# Chapter 1: Introduction

## 1.1 Introduction

By and large, communication(from Latin *commūnicāre*, meaning "to share") is a purposeful activity of exchanging information and meaning across space and time using various technical or natural means, whichever is available or preferred.

Communication requires a sender, a message, a medium and a recipient, although the receiver does not have to be present or aware of the sender's intent to communicate at the time of communication; thus communication can occur across vast distances in time and space. Communication requires that the communicating parties share an area of communicative commonality. The communication process is complete once the receiver understands the sender's message.

In this chapter, we will discuss about telecommunication.

## 1.2 Telecommunication

Telecommunications, also called telecommunication, is the exchange of information over significant distances by electronic means. A complete, single telecommunications circuit consists of two stations, each equipped with a transmitter and a receiver. The transmitter and receiver at any station may be combined into a single device called a transceiver. The medium of signal transmission can be electrical wire or cable (also known as "copper"), optical fiber or electromagnetic fields. The free-space transmission and reception of data by means of electromagnetic fields is called wireless.

The simplest form of telecommunications takes place between two stations. However, it is common for multiple transmitting and receiving stations to exchange data among themselves. Such an arrangement is called a telecommunications network The Internet is the largest example. On a smaller scale, examples include:

- Corporate and academic wide-area networks (WANs)
- Telephone networks
- Police and fire communications systems

- Taxicab dispatch networks
- Groups of amateur operators

Data is conveyed in a telecommunications circuit by means of an electrical signal called the carrier or carrier wave. In order for a carrier to convey information, some form of modulation is required. The mode of modulation can be broadly categorized as either analog or digital. In analog modulation, some aspect of the carrier is varied in a continuous fashion. The oldest form of analog modulation is amplitude modulation (AM), still used in radio broadcasting at some frequencies. Digital modulation actually predates analog modulation; the earliest form was Morse code. During the 1900s, dozens of new forms of modulation were developed and deployed, particularly during the so-called "digital revolution" when the use of computers among ordinary citizens became widespread.

In some contexts, a broadcast network, consisting of a single transmitting station and multiple receive-only stations, is considered a form of telecommunications. Radio and television broadcasting are the most common examples.

## 1.3 Major elements of telecommunication

A basic telecommunication system consists of three primary units that are always present in some form:

- A transmitter that takes information and converts it to a signal.
- A transmission medium, also called the "physical channel" that carries the signal. An example of this is the free space channel.
- A receiver that takes the signal from the channel and converts it back into usable information.

For example, in a radio broadcasting station the station's large power amplifier is the transmitter; and the broadcasting antenna is the interface between the power amplifier and the "free space channel". The free space channel is the transmission medium; and the receiver's antenna is the interface between the free space channel and the receiver. Next, the radio receiver is the destination of the radio signal, and this is where it is converted from electricity to sound for people to listen to. Sometimes, telecommunication systems are duplex (two-way systems) with a single box of electronics working as both a transmitter and a receiver, or a *transceiver*. For example, a cellular telephone is a transceiver. The transmission electronics and the receiver electronics in a transceiver are actually quite independent of each other. This can be readily explained by the fact that radio transmitters contain power amplifiers that operate with electrical powers measured in the watts or killowatts, but radio. Receivers deal with radio powers that are measured in the microwatts or nanowatts. Hence, transceivers have to be carefully designed and built to isolate their high-power circuitry and their low-power circuitry from each other. Telecommunication over fixed lines is called point to point telecommunication because it is between one transmitter and one receiver. Telecommunication through radio broadcasts is called broadcast telecommunication because it is between one powerful transmitter and numerous low-power but sensitive radio receivers. Telecommunications in which multiple transmitters and multiple receivers have been designed to cooperate and to share the same physical channel are called multiplex systems. The sharing of physical channels using multiplexing often gives very large reductions in costs. Multiplexed systems are laid out in telecommunication networks, and the multiplexed signals are switched at nodes through to the correct destination terminal receiver.

## 1.4 Forecast about telecommunication market in Bangladesh

After deregulation of the mobile market and the entry of two new operators (bringing the total number of mobile providers to five) in 2005, Bangladesh witnessed a period of booming growth in mobile subscriber numbers. While overall growth has slowed somewhat over the last two or three years, the market continues to expand in a healthy fashion. The issue of 3G licences by auction in late 2013 and the subsequent launch of 3G networks has given a huge boost to the mobile/internet segment. Foreign investment interest has also continued to be high. This report describes how the mobile market is growing and the impact this growth is having on the developing nation, as well as providing an outline of the main players. The introduction of 3G is particularly covered. The report also has a brief overview of the TV broadcasting sector.

**Key Developments:**

- the first 3G licence in the country was awarded to Teletalk;
- the state-owned operator launched a pilot 3G offering in September 2012;
- the much-anticipated 3G auction was finally held in September 2013;

- four operators - GrameenPhone Banglalink, Robi Axiata and Bharti Airtel - acquired 3G spectrum in the auction;
- the operators followed up quickly with network launches;
- overall mobile penetration had grown to 74% by September 2014, the 100 million mobile subscriber milestone having been passed in 2013;
- after banning the selling pre-activated SIM cards without proper subscriber identification, the BTRC continued follow up its decision with a strong enforcement policy;
- CDMA operator CityCell's plan to launch a GSM network after being granted a licence in 2013 seemed to be running into difficulties;
- the regulator was working to free up the 700MHz band to allow use by mobile operators for possible 4G LTE services.

**Companies covered in this report include:**

GrameenPhone; CityCell (PBTL); Orascom Telecom Bangladesh (formerly Sheba Telecom); Banglalink; Robi Axiata (formerly Aktel); Teletalk (Bangladesh Telegraph and Telephone Board); Airtel Bangla (formerly Warid Telecom).

## 1.5 Motivation

**Generally, motivation** is the driving force within individuals that impels them to action.The driving force is produced by a state of tension, which exists as the result of an unfulfilled need.The specific goals they select and the patterns of actions they undertake to achieve their goals are the result of individual thinking and learning. A good reward system is necessary to motivate the employees of an organization. This study was conducted in order to investigate the impact of rewards on the motivational level of employees of telecommunication sector of Bangladesh. The impact of three independent variables rewards, monetary rewards and non-monetary rewards on the dependent variable motivation was studied. Four dimensions of motivation, focus, determination, effort and satisfaction were considered for the development of theoretical framework. A total of 292 questionnaires were returned fully complete. The research study showed that there exists a strong positive relationship in rewards and motivation among the employees. It was concluded that monetary rewards have greater impact on motivation of employees than the non-monetary rewards. Significant differences in rewards offered to employees and motivation level were found in the analysis of comparison of means with respect to gender, age group, marital status, working duration in the organization and salary.

## 1.6 Objective of Telecommunication

The broad Bangladesh Telecommunication Policy objectives are:

1) To encourage orderly development of telecommunications system that serves to augment and strengthen the social and economic welfare of Bangladesh;
2) To ensure access to and delivery of a full range of reliable. Reasonable priced, up to date telecommunications services to as many people as is economically and socially justifiable.
3) To enhance the efficiency and competitiveness, at the national and international level of Bangladesh Telecommunications;
4) To rely increasingly on competition and a market oriented regime in the provision of telecommunication services and to ensure that regulation, where required, is efficient and effective,
5) To stimulate research and development in Bangladesh in the field of telecommunications and to encourage innovation in provision of telecommunication services;
6) To protect the interest and respond to the needs, both social and economic, of users of telecommunication services, to maintain and promote competition among service providers;
7) To encourage introduction of new services and to encourage major users outside Bangladesh to establish places of business in Bangladesh.
8) The Government of Bangladesh has plan to increase the number of telephone lines to 1300000 in the country from about 500000 now within the next two years. This will raise the ratio of telephone lines to 1:100 from the existing 0.4:100 people. The policy has emphasized improvement of telecommunications system in the private sector and creation of a competitive environment for expansion and improvement of the services. Foreign investment in the sector will also be encouraged. The private operators will play a strong role in the sector in future and the Government will provide all necessary cooperation.

9) Replacement of the analog system with digital system will be made within the year 2005 to improve the services and create confidence among the people. The ratio of telephone lines will have to be increased to 4:100 people within the year 2010, it said. Under the long term plan private sector operations will be allowed in all areas of infrastructure development after the year 2010. The fact that BTTB is a departmental enterprise, combined with its position as an enterprise through which important Government objectives are met, it is unlikely that BTTB can achieve greater autonomy under its current legal and regulatory status.

# Chapter 2: Telecommunication System Overview

## 2.1 Introduction

In its most fundamental form, a telecommunication system includes a transmitter to take information and convert it to a signal, a transmission medium to carry the signal and a receiver to take the signal and convert it back into usable information. This applies to any communication system, whether it uses computers or not. Most modern day telecommunications systems are best described in terms of a network. This includes the basic elements listed above but also the infrastructure and controls needed to support the system. There are six basic components to a telecommunications network.

## 2.2 Definition

Telecommunications refers to the exchange of information by electronic and electrical means over a significant distance. A complete telecommunication arrangement is made up of two or more stations equipped with transmitter and receiver devices. A single co-arrangement of transmitters and receivers, called a transceiver, may also be used in many telecommunication stations.

## 2.3 Major Components of Telecommunication

- Input and output devices, also referred to as 'terminals'. These provide the starting and stopping points of all communication. A telephone is an example of a terminal. In computer networks, these devices are commonly referred to as 'nodes' and consist of computer and peripheral devices.
- Telecommunication channels, which transmit and receive data. This includes various types of cables and wireless radio frequencies.
- Telecommunication processors, which provide a number of control and support functions. For example, in many systems, data needs to be converted from analog to digital and back.
- Control software, which is responsible for controlling the functionality and activities of the network.
- Messages represent the actual data that is being transmitted. In the case of a telephone network, the messages would consist of audio as well as data.
- Protocols specify how each type of telecommunication systems handle the messages. For example, GSM and 3G are protocols for mobile phone communications, and TCP/IP is a protocol for communications over the Internet.

## 2.4 Basic Block Diagram BTCL

Different Techniques are used to make a successful communication of telephone calling system .BTCL uses the following Procedure to communicate one user to another.

Calling System of BTCL

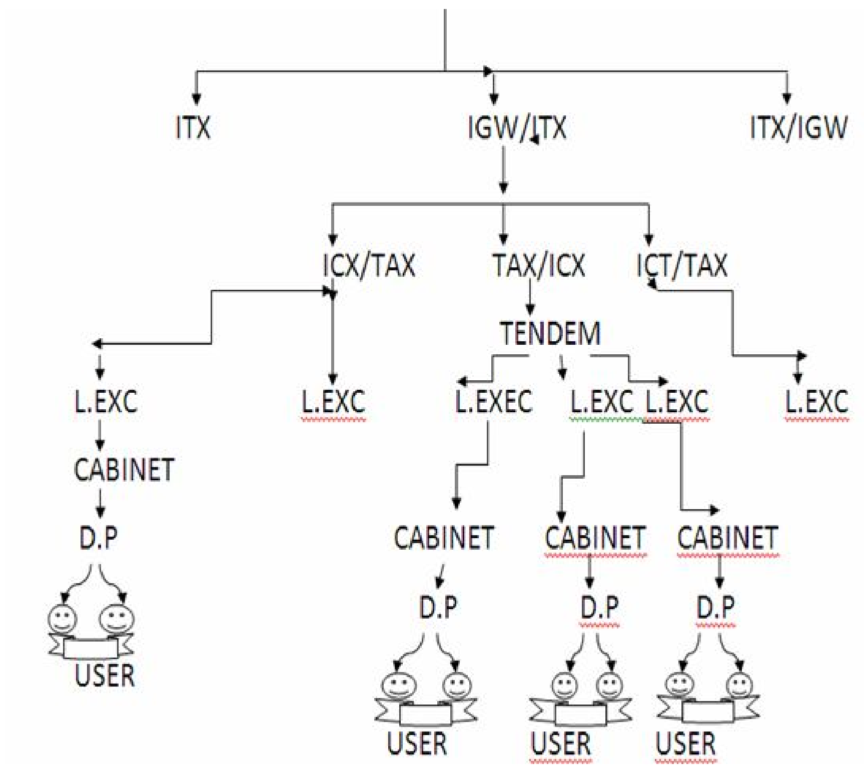


Fig 2.1: Calling System of BTCL

- ITX= International Trunk Exchange.
- IGW= International Gateway.
- ICX= Interconnected Exchange.
- TAX= Trunk Auto Exchange.
- LEX= Local Exchange.

IGW/ITX: International Gateway Facilities (IGFs) Systems or equipment that provide access between telephone systems in different countries. International gateways may convert SS7 and other signaling formats between different signaling formats. These include ANSI standards, ITU standards, national variants of SS7 signaling standards, MF signaling, and R2 signaling. International gateways may also provide for transcoding services between mu-LAW PCM and A-LAW PCM speech coding.

TAX/ICX: Inter-connecting exchange. Present existing communication network of BTCL supports one TAX/ICX each district of Bangladesh.

TANDEM: Next-generation soft switch solutions are powerful multi-technology telecommunications systems ideal for public exchange switching including end office, tandem office, and international gateways. With its patented distributed architecture, it provides a versatile platform for managing complex communications in a variety of public network applications

Local Exchange: Present existing communication network of BTCL supports one Local Exchange at every thana in Bangladesh.

Cabinet: In communication systems, a cabinet is an enclosure that is used to hold equipment or electronic assemblies.

Distribution Point: There is no checking at this point. For the easiness of line distribution this type of point is very necessary.

Receiver (User): This is user end. There is a receiver which convert electrical signal into voice signal and vice versa.

Trunk: Exchange to exchange connection is called trunk. It may be wired or wireless.

Primary Cable: Local exchange to cabinet connection is called primary cable.

Secondary Cable: Connection from cabinet to distribution point is called secondary cable.\

Drop wire: Distribution point to receiver is called drop wire.

## 2.5 GATEWAY Exchange

The gateway exchange is the center at which the international exchange multiplex equipment and ancillary equipment, for international telephone and/or telegraph, Telex data, Television and Facsimile are located. The gateway exchange is an international transit exchange-(A transit exchange is that to which no subscribers are connected directly but it serves as switching centers among different exchanges, it also serves as tandem exchange), to which different transit exchanges are connected. The gateway exchange connects the subscribers to an exchange outside the country.

All international trunks of a country are connected to the gateway exchange. The international trunks are brought to the international gateway from their points of arrival, by cable transmission systems and line-of-sight microwave radio systems. The international exchange performs the following two functions:

1. International gateway: providing a means of connecting calls from the national system of a country to the international network.
2. Trunk exchange: It acts as a trunk exchange for calls connected between other countries.

## 2.6 DDFs in Telecom Networks

A Digital Distribution Frame (DDF) is the interface when coaxial cable has to be terminated, organized or cross-connected in long-distant transport networks, or in access Networks close to subscribers. In fixed networks, a DDF is installed between the exchange and transmission equipment, to mention one example. In mobile networks, DDFs can also serve as the interface between an MSC (Mobile Services Switching Centre)or BSC (Base Station Controller) and the transmission equipment.75 ohm. Digital Distribution Frames are used to terminate, cross-connect and inter-connect 75 ohm coaxial cables, and to supervise digital transmission equipment. In the DDF, signals can be extracted from the desired level to measure incoming and outgoing signals, allowing the rearrangement or disconnection of traffic.

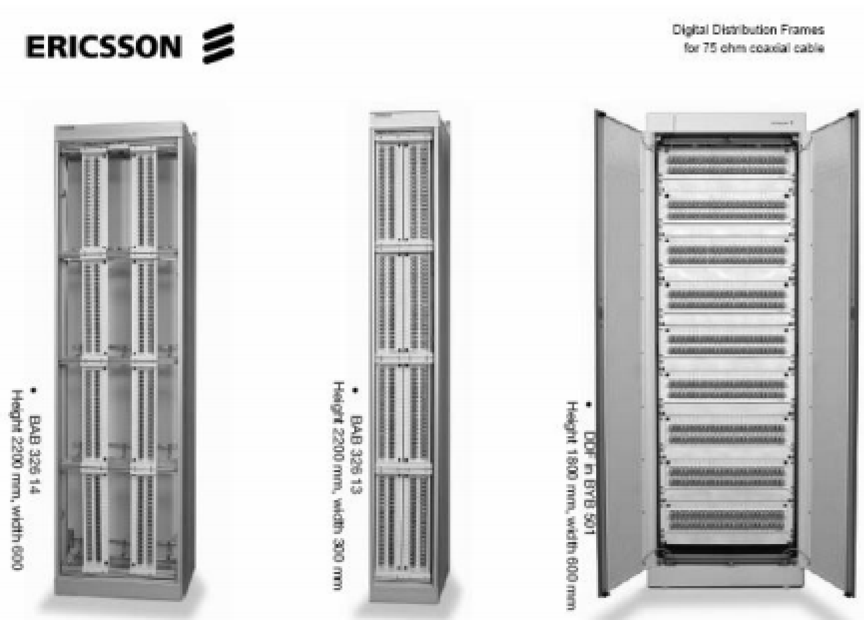


Fig 2.2: DDF

## 2.7 Switching System

The assemblies of switching and control devices provided so that any station in a communications system may be connected as desired with any other station. A telecommunications network consists of transmission systems, switching systems, and stations. Transmission systems carry messages from an originating station to one or more distant stations. They are engineered and installed in sufficient quantities to provide a quality of service commensurate with the cost and expected benefits. To enable the transmission facilities to be shared, stations are connected to and reached through switching system nodes that are part of most telecommunications networks. Switching systems act under built-in control to direct messages toward their ultimate destination or address.

Telecommunications switching systems generally perform three basic functions:

- They transmit signals over the connection or over separate channels to convey the identity of the called (and sometimes the calling) address (for example, the telephone number), and alert (ring) the called station;
- They establish connections through a switching network for conversational use during the entire call;
- They process the signal information to control and supervise the establishment and disconnection of the switching network connection.

In some data or message switching when real-time communication is not needed, the switching network is replaced by a temporary memory for the storage of messages. This type of switching is known as store-and-forward switching.

Fig 2.3: Switching System

# Chapter 3: Transmission Sub System

In telecommunications, transmission sub system is used for receiving and transmitting commands and data. The two kinds of transmission Sub System are wired based transmission system and another is wireless transmission system.

## 3.1 Wired based Transmission system

Wired based Transmission system belongs to the web-based client-server systems. It refers to the transmission of data over a wired-based communication technology.

Wired based Transmission system can support hardware manufacturers and network operators in developing, introducing and operating wired transmission technologies and to help create significantly more added value for the customer.

## 3.2 Evolution of Wired transmission system

- Co-axial cable Transmission
- Twisted pair PCM Transmission
- Optical fiber Transmission

### 3.2.1 Co-axial cable Transmission

Coaxial cable is used as a transmission line for radio frequency signals. Its applications include feedlines connecting radio transmitters and receivers with their antennas, computer network (Internet) connections, and distributing cable television signals. One advantage of coaxial over other types of radio transmission line is that in an ideal coaxial cable the electromagnetic field carrying the signal exists only in the space between the inner and outer conductors.

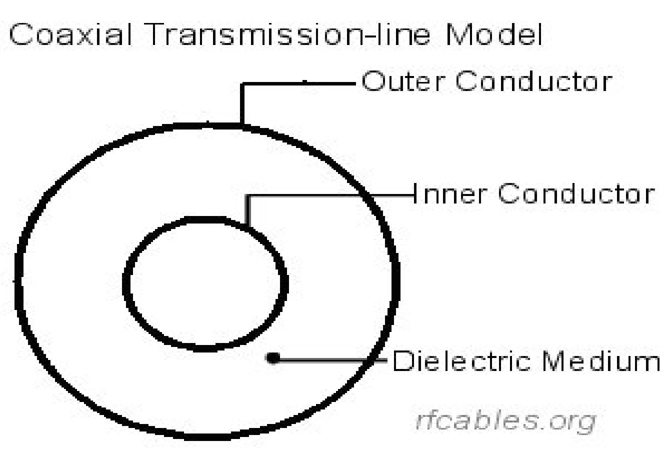


Fig 3.1: Coxial cable Transmission

Application of Co-axial cable Transmission

- ✓ Most versatile medium
- ✓ Television distribution
  - ▪ Ariel to TV
  - ▪ Cable TV
- ✓ Long distance telephone transmission
  - Can carry 10,000 voice calls simultaneously
  - Being replaced by fiber optic
- ✓ Short distance computer systems links
- ✓ Local area networks.

### 3.2.2 Twisted Pair PCM Transmission

Twisted pair cable consists of a pair of insulated wires twisted together. It is a cable type used in telecommunication for very long time. Cable twisting helps to reduce noise pickup from outside sources and crosstalk on multi-pair cables. Twisted pair cable is good for transferring balanced differential signals. The practice of transmitting signals differentially dates back to the early days of telegraph and radio. The advantages of improved signal-to-noise ratio, crosstalk, and ground bounce that balanced signal transmission bring are particularly valuable in wide bandwidth and high fidelity systems. By transmitting signals along with a 180 degree out-of-phase complement, emissions and ground currents are theoretically canceled. This eases the requirements on the ground and shield compared to single ended transmission and results in improved EMI performance.

Applications of Twisted Pairs

- ➢ Most common medium
- ➢ Telephone network
  - Between house and local exchange (subscriber loop)
- ➢ Within buildings
  - To private branch exchange (PBX)
- ➢ For local area networks (LAN)
  - 10Mbps or 100Mbps

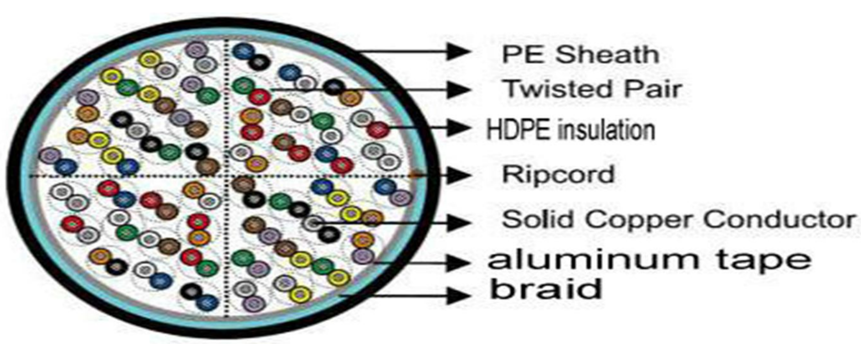

Fig 3.2: Twisted-pair transmission model

### 3.2.3 Optical fiber Transmission

Fiber-optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. The light forms an electromagnetic carrier wave that is modulated to carry information.

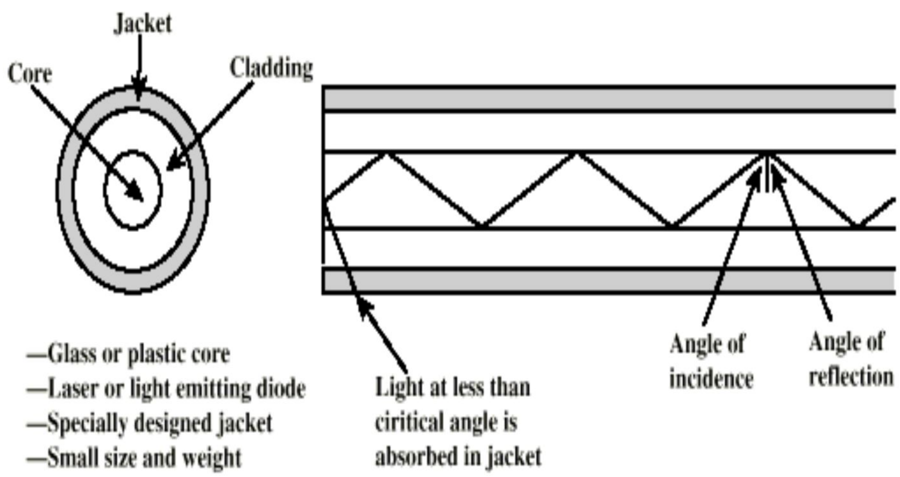


Fig 3.3: Optical fiber Transmission

Applications of Optical fiber Transmission:

- Long-haul trunks
- Metropolitan trunks
- Rural exchange trunks
- Subscriber loops
- LANs

## 3.3 Wireless Transmission System

Wireless Transmission system is the transmission of electrical power from a power source to an electrical load without using solid wires or conductors.[1][2] It is a generic term that refers to a number of different power transmission technologies that use time-varying electromagnetic fields. Wireless transmission is useful to power electrical devices in cases where interconnecting wires are inconvenient, hazardous, or cannot be run.

## 3.4 Evolution of Wireless Transmission System

- HF radio system ( 3-30MHz)
- VHF radio system ( 30-300MHz)
- UHF and Microwave Radio System ( 300MHz-300GHz)

### 3.4.1 HF radio system

High Frequency (HF) radio is used for first-line and backup communications over long distances, mainly in remote regions of the developed world and in developing countries. Government and private organizations are continually searching for the most flexible, reliable and cost effective solutions for their remote, emergency and security communications needs.

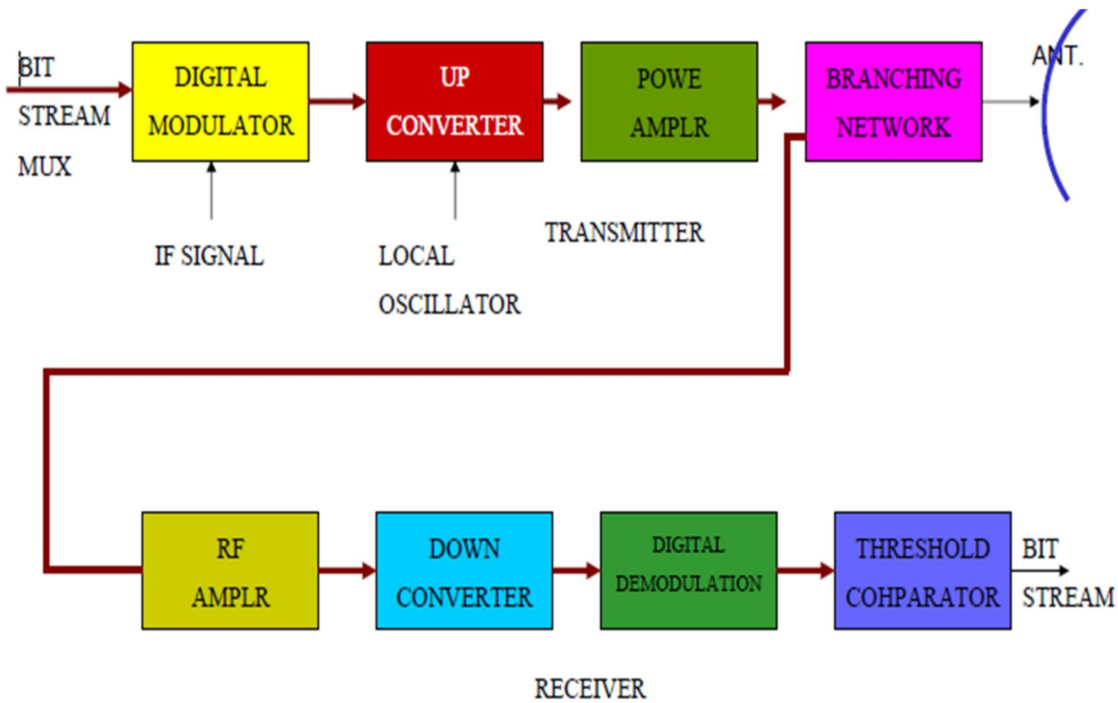


Fig 3.4: Digital Radio System

Uses of HF radio system

- Military and governmental communication systems
- Aviation air-to-ground communications
- Amateur Radio
- Shortwave international and regional broadcasting
- Maritime sea-to-shore services
- Over the horizon radar systems
- Global Maritime Distress and Safety System (GMDSS) communication.

### 3.4.2 VHF Radio System

VHF radio system is used for the range of radio frequency electromagnetic waves from 30 MHz to 300 MHz, with corresponding wavelengths of ten to one meters.

VHF propagation characteristics are suited for short-distance terrestrial communication, with a range generally somewhat farther than line-of-sight from the transmitter. Unlike high frequencies (HF), the ionosphere does not usually reflect VHF waves so transmissions are restricted to the local radio horizon less than 100 miles.

Uses of VHF radio system

- FM radio broadcasting
- Television broadcasting
- Two way land mobile radio system
- Long range data communication
- Air traffic control communication
- Air navigation system
- Analog television station

Whilst VHF and UHF radio is also commonly used for short-range line-of sight (LOS) communications, only HF is capable of communicating over distances of 3000 km or more.

### 3.4.3 UHF and Microwave Radio System

UHF and Microwave Radio System is used for radio frequencies in the range between 300 MHz and 3 GHz, also known as the decimetre band as the wavelengths range from one to ten decimetres.

The main advantage of UHF transmission is the short wavelength that is produced by the high frequency. The size of transmission and reception antennas is related to the size of the radio wave.

The UHF antenna is stubby and short. Smaller and less conspicuous antennas can be used with higher frequency bands.

Uses of UHF and Microwave Radio System

- Television broadcasting
- Cordless phones
- Walkie-talkies
- Persona radio services satellite communication
- Cell phones application.

## 3.5 Access Network

Network access is a critical component of any organization's network infrastructure. Administrators have to dynamically enable and control network access for employees, vendors, business partners, and entire branch offices that are in a variety of physical locations and that are using many different types of devices. Enabling network access, while maintaining security, is an enormous challenge for administrators.

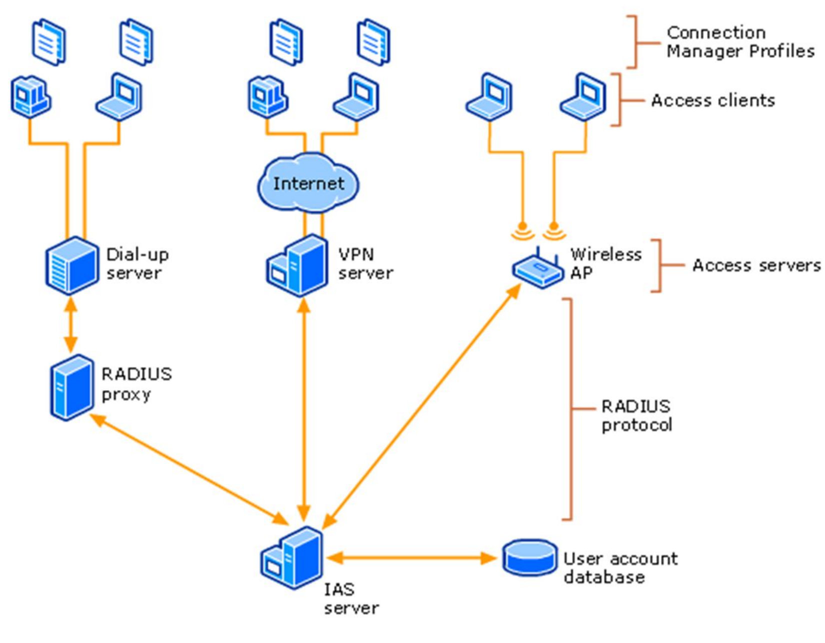


Fig 3.5: Access Network Technology

An access point connects wired and wireless networks together and enables the sending and receiving of data between wireless clients and the wired network. Using multiple access points increases total system capacity and range. Users can "roam" between access points without losing their connection similar to the way a cellular phone can roam between cellular phone towers.

## 3.6. Components of Access Network

- Wired Access Network
- Wireless Access Network

### 3.6.1 Wired Access Network

The wired network connection requires a computer to be connected to a port in the wall via an ethernet cable, whereas the wireless network connection can be accessed without a cable.

Wired Access Network can transferred data over a wire-based communication technology. It means a communication technology that don't rely on wires.

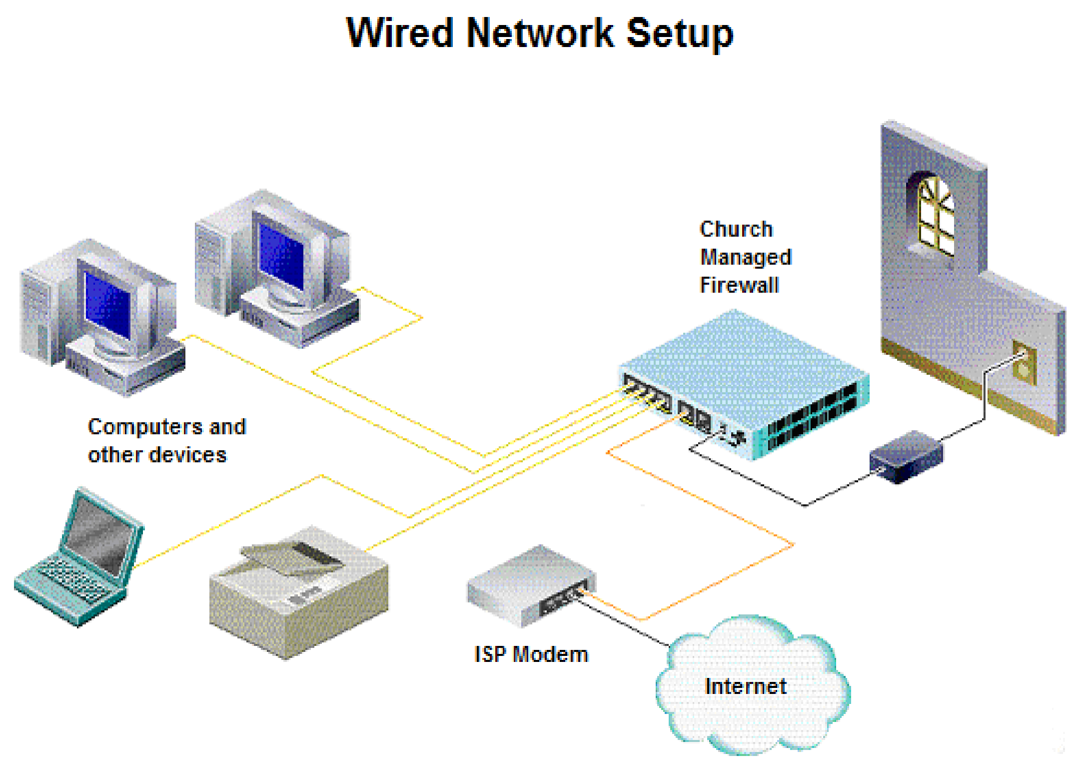


Fig 3.6: Wired Access Network

### 3.6.2 Wireless Access Network

A wireless network is any type of computer network that uses wireless data connections for connecting network nodes.

Wireless telecommunications networks are generally implemented and administered using radio communication. This implementation takes place at the physical level (layer) of the OSI model network structure.

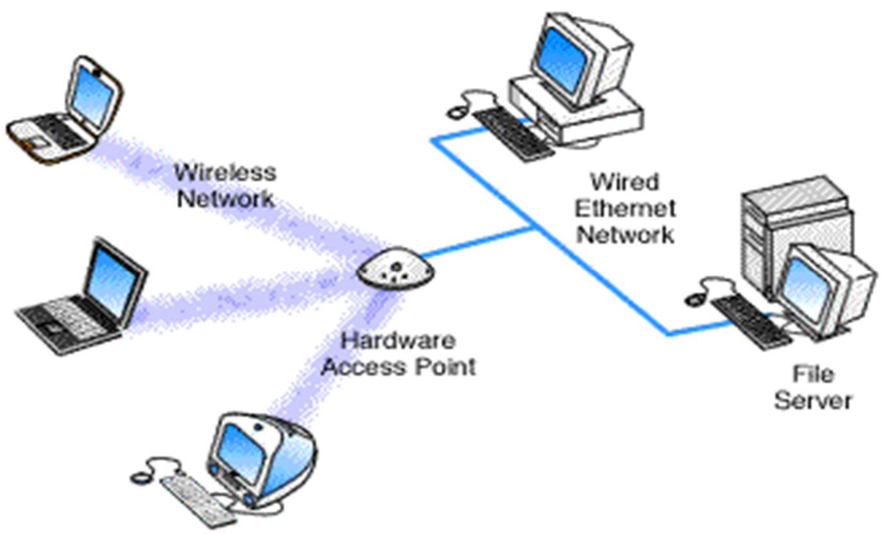


Fig 3.7: Wireless Network Access

# Chapter 4: Fiber Optic Communication

## 4.1 Introduction

Optic or optical communication is the communication process where light is used to carry information. Here used electronic devices to perform the process. And Fiber Optic communication is a method of transmitting information from one place to another by sending pulses of light through an optical fiber. The light forms an electromagnetic carrier wave that is modulated to carry information.

Fiber Optic is dielectric waveguide of cylindrical geometry with core and cladding of suitable material. The main motivation is to meet demand of increase in the telecommunication data transmission.

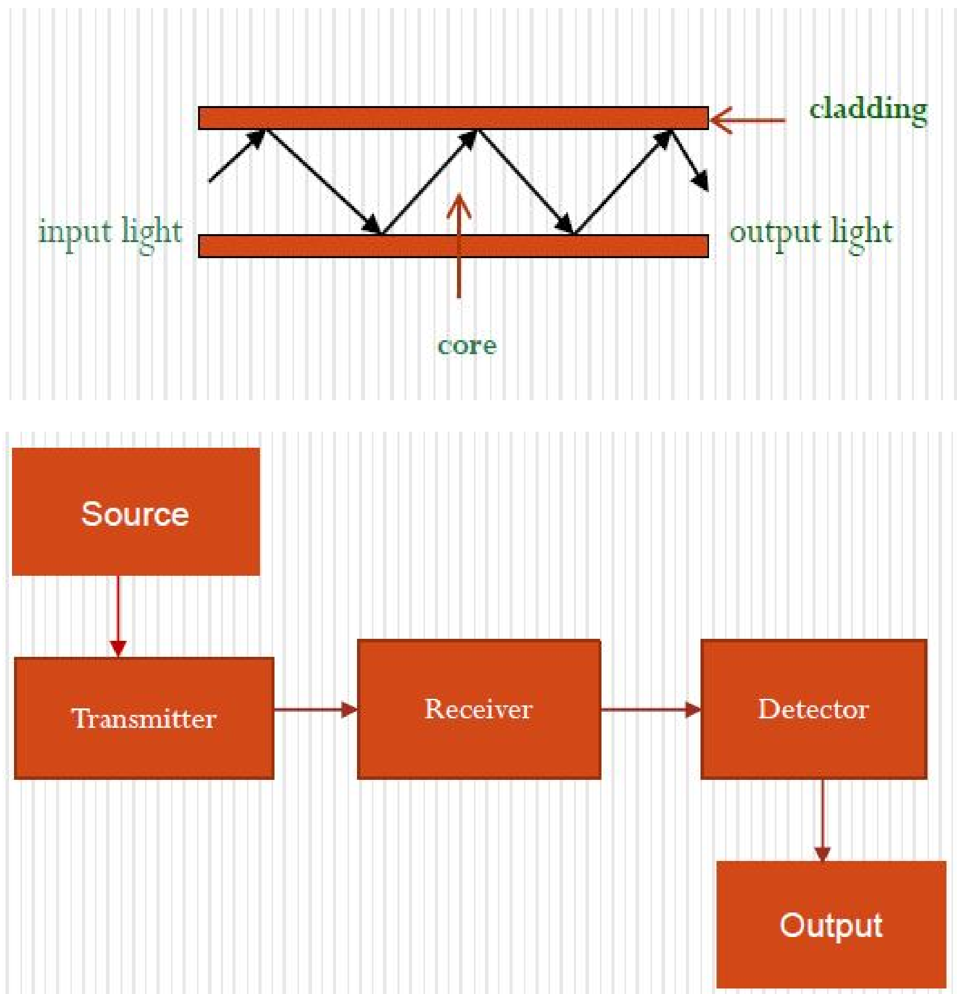


Fig 4.1: Fiber Optic Communication System Model

## 4.2 Application

- Interconnects : Interconnections are one of the largest and most widely used areas for fiber optic cables and assemblies.

- Networking : Networking is a wide ranging and loosely defined area in the industry. With all broadband and MSO applications using a network structure...

- Gigabit Ethernet: Gigabit Ethernet solutions have become a necessity with the accelerating growth of LAN traffic, pushing network administrators to look for higher speed...

- Military: Fiber optic products are used in a variety of military applications requiring rigorous testing and harsh environment certification to ensure reliability.

- Data Transfer Tests : Fiber optic products are designed and manufactured to optimize your data storage process and also to effectively manage the testing of.

- Unmanned Aerial Vehicles: Unmanned Aerial Vehicles (UAVs) are a relatively new and rapidly growing application for fiber optic communications. Utilized as the primary communications conduit.

- Data Storage Equipment : The main function of fiber optics in data storage equipment is to provide the communications link between multiple devices on a network.

- Diagnostics & Troubleshooting: Fiber optics for diagnostics and troubleshooting are used in varying capacities to test, measure, analyze, transmit, distribute, and/or simulate an optical signal.

- Simulation : Network or signal simulation is a widely used method for testing, training, demonstration, and diagnostics of equipment, networks, and physical infrastructure applications.

- Premise Networks : Premise network is defined as the transmission network (LAN) inside the users' building or group of buildings that connects the various types.

- Carrier Networks : Carrier networks are defined as a network, or series of networks, providing connectivity to cities, towns, or other entities on a large.

- Independent Telecommunication Providers : The independent telecommunication providers segment is an area of the industry that provides service(s) in rural areas, typically supporting residential and small.

- Outside Plant: Outside plant is defined as all the cables, conduits, ducts, poles, towers, repeaters, repeater huts, and other equipment located between a demarcation.

- Semiconductor Equipment : Fiber optics are commonly used in the semiconductor industry for a variety of applications. The unique performance characteristics of fiber optics make.

- Network Equipment: Fiber optics are used for a wide variety of applications in the network equipment market. Typically, fiber optics are used as internal.

- Broadcast : Broadcast media utilizes outside plant, ruggedized, and harsh environment fiber optic products to support a variety of connectivity and communication requirements. These broadcast.

- Automotive: Fiber optic technology is becoming the medium of choice for a variety of automotive applications. With its unique characteristics, fiber optics are.

- Sensing: Fiber optics for sensing applications are used to communicate with a sensor device, or use a fiber as the sensor itself.

- Electronics : Fiber optic products for the electronics market cover a wide range of applications, from integrated internal component links to external product-to-product communications.

- Oil & Gas : Fiber optics are used for a number of applications in the oil and gas markets. These markets require very specific cabling.

- FTTx : FTTx (Fiber To The X), most commonly covers FTTh (Fiber To The Home), FTTc (Fiber To The curb), FTTp .

- HDTV: HDTV (high definition television) is the broadcasting of a higher resolution format than possible with traditional analog television broadcasting.

- CATV : CATV (cable television) systems support multiple services including broadcast television, on-demand entertainment (video), and high speed internet access.

- Data Transmission: Data transmission fiber optics, simply put, is the sending and receiving of data from point-to-point via a network, thus the fundamental function

- Imaging: Fiber optic imaging is used for a myriad of applications across several different industries. The concept of fiber optic imaging uses.

- Illumination: Fiber optic illumination is the conveyance or transmission of light from a source (output) to one or several fibers, allowing light to.

- Institutions: Fiber optics for institutions represent a small but growing area of the market. With many of these organizations focusing on education, research.

- Education : Educational institutions are finding many ways to apply fiber optic technology on their campuses. From research and classroom applications to setting up.

- Ship to Shore :Fiber optics for ship to shore applications are designed to provide data, phone, and other services to docked ships via umbilical cable.

- Space : Over the last several years, fiber optics have become increasingly popular in space environments as a medium of choice for a variety.

## 4.3 Technology

Including an optical transmitter, a cable, multiple kinds of amplifiers and an optical receiver modern fiber-optic communication is structured. Transmitter is used to convert an electrical signal into an optical signal to send into the optical fiber. Cable containing bundle of multiple optical fibers that is routed through underground conduits and buildings. An optical receiver to recover the signal as an electrical signal.

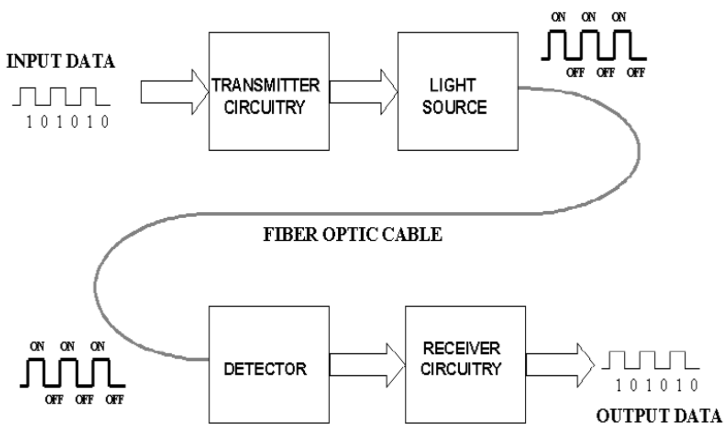


Fig 4.2: Basic fiber optic communication

### 4.3.1 Transmitters

The most commonly used optical transmitters are semiconductor devices such as light-emitting diodes (LEDs) and laser diodes. The difference between LEDs and laser diodes is that LEDs produce incoherent light, while laser diodes produce coherent light. For use in optical communications, semiconductor optical transmitters must be designed to be compact, efficient, and reliable, while operating in an optimal wavelength range, and directly modulated at high frequencies.

### 4.3.2 Receivers

The main component of an optical receiver is a photodetector, which converts light into electricity using the photoelectric effect. The primary photodetectors for telecommunications are made from Indium gallium arsenide. The photodetector is typically a semiconductor-based photodiode. Several types of photodiodes include p-n photodiodes, p-i-n photodiodes, and avalanche photodiodes. Metal-semiconductor-metal (MSM) photodetectors are also used due to their suitability for circuit integration in regenerators and wavelength-division multiplexers.

### 4.3.3 Fiber Cable Types

An optical fiber cable is a cable containing one or more optical fibers that are used to carry light. The optical fiber elements are typically individually coated with plastic layers and contained in a protective tube suitable for the environment where the cable will be deployed.

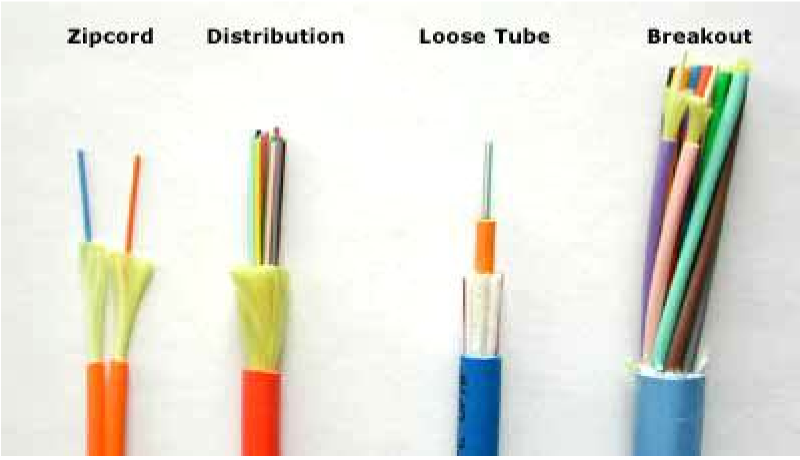


Fig 4.3: Different types of Fiber Cable

Two main types of optical fiber used in optic communications include

- Multi-mode optical fibers
- Single-mode optical fibers.

A multi-mode optical fiber has a larger core (≥ 50 micrometers), allowing less precise, cheaper transmitters and receivers to connect to it as well as cheaper connectors. However, a multi-mode fiber introduces multimode distortion, which often limits the bandwidth and length of the link. Furthermore, because of its higher dopant content, multi-mode fibers are usually expensive and exhibit higher attenuation.

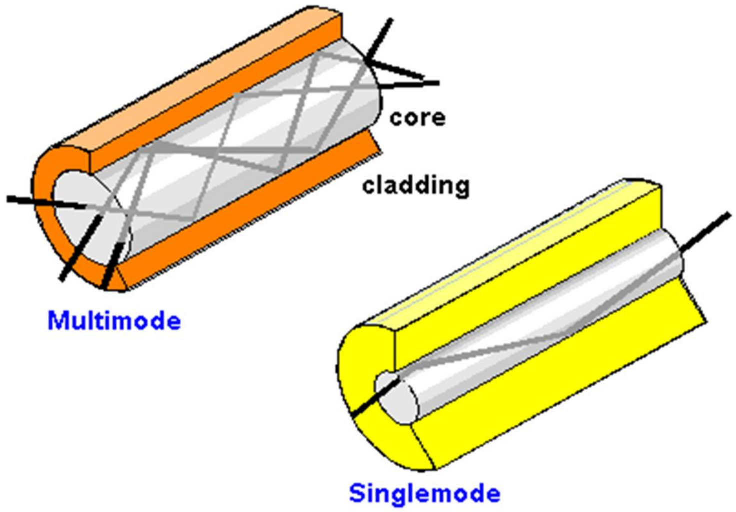


Fig 4.4: Multimode and Single mode Optical Fiber

The core of a single-mode fiber is smaller (<10 micrometers) and requires more expensive components and interconnection methods, but allows much longer, higher-performance links.

## 4.4 Splicing

There are several reasons for splicing a fiber cable, these include:

- To join two fibers due to a breakage.
- To connect some of the cores straight through a patch cabinet.
- To extend a cable run.
- To reduce losses, a fusion splice has much lower losses than two connectorized cables joined through a coupler.
- To attach a pre-terminated pigtail.

- Materials used for cable splicing
  - Fiber Optic Cable
  - Closure
  - Termination box, panel, FDF.
  - Pig tail
  - Protection sleeve
  - Alcohol
  - Cotton gauze
  - Cotton Bud
  - Cotton waste.

There are two methods of fiber optic splicing:

- ✓ Fusion Splicing
- ✓ Mechanical Splicing.


Fig 4.5: Splicing Machine

### 4.4.1 Fusion Splicing:

In fusion splicing a machine is used to precisely align the two fiber ends then the glass ends are "fused" or "welded" together using some type of heat or electric arc. This produces a continuous connection between the fibers enabling very low loss light transmission.

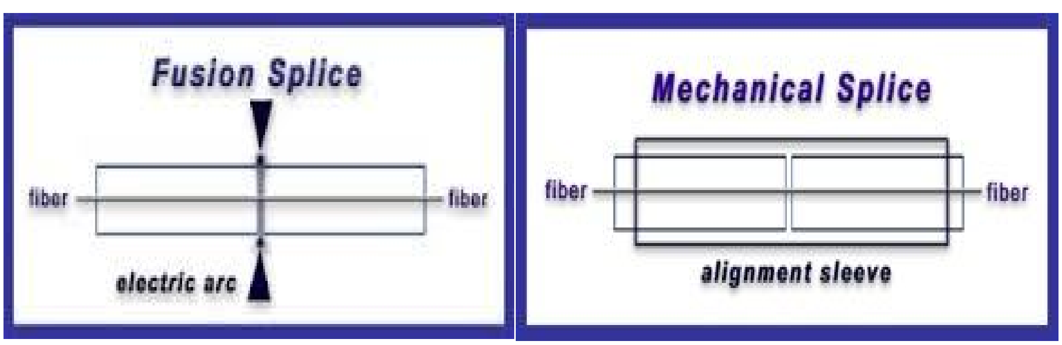


Fig 4.6: Fusion Splicing

**Four basic steps to completing a proper fusion splice:**

1. Step 1: Preparing the fiber - Strip the protective coatings, jackets, tubes, strength members, etc. leaving only the bare fiber showing. The main concern here is cleanliness.

2. Step 2: Cleave the fiber - Using a good fiber cleaver here is essential to a successful fusion splice. The cleaved end must be mirror-smooth and perpendicular to the fiber axis to obtain a proper splice. NOTE: The cleaver does not cut the fiber! It merely nicks the fiber and then pulls or flexes it to cause a clean break. The goal is to produce a cleaved end that is as perfectly perpendicular as possible. That is why a good cleaver for fusion splicing can often cost $1,000 to $3,000. These cleavers can consistently produce a cleave angle of 0.5 degree or less.

3. Step 3: Fuse the fiber - There are two steps within this step, alignment and heating. Alignment can be manual or automatic depending on what equipment you have. The higher priced equipment you use, the more accurate the alignment becomes. Once properly aligned the fusion splicer unit then uses an electrical arc to melt the fibers, permanently welding the two fiber ends together.

4. Step 4: Protect the fiber - Protecting the fiber from bending and tensile forces will ensure the splice not break during normal handling. A typical fusion splice has a tensile strength between 0.5 and 1.5 lbs and will not break during normal handling but it still requires protection from excessive bending and pulling forces. Using heat shrink tubing, silicone gel and/or mechanical crimp protectors will keep the splice protected from outside elements and breakage.

## 4.4.2 Mechanical Splicing:

Mechanical splices are simply alignment devices, designed to hold the two fiber ends in a precisely aligned position thus enabling light to pass from one fiber into the other.

**Four steps to performing a mechanical splice:**

1. Step 1: Preparing the fiber - Strip the protective coatings, jackets, tubes, strength members, etc. leaving only the bare fiber showing. The main concern here is cleanliness.

2. Step 2: Cleave the fiber - The process is identical to the cleaving for fusion splicing but the cleave precision is not as critical.

3. Step 3: Mechanically join the fibers - There is no heat used in this method. Simply position the fiber ends together inside the mechanical splice unit. The index matching gel inside the mechanical splice apparatus will help couple the light from one fiber end to the other. Older apparatus will have an epoxy rather than the index matching gel holding the cores together.

4. Step 4: Protect the fiber - the completed mechanical splice provides its own protection for the splice.

## 4.5 Amplifier

An optical amplifier is a device which amplifies the optical signal directly without ever changing it to electricity. The light itself is amplified.

Reasons to use the optical amplifiers:

- Reliability
- Flexibility
- Wavelength Division Multiplexing (WDM)
- Low Cost

Necessity of Optical amplifiers

- To Transmit a signals over long distances (>100km), to compensate attenuation losses.
- Initially this was accomplished with an optoelectronic module consisting of optical RX, regenerator, equalizer, & an optical TX to send the data.
- Although functional this arrangement is limited by optical to electrical & electrical to optical conversions.

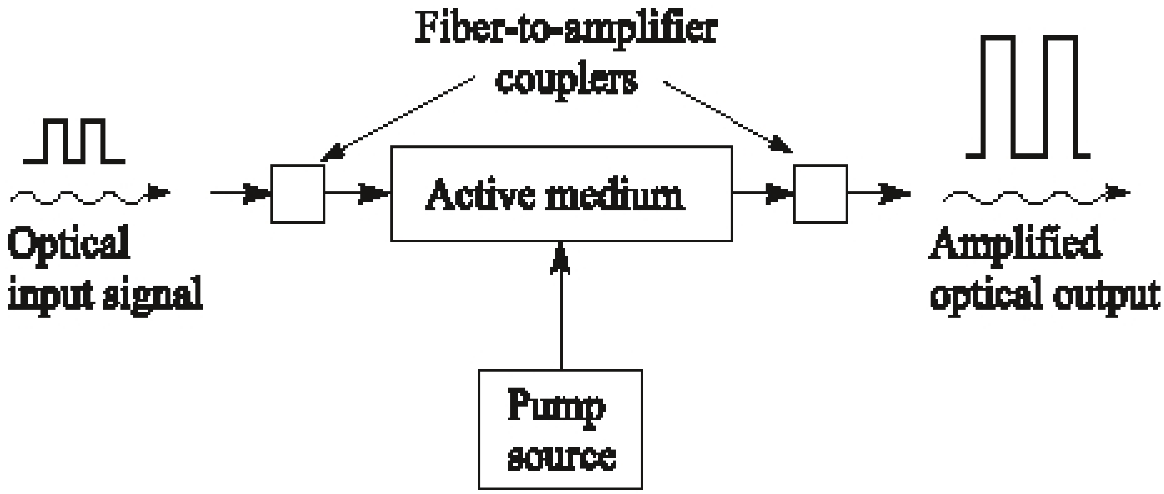


Fig 4.7: Optical Amplifier

- Optical amplifiers perform a critical function in modern optical networks, enabling the transmission of many terabits of data over long distances of up to thousands of kilometers.

# Chapter 5: Microwave Communication

## 5.1 Introduction

The prefix "micro-" in "microwave" is not meant to suggest a wavelength in the micrometer range. It indicates that microwaves are "small" compared to waves used in typical radio broadcasting, in that they have shorter wavelengths. The boundaries between far infrared, terahertz radiation, microwaves, and ultra-high-frequency radio waves are fairly arbitrary and are used variously between different fields of study.

Microwaves are a form of electromagnetic radiation with wavelengths ranging from as long as one meter to as short as one millimeter; with frequencies between 300 MHz (0.3 GHz) and 300 GHz.[1][2] This broad definition includes both UHF and EHF (millimeter waves), and various sources use different boundaries. In all cases, microwave includes the entire SHF band (3 to 30 GHz, or 10 to 1 cm) at minimum, with RF engineering often restricting the range between 1 and 100 GHz (300 and 3 mm).

## 5.2 The Electromagnetic Spectrum

| Name | Wavelength (Ă) | Frequency (Hz) |
|---|---|---|
| Radio wave | $3\times10^{14}-3\times10^{7}$ | $1\times10^{5}-1\times10^{9}$ |
| Microwave | $3\times10^{7}-6\times10^{6}$ | $1\times10^{9}-5\times10^{11}$ |
| Infrared (IR) | $6\times10^{6}-7600$ | $5\times10^{11}-3.95\times10^{16}$ |
| Visible | $7600-3800$ | $3.95\times10^{16}-7.9\times10^{14}$ |
| Ultraviolet (UV) | $3800-150$ | $7.9\times10^{14}-2\times10^{16}$ |
| $X$-Rays | $150-0.1$ | $2\times10^{16}-3\times10^{19}$ |
| $\gamma$- Rays | $0.1-0.01$ | $3\times10^{19}-3\times10^{20}$ |
| Cosmic Rays | 0.01- zero | $3\times10^{20}$ –infinity |

Fig 5.1: Electromagnetic Spectrum Table

## 5.3 Microwave Sources

High-power microwave sources use specialized vacuum tubes to generate microwaves. These devices operate on different principles from low-frequency vacuum tubes, using the ballistic motion of electrons in a vacuum under the influence of controlling electric or magnetic fields, and include the magnetron (used in microwave ovens), klystron, traveling-wave tube (TWT), and gyrotron. These devices work in the density modulated mode, rather than the current modulated mode. This means that they work on the basis of clumps of electrons flying ballistically through them, rather than using a continuous stream of electrons.

Low-power microwave sources use solid-state devices such as the field-effect transistor (at least at lower frequencies), tunnel diodes, Gunn diodes, and IMPATT diodes. Low-power sources are available as benchtop instruments, rackmount instruments, embeddable modules and in card-level formats. A maser is a solid state device which amplifies microwaves using similar principles to the laser, which amplifies higher frequency light waves.

All warm objects emit low level microwave black body radiation, depending on their temperature, so in meteorology and remote sensing microwave radiometers are used to measure the temperature of objects or terrain .The sun and other astronomical radio sources such as Cassiopeia A emit low level microwave radiation which carries information about their makeup, which is studied by radio astronomers using receivers called radio telescopes. The cosmic microwave background radiation (CMBR), for example, is a weak microwave noise filling empty space which is a major source of information on cosmology's Big Bang theory of the origin of the Universe.

## 5.4 Use of Microwave

There are many use of microwave technology. There are mainly three major use of microwave technology. They are:

- Microwave Communication
- Microwave Power Application
- Spectroscopy

## 5.5 Communication

The communication system via microwave are described below:

- Wireless LAN protocols, such as Bluetooth and the IEEE 802.11 specifications, also use microwaves in the 2.4 GHz ISM band, although 802.11a uses ISM band and U-NII frequencies in the 5 GHz range. Licensed long-range (up to about 25 km) Wireless Internet Access services have been used for almost a decade in many countries in the 3.5–4.0 GHz range. The FCC recently carved out spectrum for carriers that wish to offer services in this range in the U.S. — with emphasis on 3.65 GHz. Dozens of service providers across the country are securing or have already received licenses from the FCC to operate in this band..

- Metropolitan area network (MAN) protocols, such as WiMAX (Worldwide Interoperability for Microwave Access) are based on standards such as IEEE 802.16, designed to operate between 2 to 11 GHz. Commercial implementations are in the 2.3 GHz, 2.5 GHz, 3.5 GHz and 5.8 GHz ranges.
- Mobile Broadband Wireless Access (MBWA) protocols based on standards specifications such as IEEE 802.20 or ATIS/ANSI HC-SDMA (such as iBurst) operate between 1.6 and 2.3 GHz to give mobility and in-building penetration characteristics similar to mobile phones but with vastly greater spectral efficiency.
- Some mobile phone networks, like GSM, use the low-microwave/high-UHF frequencies around 1.8 and 1.9 GHz in the Americas and elsewhere, respectively. DVB-SH and S-DMB use 1.452 to 461.492 GHz, while proprietary/incompatible satellite radio in the U.S. uses around 2.3 GHz for DARS.
- Microwave radio is used in broadcasting and telecommunication transmissions because, due to their short wavelength, highly directional antennas are smaller and therefore more practical than they would be at longer wavelengths (lower frequencies). There is also more bandwidth in the microwave spectrum than in the rest of the radio spectrum; the usable bandwidth below 300 MHz is less than 300 MHz while many GHz can be used above 300 MHz. Typically, microwaves are used in television news to transmit a signal from a remote location to a television station from a specially equipped van. See broadcast auxiliary service (BAS), remote pickup unit (RPU), and studio/transmitter link (STL).
- Most satellite communications systems operate in the C, X, Ka, or Ku bands of the microwave spectrum. These frequencies allow large bandwidth while avoiding the crowded UHF frequencies and staying below the atmospheric absorption of EHF frequencies. Satellite TV either operates in the C band for the traditional large dish fixed satellite service or Ku band for direct-broadcast satellite. Military communications run primarily over X or Ku-band links, with Ka band being used for Milstar.

## 5.6 Power Application

The power application of microwave technology are described below:

- A microwave passes (non-ionizing) microwave radiation (at a frequency near 2.45 GHz) through food, causing dielectric heating primarily by absorption of the energy in water. Microwave ovens became common kitchen appliances in Western countries in the late 1970s, following the development of less expensive cavity magnetrons. Water in the liquid state possesses many molecular interactions that broaden the absorption peak. In the vapor phase, isolated water molecules absorb at around 22 GHz, almost ten times the frequency of the microwave oven.

- Microwave heating is used in industrial processes for drying and curing products. Many semiconductor processing techniques use microwaves to generate plasma for such purposes as reactive ion etching and plasma-enhanced chemical vapor deposition (PECVD).
- Microwave frequencies typically ranging from 110 – 140 GHz are used in stellarators and more notably in tokamak experimental fusion reactors to help heat the fuel into a plasma state. The upcoming ITER thermonuclear reactor[7] is expected to range from 110–170 GHz and will employ electron cyclotron resonance heating (ECRH).
- Microwaves can be used to transmit power over long distances, and post-World War II research was done to examine possibilities. NASA worked in the 1970s and early 1980s to research the possibilities of using solar power satellite (SPS) systems with large solar arrays that would beam power down to the Earth's surface via microwaves.
- Less-than-lethal weaponry exists that uses millimeter waves to heat a thin layer of human skin to an intolerable temperature so as to make the targeted person move away. A two-second burst of 47 the 95 GHz focused beam heats the skin to a temperature of 54 °C (129 °F) at a depth of 0.4 millimetres (1⁄64 in). The United States Air Force and Marines are currently using this type of active denial system in fixed installations.

## 5.7 Spectroscopy

Microwave radiation is used in electron paramagnetic resonance (EPR or ESR) spectroscopy, typically in the X-band region (~9 GHz) in conjunction typically with magnetic fields of 0.3 T. This technique provides information on unpaired electrons in chemical systems, such as free radicals or transition metal ions such as Cu(II). Microwave radiation is also used to perform rotational spectroscopy and can be combined with electrochemistry as in microwave enhanced electrochemistry.

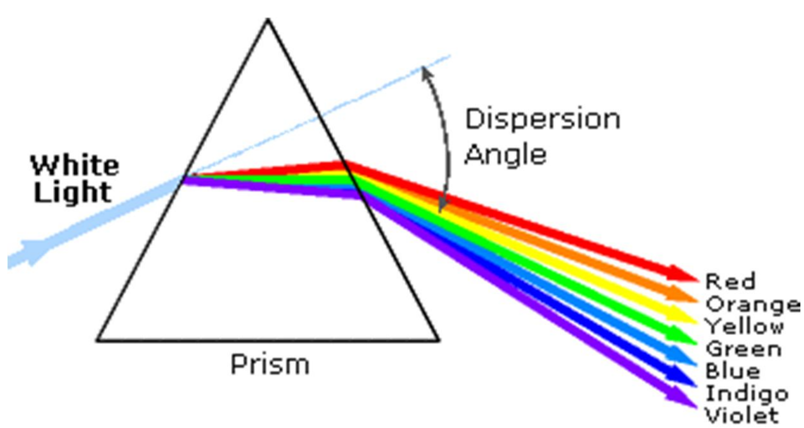


Fig 5.2: Spectroscopy

## 5.8 Microwave Frequency Bands

Rough plot of Earth's atmospheric transmittance (or opacity) to various wavelengths of electromagnetic radiation. Microwaves are strongly absorbed at wavelengths shorter than about 1.5 cm (above 20 GHz) by water and other molecules in the air. The microwave spectrum is usually defined as electromagnetic energy ranging from approximately 1 GHz to 100 GHz in frequency, but older usage includes lower frequencies. Most common applications are within the 1 to 40 GHz range. One set of microwave frequency bands designations by the Radio Society of Great Britain (RSGB), is tabulated below:

| $f$ | $\lambda$ | Band | Description |
|---|---|---|---|
| 30–300 Hz | $10^4$–$10^3$ km | ELF | Extremely low frequency |
| 300–3000 Hz | $10^3$–$10^2$ km | VF | Voice frequency |
| 3–30 kHz | 100–10 km | VLF | Very low frequency |
| 30–300 kHz | 10–1 km | LF | Low frequency |
| 0.3–3 MHz | 1–0.1 km | MF | Medium frequency |
| 3–30 MHz | 100–10 m | HF | High frequency |
| 30–300 MHz | 10–1 m | VHF | Very high frequency |
| 300–3000 MHz | 100–10 cm | UHF | Ultra-high frequency |
| 3–30 GHz | 10–1 cm | SHF | Superhigh frequency |
| 30–300 GHz | 10–1 mm | EHF | Extremely high frequency (millimeter waves) |

Fig 5.3: Microwave Frequency Band

## 5.9 Microwave Frequency Measurement

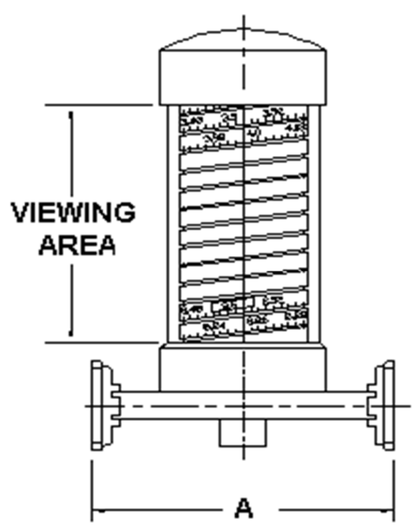


Fig 5.4: Wave meter for measuring in the Ku band

Microwave frequency can be measured by either electronic or mechanical techniques.

Frequency counters or high frequency heterodyne systems can be used. Here the unknown frequency is compared with harmonics of a known lower frequency by use of a low frequency generator, a harmonic generator and a mixer. Accuracy of the measurement is limited by the accuracy and stability of the reference source. Mechanical methods require a tunable resonator such as an absorption wavemeter, which has a known relation between a physical dimension and frequency. In a laboratory setting, Lecher lines can be used to directly measure the wavelength on a transmission line made of parallel wires, the frequency can then be calculated. A similar technique is to use a slotted waveguide or slotted coaxial line to directly measure the wavelength. These devices consist of a probe introduced into the line through a longitudinal slot, so that the probe is free to travel up and down the line. Slotted lines are primarily intended for measurement of the voltage standing wave ratio on the line. However, provided a standing wave is present, they may also be used to measure the distance between the nodes, which is equal to half the wavelength. Precision of this method is limited by the determination of the nodal locations.

## 5.10 History and Research

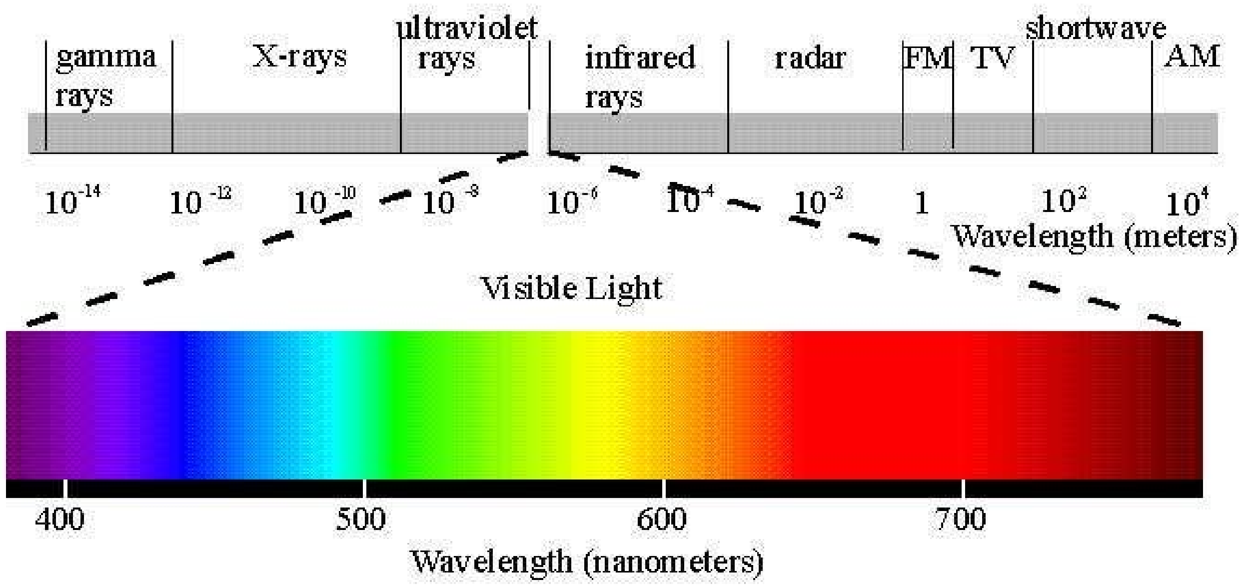


Fig 5.5: Electromagnetic spectrum with visible light highlighted

The existence of radio waves was predicted by James Clerk Maxwell in 1864 from his equations. In 1888, Heinrich Hertz was the first to demonstrate the existence of radio waves by building a spark gap radio transmitter that produced 450 MHz microwaves, in the UHF region. The equipment he used was primitive, including a horse trough, a wrought iron point spark, and Leyden jars. He also built the first parabolic antenna, using a zinc gutter sheet. In 1894 Indian radio pioneer Jagdish Chandra Bose publicly demonstrated radio control of a bell using millimeter wavelengths, and conducted research into the propagation of microwaves. Perhaps the first, documented, formal use of the term microwave occurred in 1931: "When trials with wavelengths as low as 18 cm were made known, there was undisguised surprise that the problem of the micro-wave had been solved so soon." Telegraph & Telephone Journal XVII. 179/1In 1943, the Hungarian engineer Zoltán Bay sent ultra-short radio waves to the moon, which, reflected from there, worked as a radar, and could be used to measure distance, as well as to study the moon.Perhaps the first use of the word microwave in an astronomical context occurred in 1946 in an article "Microwave Radiation from the Sun and Moon" by Robert Dicke and Robert Beringer. This same article also made a showing in the New York Times issued in 1951.In the history of electromagnetic theory, significant work specifically in the area of microwaves and their applications was carried out by researchers including:

- Specific work on microwaves Work carried out by Area of work
- Barkhausen and Kurz Positive grid oscillators
- Hull Smooth bore magnetron
- Varian Brothers Velocity modulated electron beam → klystron tube
- Randall and Boot Cavity magnetron

# Chapter 6: Satellite Communication

## 6.1 History

The first idea of satellite communication came from an article in 1945 named Wireless World, where Author C. Clarke described the use of manned satellites in 24 hour orbits to distribute television programs. However, the first person to carefully evaluate the technical and financial aspects of such a venture was John R. Pierce of Bell Telephone Laboratories.

In a 1954 speech and 1955 article, Pierce described the usefulness of a communications "mirror" in space, a medium-orbit "repeater" and a 24-hour-orbit "repeater." In comparing the communications capacity of a satellite, which he estimated the capacity at 1,000 simultaneous telephone calls, and the capacity of the first trans-atlantic telephone cable, which could carry 36 simultaneous telephone calls at a cost of 30-50 million dollars, Pierce wondered if a satellite would be worth a billion dollars.

By the middle of 1961, RCA had a contract with NASA to build, a 4000 mile high, medium-orbit, active communications satellite called RELAY, AT&T was working on its own medium-orbit satellite called TELSTAR, and Hughes Aircraft Company had an exclusive contract to build a 24-hour orbit, 20,000 mile high satellite, called SYNCOM. By 1964, two TELSTARs, two RELAYs, and two SYNCOMs had operated successfully in space.

## 6.2 Major Elements

There are two major elements of a satellite system. They are Space and Ground Segments.

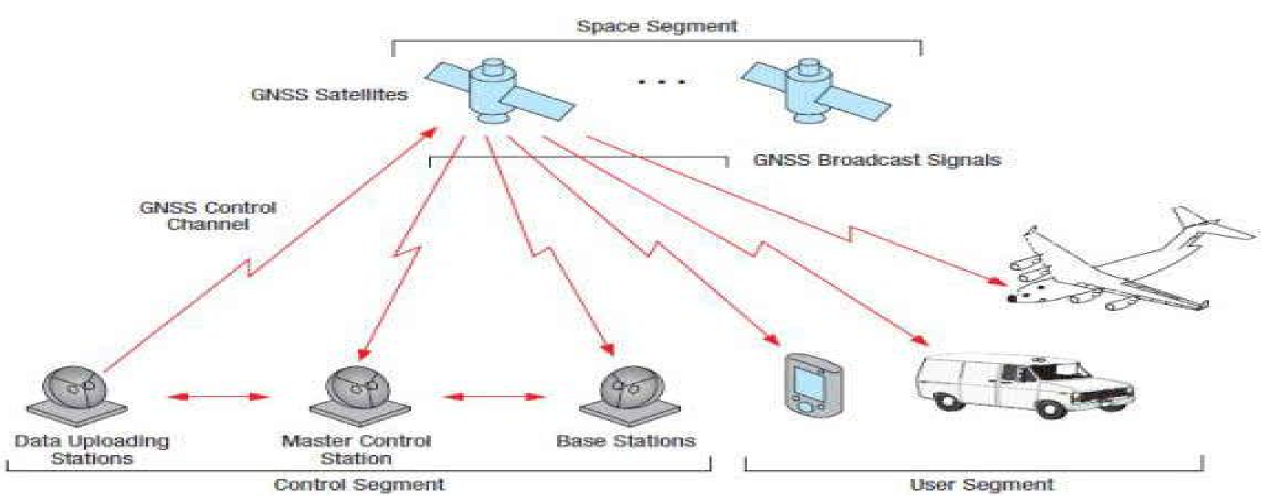


Fig 6.1: Satellite Elements

### 6.2.1 Space Segment

Space systems are complex pieces of equipment designed to perform specific functions for a specified design life. Space systems are not merely robots launched into space and then left to perform their mission. To keep a space system functioning over many years requires almost constant attention through a complex network of equipment and the involvement of many people.

Space systems have three distinct segments:

- Space Segment: The satellites placed into orbit or components used to launch the satellites.
- Control Segment: The personnel, equipment and facilities responsible for the operation and control of the satellite and, in many communications systems, control of users' transmissions through the satellites.
- User Segment: The personnel, equipment and facilities that use the capabilities provided by the satellite payload. The user segment is covered in detail in subsequent chapters which cover specific space systems.

There are numerous types of space systems providing a wide variety of capabilities and services. In spite of this diversity, there are similarities among all satellites because they all must operate in the environment of space.

### 6.2.2 Ground Segment

Fig 6.2: Mohakhali Earth Station

The ground segment is a network of earth stations and user terminals that provides applications and services to end users. Each network requires:

- A central point of management and control.
- A means to connect distant users to sources of content or other networks, such as the Internet.

Each network within the ground segment serves a particular group of users or type of application:

Users:

- Corporate enterprise
- Government agency
- Non-profit organization
- Internet service provider

Applications:

- Video distribution
- Data communications
- Telephone services

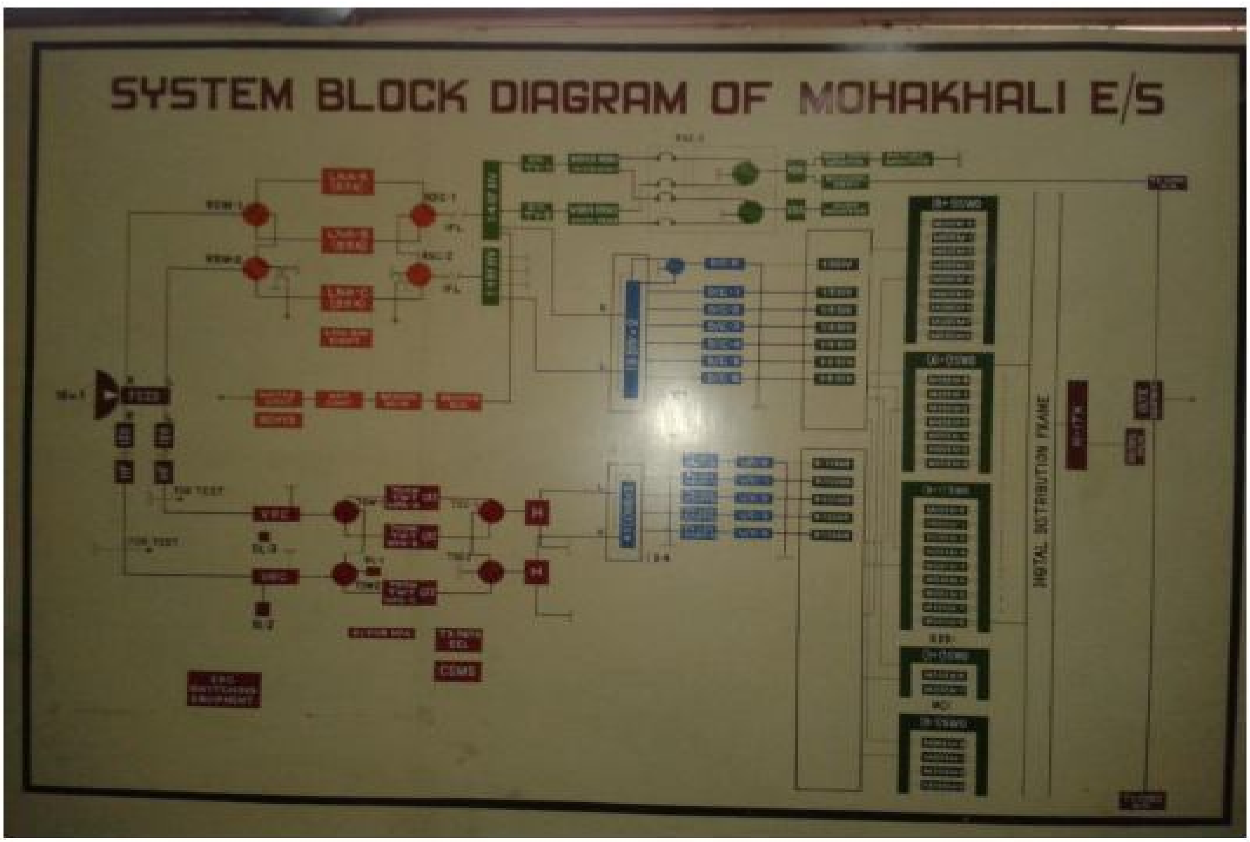


Fig 6.3: Block Diagram of Mohakhali Earth Station

Individual users at remote sites receive service via user terminals. The Very Small Aperture Terminal (VSAT) provides two way communications capability for one or a local group of users. A user terminal without a transmit capability is called a receive-only (RO) terminal. While commonly used for TV reception, ROs are popular for interactive data networks that use some other means for the return channel (DSL or terrestrial wireless).

## 6.3 Satellite Orbits

Satellite Orbits are classified in two broad categories. They are Non-Geostationary Orbit (NGSO) and Geo Stationary Orbit (GSO).

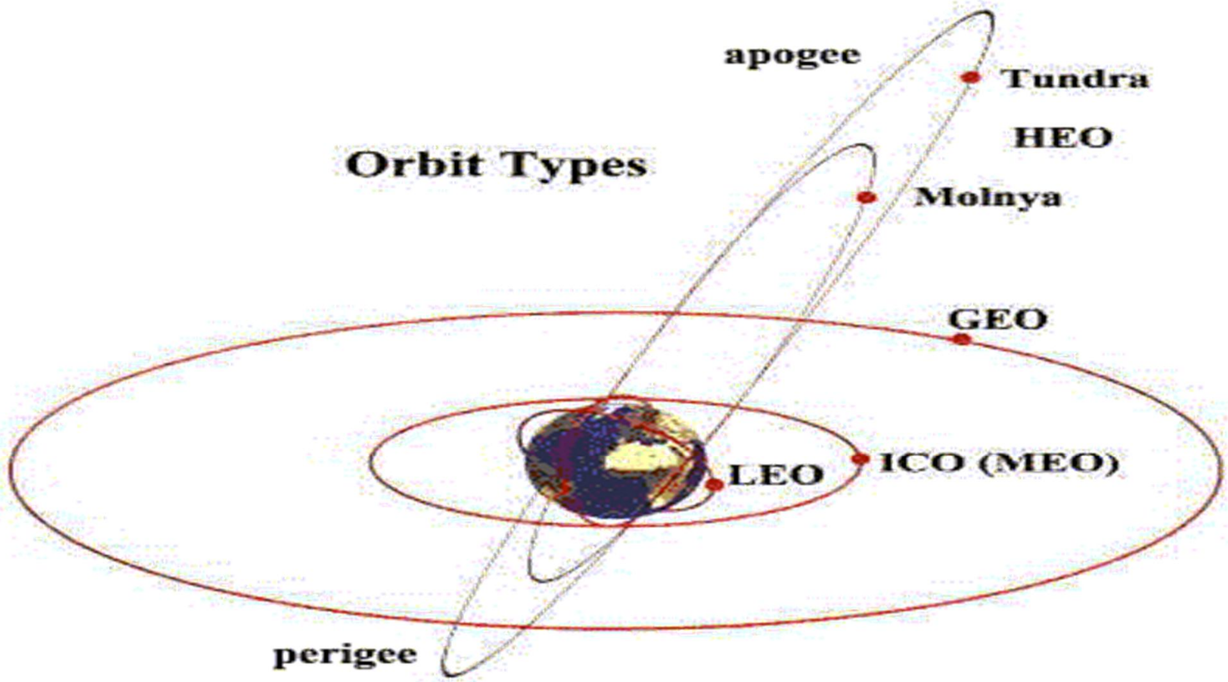


Fig 6.4: Satellite Orbits

### 6.3.1 Non-Geostationary Orbit (NGSO)

As the figures below show, satellites that orbit at an altitude of 36,000km such as BS and CS satellites, revolve at the same velocity as the earth's rotation, thus appearing to be standing still from the earth's surface. Satellites in addition to this kind that have different orbital velocities than the earth are called non-geostationary satellites.

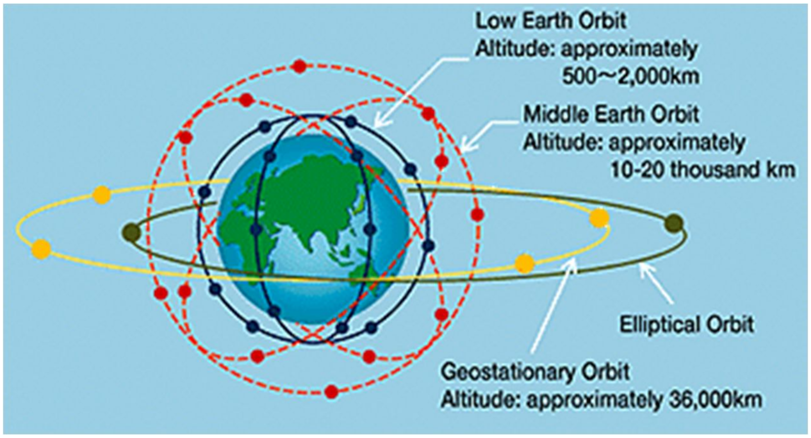


Fig 6.5: NGEO

Classification of NGSOs as per the orbital plane are:

- Polar Orbit: In polar orbit the satellite moves from pole to pole and the inclination is equal to 90 degrees.
- Equatorial Orbit: In equatorial orbit the orbital plane lies in the equatorial plane of the earth and the inclination is zero or very small.
- Inclined Orbit: All orbits other than polar orbit and equatorial orbit are called inclined orbit.

Advantages:

- Less booster power required
- Less delay in transmission path
- Reduced problem of echo in voice communications
- Suitability for providing service at higher latitude
- Lower cost to build and launch satellites at NGSO

Disadvantages:

- Complex problem of transferring signal from one satellite to another.
- Less expected life of satellites at NGSO
- Requires frequent replacement of satellites compared to satellite in GSO.

## 6.3.2 Geostationary Orbit (GSO)

Geostationary or communications satellites are PARKED in space 22,300 miles (35,900 km) above the equator of the STATIONARY earth. Geostationary satellites are used for weather forecasting, satellite TV, satellite radio and most other types of global communications.

Fig 6.6: GEO Satellite

Advantage:

- Simple ground station tracking.
- Nearly constant range
- Very small frequency shift

Disadvantage:

- Transmission delay of the order of 250 msec.
- Large free space loss
- No polar coverage

## 6.4 Evolution of Satellite Communication

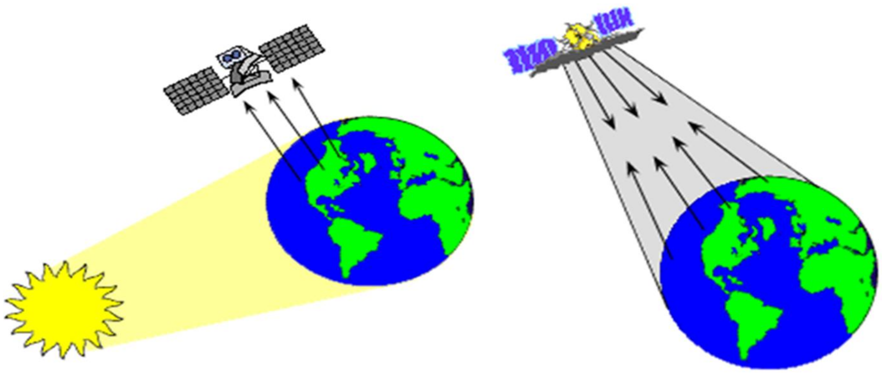


Fig 6.7: Satellite Communication

### 6.4.1 Active Satellite

Active satellites is a satellite which can amplify or modify and retransmit the signal from the earth. It also can transmit power. It is a functioning SATELLITE that receives and transmits or retransmits radio-communication signals to or from a base station.

World's first active satellite was SCORE (Satellite Communication by Orbiting Relay Equipment)

- Launched by US Air force in 1958.
- At orbital height of 110 to 900 miles.

The first fully active satellite was Courier

- Launched into an orbit of 600 - 700 mile,
- By Department of Defense in 1960.

### 6.4.2 Passive Satellite

A satellite that only reflects signals from one Earth station to another, or from several Earth stations to several others. It reflect the incident electromagnetic radiation without any modification or amplification. It can't generate power, they simply reflect the incident power.

The first artificial passive satellite **Echo-I** of NASA was launched in August 1960.

The principle of communication by passive satellite is based on the properties of distribution of electromagnetic waves from different surface areas.

Thus an electromagnetic wave incident on a passive satellite is scattered back towards the earth and a receiving station can receive the scattered wave. The passive satellites used in the early years of satellite communications were both artificial as well as natural.

# Chapter 7: What we learn?

In this industrial tour we have learn many practical things for our real life use. We got an overall concept about how the telecommunication system works in Bangladesh. The practical use of the tools and material now is known to us. Some important matters are listed below about what we have leant from this tour:

- How a Telephone works
- The Overall structure of telephone system
- Telephone Switching (Both analog and Digital)
- How internet Connection is established
- Details about fiber optic cable and Splicing
- How satellite works
- Details about satellite earth station

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