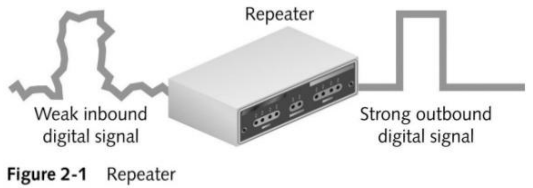


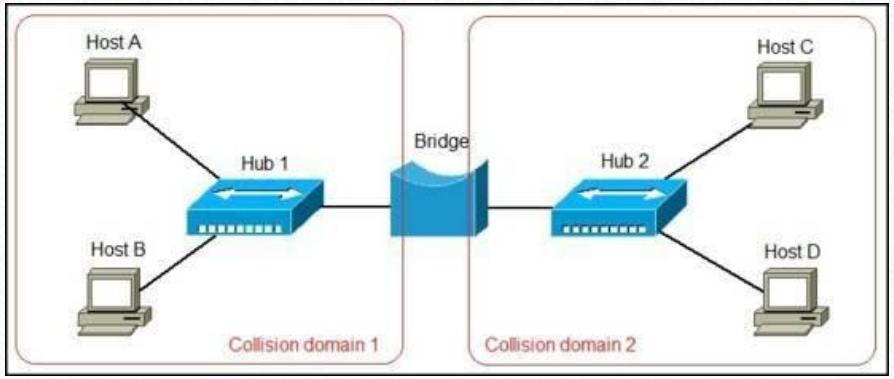
Figure 2-1 Repeater

Hub

- A hub is basically a multiport repeater. A hub connects multiple wires coming from different branches, for example, the connector in star topology which connects different stations. Hubs cannot filter data, so data packets are sent to all connected devices. In other words, collision domain of all hosts connected through Hub remains one. Also, they do not have intelligence to find out best path for data packets which leads to inefficiencies and wastage.

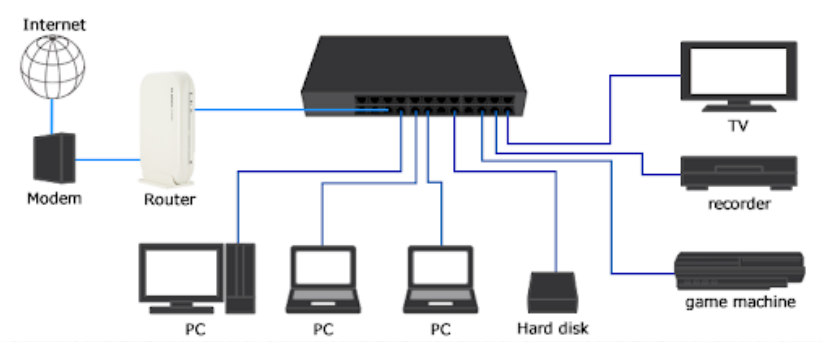
Bridge

- A bridge operates at data link layer. A bridge is a repeater, with add on the functionality of filtering content by reading the MAC addresses of source and destination. It is also used for interconnecting two LANs working on the same protocol. It has a single input and single output port, thus making it a 2 port device.



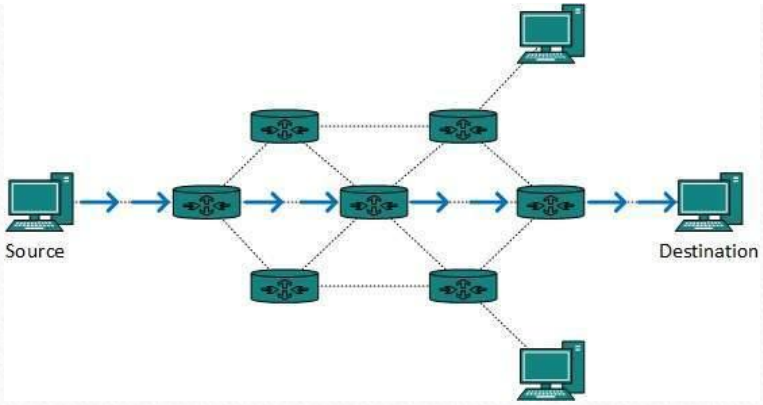
Switch

- A switch is a multiport bridge with a buffer and a design that can boost its efficiency(a large number of ports imply less traffic) and performance. A switch is a data link layer device. The switch can perform error checking before forwarding data, that makes it very efficient as it does not forward packets that have errors and forward good packets selectively to correct port only. In other words, switch divides collision domain of hosts, but broadcast domain remains same.



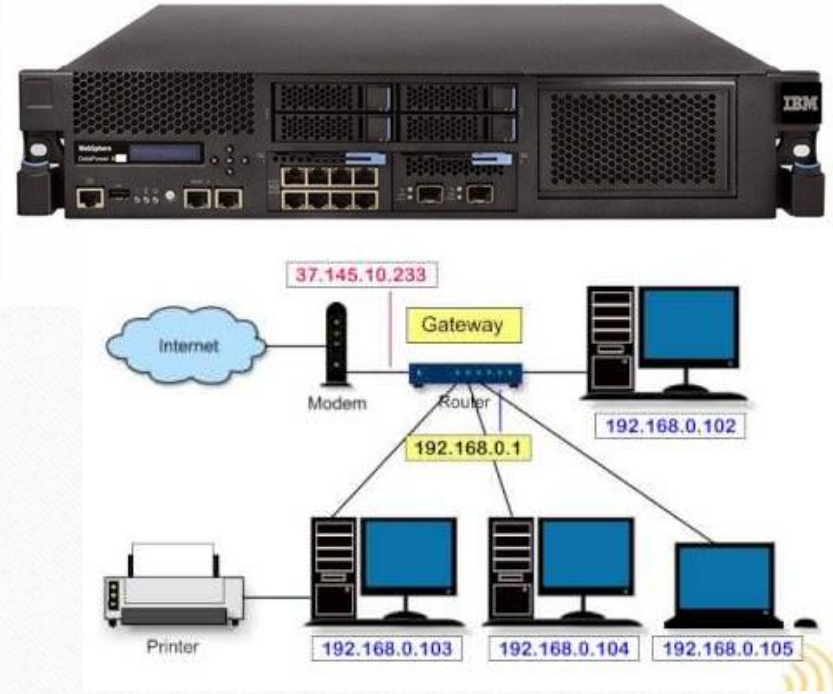
Routers

- A router is a device like a switch that routes data packets based on their IP addresses. Router is mainly a Network Layer device. Routers normally connect LANs and WANs together and have a dynamically updating routing table based on which they make decisions on routing the data packets. Router divide broadcast domains of hosts connected through it.



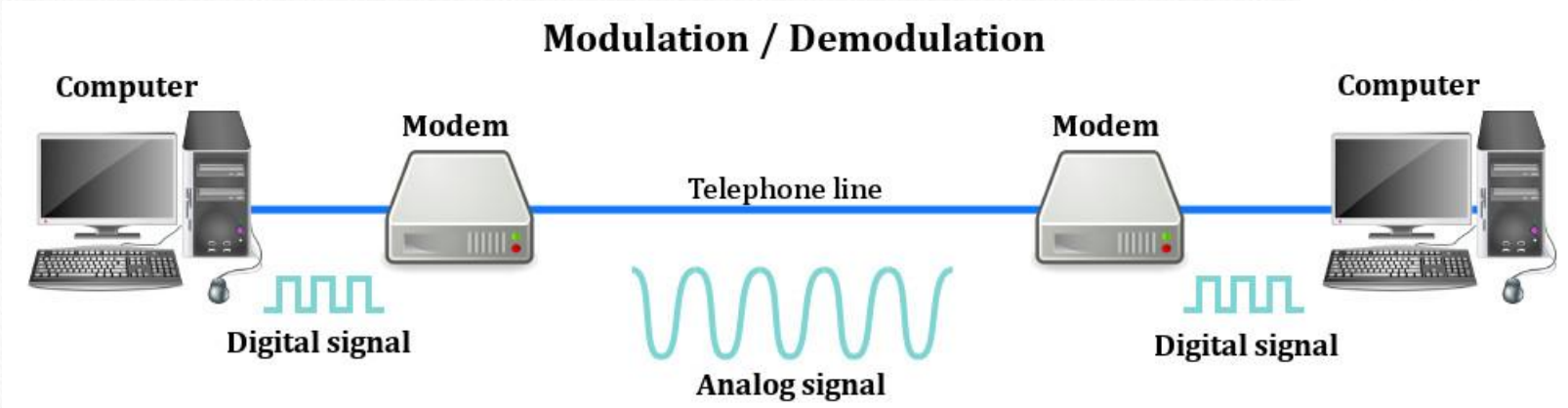
Gateway

- A gateway, as the name suggests, is a passage to connect two networks together that may work upon different networking models. They basically work as the messenger agents that take data from one system, interpret it, and transfer it to another system. Gateways are also called protocol converters and can operate at any network layer. Gateways are generally more complex than switch or router.



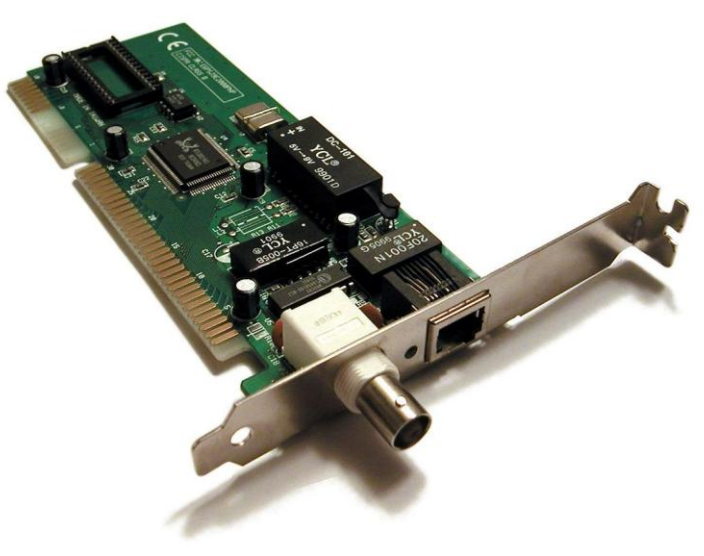
Modem

- Modem is short for "Modulator-Demodulator." It is a hardware component that allows a computer or another device, such as a router or switch, to connect to the Internet.



NIC

- Short for **network interface card**, the **NIC** is also referred to as an **Ethernet card** and **network adapter**. A NIC is a computer expansion card for connecting to a network (e.g., home network or Internet) using an Ethernet cable with an RJ-45 connector.



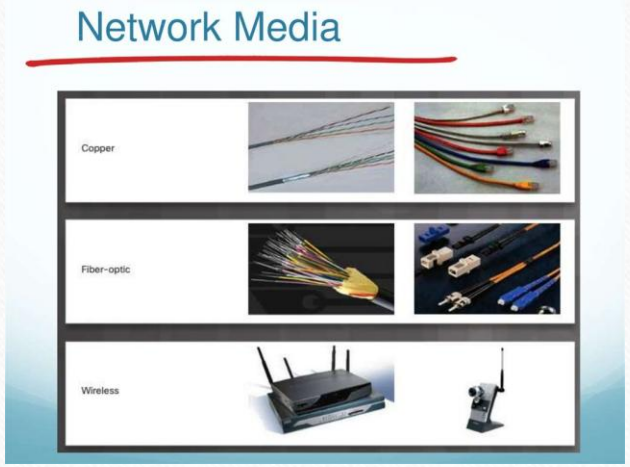
OTHER NETWORK DEVICES

WAN Interface Card

- A **WAN interface card**, or WIC, is a specialized **network interface card** (NIC) that allows devices to connect to a wide area **network**.

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.

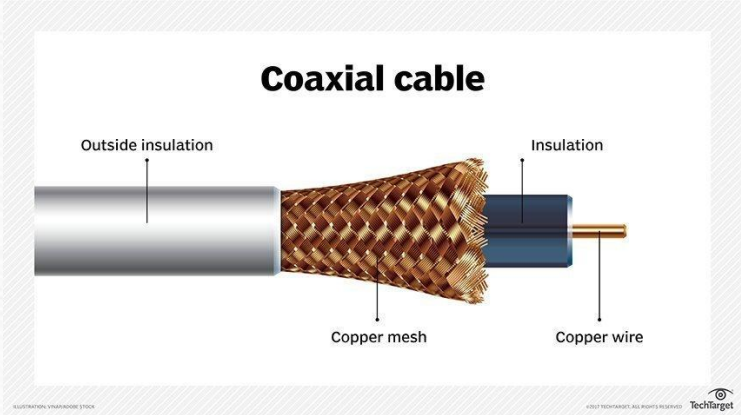


Guided Media

- Coaxial Cable
- STP and UTP Cable
- Power Lines
- Fiber Optic Cable

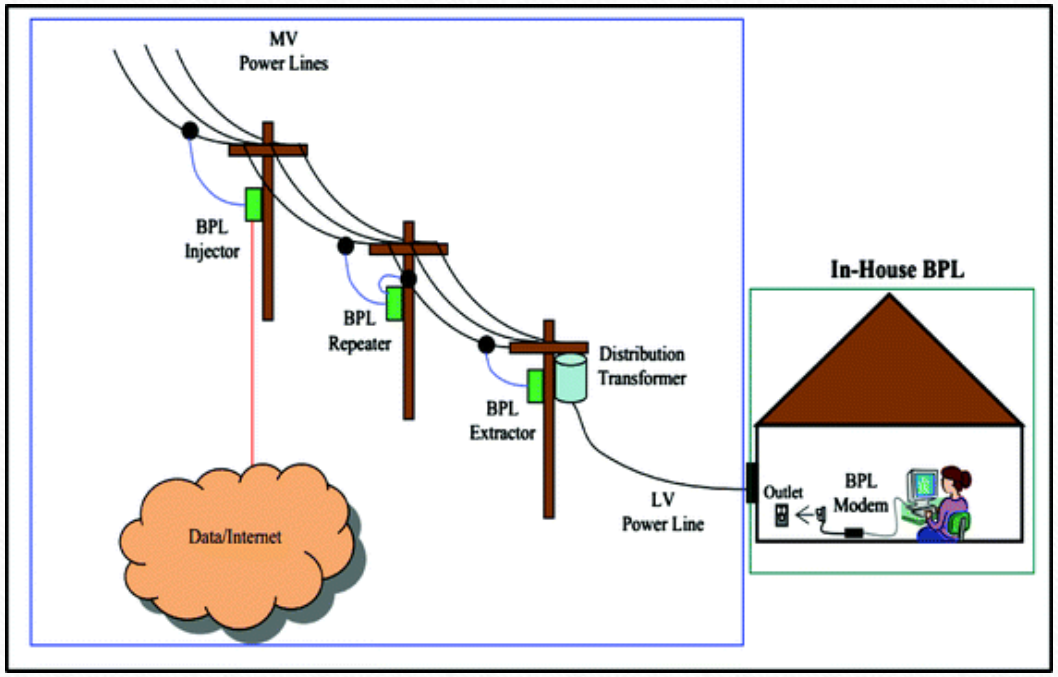
Coaxial Cable

- **Coaxial cable** is a type of copper **cable** specially built with a metal shield and other components engineered to block signal interference. It is primarily used by **cable** TV companies to connect their satellite antenna facilities to customer homes and businesses.



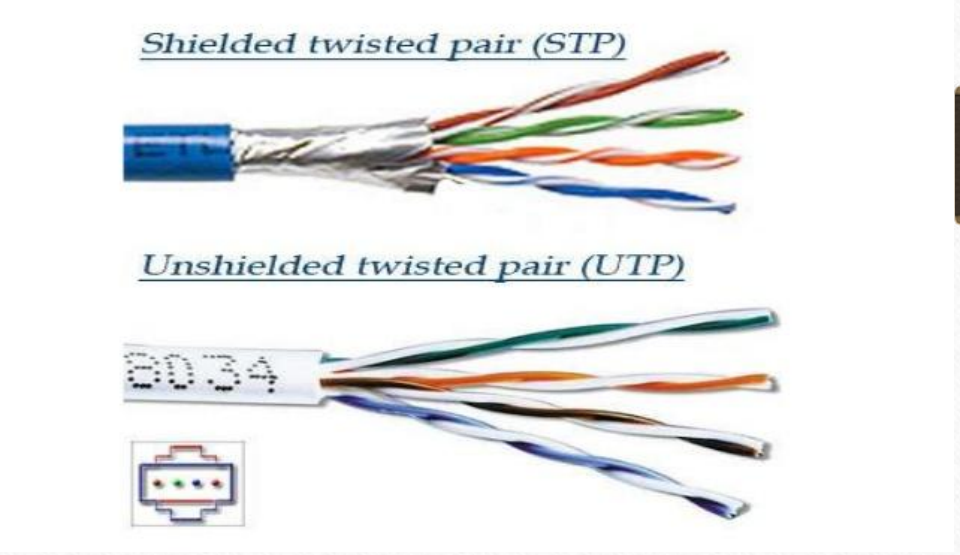
Power Lines

- Power Line communication (PLC) is Layer-1 (Physical Layer) technology which uses power cables to transmit data signals. In PLC, modulated data is sent over the cables. The receiver on the other end de-modulates and interprets the data.



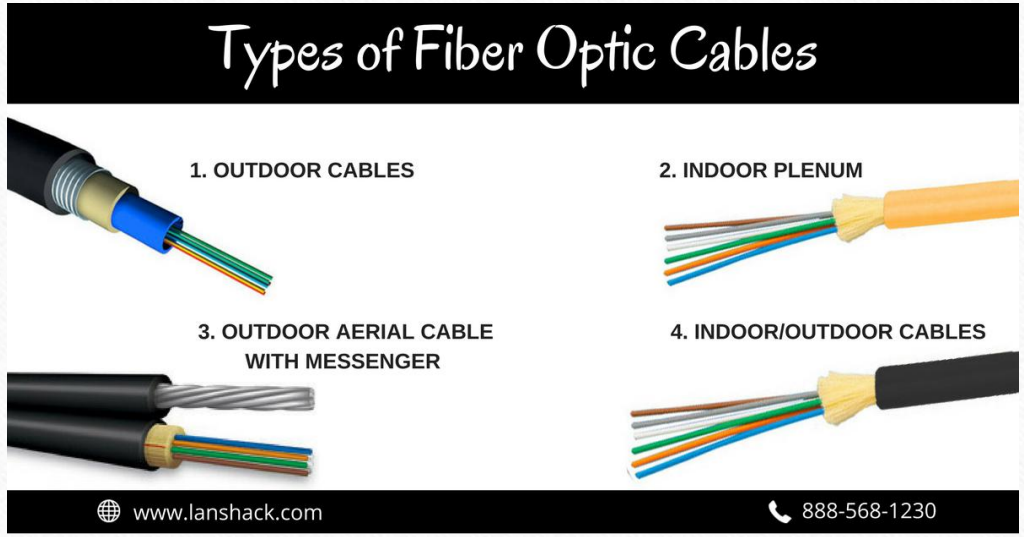
Shielded and Unshielded Twisted Pair Cable

- The basic difference between **UTP and STP** is **UTP** (Unshielded twisted pair) is a **cable** with wires that are twisted together to reduce noise and crosstalk. On the contrary, **STP** (Shielded twisted pair) is a twisted pair **cable** confined in foil or mesh shield that guards the **cable** against electromagnetic interference.



Fiber Optic Cable

- A fiber optic cable is a network cable that contains strands of glass fibers inside an insulated casing. They're designed for long-distance, high-performance data networking, and telecommunications. Compared to wired cables, fiber optic cables provide higher bandwidth and transmit data over longer distances. Fiber optic cables support much of the world's internet, cable television, and telephone systems.



UTP VS WIRELESS VS POWER LINE

FIBER OPTIC CABLE

Unguided Media

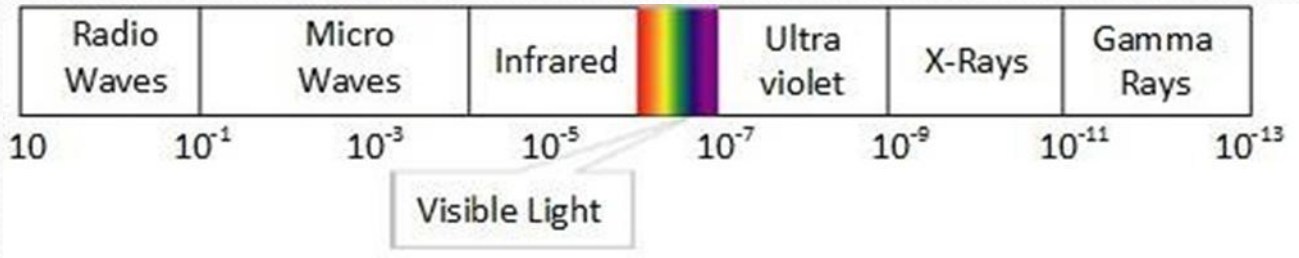
- Radio Transmission
- Microwave Transmission
- Infrared Transmission
- Light Transmission

WIRELESS TRANSMISSION

- Wireless transmission is a form of unguided media. Wireless communication involves no physical link established between two or more devices, communicating wirelessly. Wireless signals are spread over in the air and are received and interpreted by appropriate antennas.
- When an antenna is attached to electrical circuit of a computer or wireless device, it converts the digital data into wireless signals and spread all over within its frequency range. The receptor on the other end receives these signals and converts them back to digital data.

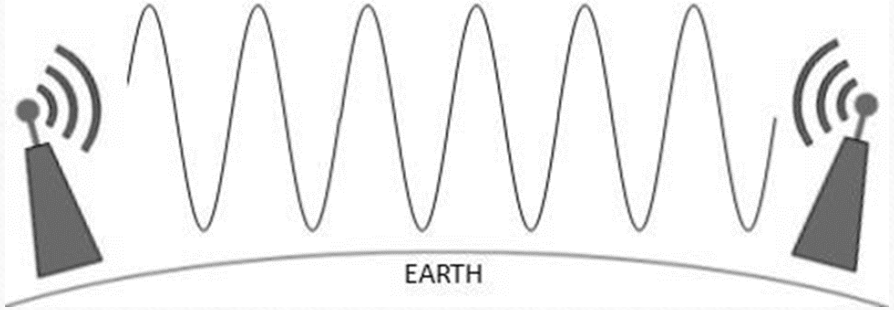
WIRELESS TRANSMISSION

- A little part of electromagnetic spectrum can be used for wireless transmission.



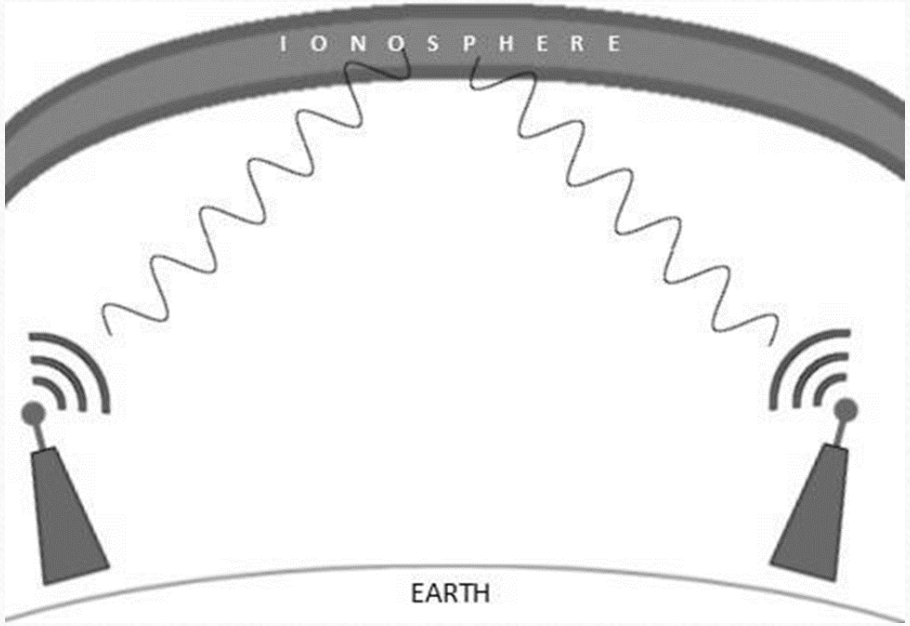
RADIO TRANSMISSION

- Radio frequency is easier to generate and because of its large wavelength it can penetrate through walls and structures alike. Radio waves can have wavelength from 1mm – 100,000km and have frequency ranging from 3Hz (Extremely Low Frequency) to 300 GHz (Extremely High Frequency). Radio frequencies are sub-divided into six bands.
- Radio waves at lower frequencies can travel through walls whereas higher RF can travel in straight line and bounce back. The power of low frequency waves decreases sharply as they cover long distance. High frequency radio waves have more power.
- Lower frequencies such as VLF, LF, MF bands can travel on the ground up to 1000 kilometers, over the earth's surface.



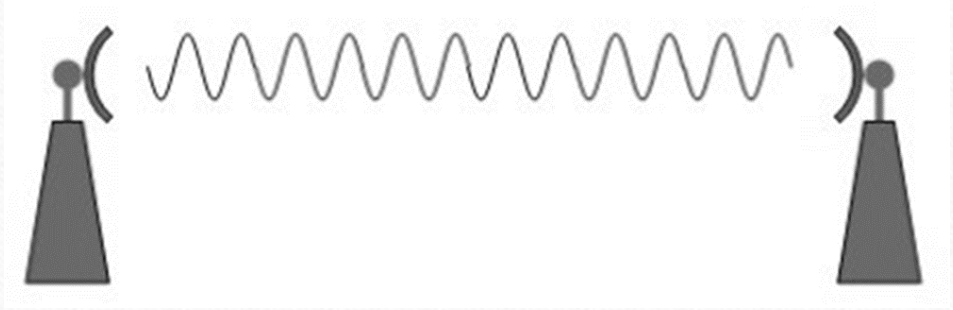
RADIO TRANSMISSION

- Radio waves of high frequencies are prone to be absorbed by rain and other obstacles. They use Ionosphere of earth atmosphere. High frequency radio waves such as HF and VHF bands are spread upwards. When they reach Ionosphere, they are refracted back to the earth.



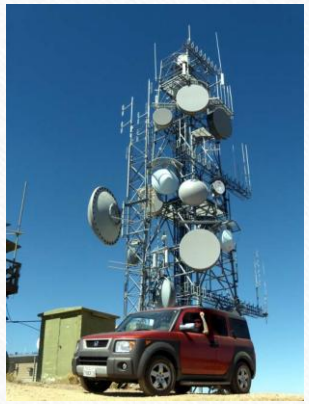
MICROWAVE TRANSMISSION

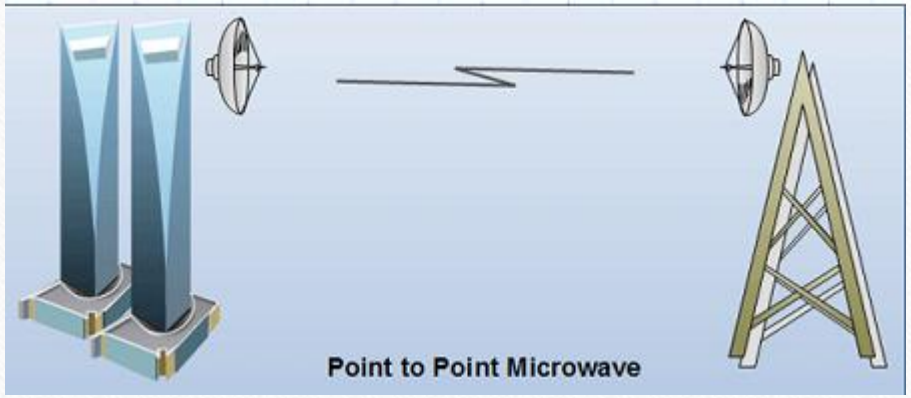
- Electromagnetic waves above 100MHz tend to travel in a straight line and signals over them can be sent by beaming those waves towards one particular station. Because Microwaves travels in straight lines, both sender and receiver must be aligned to be strictly in line-of-sight.
- Microwaves can have wavelength ranging from 1mm – 1meter and frequency ranging from 300MHz to 300GHz.



MICROWAVE TRANSMISSION

- Microwave antennas concentrate the waves making a beam of it. As shown in picture above, multiple antennas can be aligned to reach farther. Microwaves have higher frequencies and do not penetrate wall like obstacles.
- Microwave transmission depends highly upon the weather conditions and the frequency it is using.



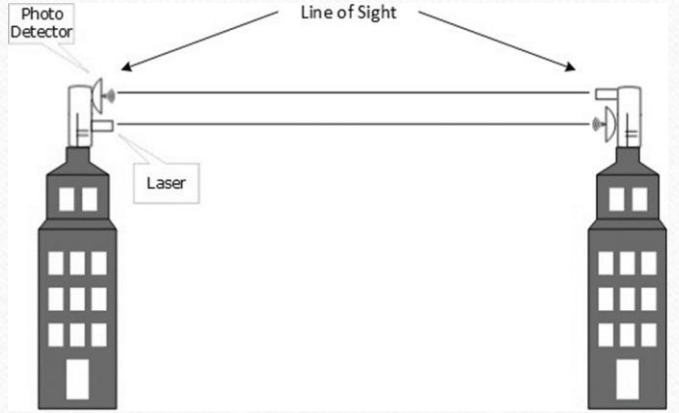


INFRARED TRANSMISSION

- Infrared wave lies in between visible light spectrum and microwaves. It has wavelength of 700nm to 1mm and frequency ranges from 300GHz to 430THz.
- Infrared wave is used for very short range communication purposes such as television and its remote. Infrared travels in a straight line hence it is directional by nature. Because of high frequency range, Infrared cannot cross wall-like obstacles.

LIGHT TRANSMISSION

- Highest most electromagnetic spectrum which can be used for data transmission is light or optical signaling. This is achieved by means of LASER.
- Because of frequency light uses, it tends to travel strictly in straight line. Hence the sender and receiver must be in the line-of-sight. Because laser transmission is unidirectional, at both ends of communication the laser and the photo-detector needs to be installed. Laser beam is generally 1mm wide hence it is a work of precision to align two far receptors each pointing to lasers source.



LIGHT TRANSMISSION

- Laser works as Tx (transmitter) and photo-detectors works as Rx (receiver).
- Lasers cannot penetrate obstacles such as walls, rain, and thick fog. Additionally, laser beam is distorted by wind, atmosphere temperature, or variation in temperature in the path.
- Laser is safe for data transmission as it is very difficult to tap 1mm wide laser without interrupting the communication channel.