CHAPTER 5

Communication Techniques

LEARNING OBJECTIVE

In this chapter, the students can easily.....

- Understand the working principle and application of OFC.
- Study the difference between OFC and wire communication.
- Understand the types of satellite communication and uses.
- Describe the function of RADAR and SONAR.
- Learn about microwave communication.
- Describe the function of Tsunami warning system, Seismograph and Avionics.

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CONTENT

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5.1 Introduction

In this present scenario, we use to say "the world becomes so fast", comparatively before 50 to 100 years. It means whether the rotation of earth becomes faster. The same 24 hours is observed on those days and today. Then which makes us to feel like that?

On those days if a message has to be conveyed or intimated to a person who is at a distance, say near town, or nearby country or near to a continent, it took few hours, few days and few months, respectively. So that the reaction times, is also long. This makes us to realize that the world gives much time to us.

But now, in this 21st century, any incident happening in any tiny part of this world, can be seen or heard by the other people all over the world in no time or even to say on live.

How it becomes realized? This all because of the communication system. Hence let us study and understand the basic concepts of few communication systems in this chapter.

5.2 OFC Technology

Fiber optics (optical fibers) are long thin, strands of very pure glass about the diameter of a human hair. They are arranged in bundles called optical cables and used to transmit light signal over long distances.

Optical fibre is mostly made from Silicon Dioxide (Sio2) but some little amount of other materials such as fluoroziconate glasses, fluoroaluminate glasser and Chalcogenide glasses as well as crystoline materials like sapphire glasses are used for longer wavelength infrared or other specialized applications.

HISTORY OF OPTICAL FIBER

In 1870, John Tyndall, using a jet of water that flowed from one container to another and a beam of light, demonstrated that light used internal reflection to follow a specific path. As water poured out through the spout of the first container . Tyandall directed a beam of sunlight at the path of the water. The light as seen by the audience, followed a zigzag path inside the curved path of the water. This Simple experiments illustrated in Figure 5.1(a) marked the first research into the guided transmission of light.

DO YOU KNOW?

Who invented fiber optic technology?

Indian Dr. Narinder Singh Kapany invented the fiber optical cable based on John.Tyndall experiments. He is also called father of fiber optics.

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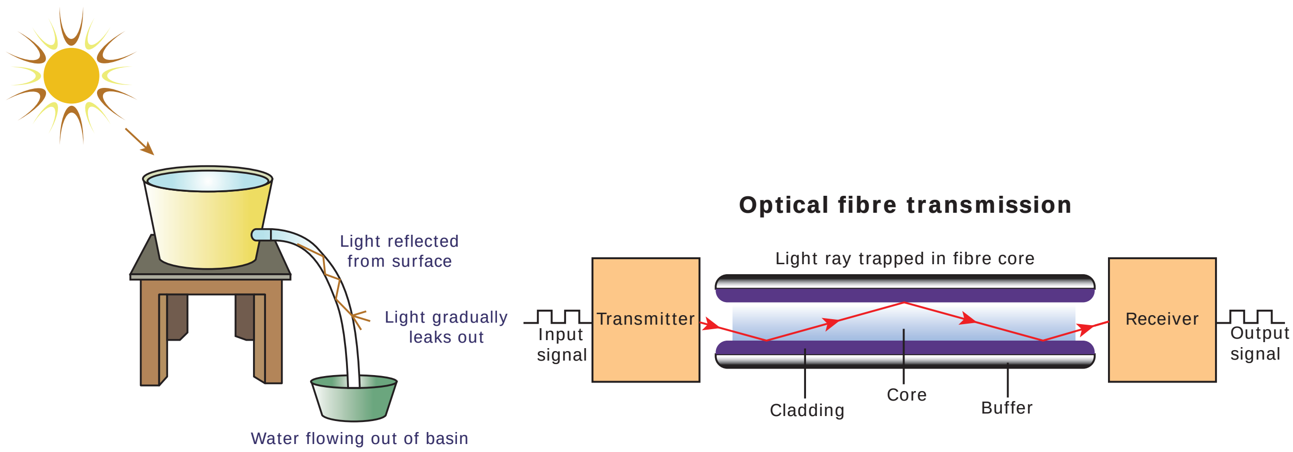

FIG 5.1 (a), (b) Internal reflection of OFC

5.2.1 Fiber Optic Communication

Fiber optic communication is based on the principle that light in a glass medium can carry more information over longer distance than electrical signals can carry in a copper or coaxial medium or radio frequencies through a wireless medium. The purity of today's glass fiber, combination with improved system enables fiber to transmit digitized light signals hundreds of kilometers without amplifications.

The propagation of light through the fiber is based on the principle of total internal reflection. The fig 5.1 shows the internal reflection of OFC.

5.3 Construction of an Optical Fiber

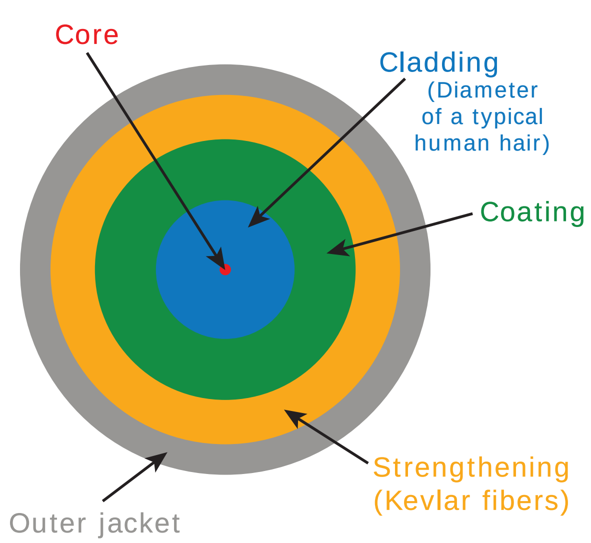

FIGURE 5.2 Construction of optical fiber.

5.3.1 Elements of OFC

Three basic elements of an optical fiber are the core, the cladding and the outer coating. Figure 5.2 shows the construction of an optical fiber

- The core is usually made of glass or plastic depending on the transmission spectrum desired. The core is the light transmitting portion of the fiber. The core is cylinderical rod shape, made up of dielectric material. Dielectric material conducts no electrical signal. Light propogates mainly along the core of the fibre. It is described as having a radius of an index of refraction.
- The cladding is usually made of the same material as the core but with a slightly lower refracting index.
- The coating usually comprises of one or more coats of a plastic material to protect the fiber from the physical environment.

5.3.2 Working principle of OFC

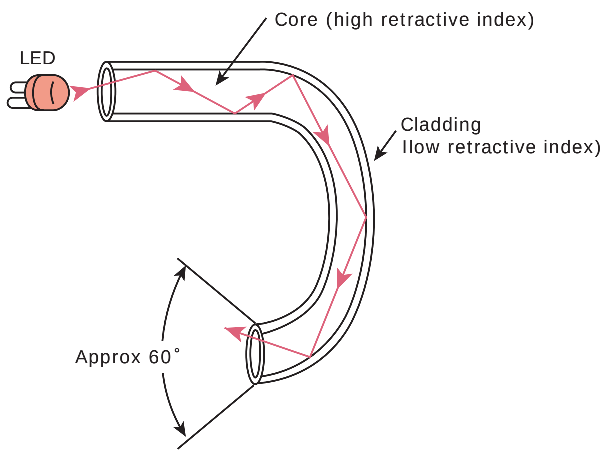

FIGURE 5.3 Working principle of OFC

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Figur 5.3 shows the working principle of an OFC. An Optical Fiber is a cylindrical di-electric wave guide (non-conducting waveguide) that transmits light along its axis, by the process of total internal reflection. To confine the Optical Signal in the core, the refractive index of the core must be greater than that of the cladding. Because the cladding does not absorb any light from the core, and the light wave can travel longer distances. Fig 5.4 shows the structure of optical fibers.

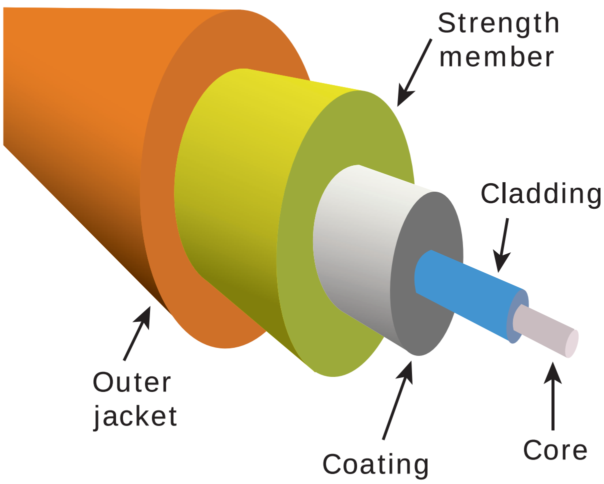

FIGURE 5.4 Structure of Optical Fiber.

DO YOU KNOW?

Whether the audio and video signal can be transmitted through OFC as in original form?

No.., Any signal audio or video or any other should be converted into light signal and be transmitted through OFC.

5.3.3 Types of Optical Fiber

There are three types of optical fiber commonly used.

1. Step index single mode
2. Step index multi mode
3. Graded index

Step index single mode

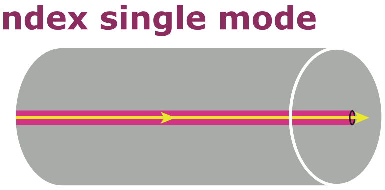

FIGURE 5.5 Step index single mode

Figure 5.5 shows the step index single mode OFC. This type of fiber allows only one path or mode for travelling the light with in the fiber. The core diameter of this type is 5µm and 10µm with a 125µm cladding.

Application

- Long distance communication
- All Telcommunication areas

Step index multimode

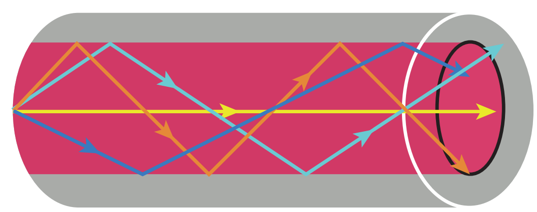

FIGURE 5.6 Step index multimode

Fig 5.6 shows the type of step index multimode. This type of fiber has an index refraction profile that steps from low to high or high to low as measured from cladding to code or code to cladding. The diameter of this type is 62.5µm/125µm. The term multimode refers to the fact that multiple modes or paths are possible for the light to travel through the fiber.

Graded Index Fiber Multimode

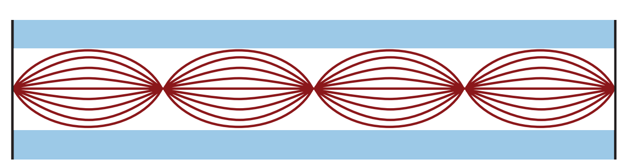

FIGURE 5.7 Graded index fiber (Multimode)

Fig (5.7) shows the Multimode graded index fiber. Graded index fiber is a type of fiber where the refractive index of the core is lower towards outside of the fiber.

The core in a graded index fiber has an index of refraction that radially decreases continuously from the center to the cladding interface. As a result, the light travels faster at the edge of the core than in the center as shown in Figure 5.7.

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The diameter of this type of fiber is 50 μm, 62.5 μm and 100μm. The main application of graded index is in medium range communications such as Local Area Network (LAN).

Difference between step index and graded index fiber	
Step index fiber	**Graded index fiber**
The refractive index of the core is uniform	The refractive index of the core is non-uniform
The light rays propagate in zig-zag manner inside the core of step index fiber	The light rays will not cross the graded index fiber
It is too slow for most uses	It is too fast for most uses
Lower bandwidth	Higher bandwidth

5.3.4 Wire or Co–axial Cable communication

In wire communication, the medium of transmission is a pair of conductors called the transmission line. This means, in wire communication the transmitter and receiver are connected through a wire or line. However the installation and maintenance of a transmission line is not only costly and complex, but also occupies more space. Apart from, its message transmission capability is also limited.

5.4 Difference between Optical Fiber and Co-axial cable (Copper wire)

	Optical fiber	Co-axial cable
Basis of comparison	Transmission of the signal is in optical form(light form)	Transmission of the signal is in electrical form
Comparison of cable	Glass and plastic	Plastic or usually copper wire
Efficiency	High	Low
Cost	Expensive	Less expensive
Bending effect	Can affect the signal transmission	Bending of wire does not affect the signal transmission
Data transmission rate	2 Gbps	44.736 Mbps
Installation of cable	Difficult	Easy
Bandwidth	Very high	Moderately high
External magnetic field	Does not affect the cable	Affects the cable
Noise immunity	High	Intermediate
Diameter of the cable	Small	Large
Weight	Lighter weight	Heavier weight

5.4.1 How a fiber optic communication works?

A fiber optic communication network consists of

1. transmitting and receiving circuitry
2. a light sources
3. detector devices

The figure 5.8 shows the above network. *When the input data in the form of electrical signals is given to the transmitter circuitry, it converts them into light signals with the help of light source.* This source is a LED, whose amplitude frequency and phases must remain stable and free from fluctuation in order to have efficient transmission. The light beam from the light source is carried by an OFC to the detector circuitry.

With the help of detector circuit the light signal is converted into electrical signal by a receiver circuitry. Laser diodes also are

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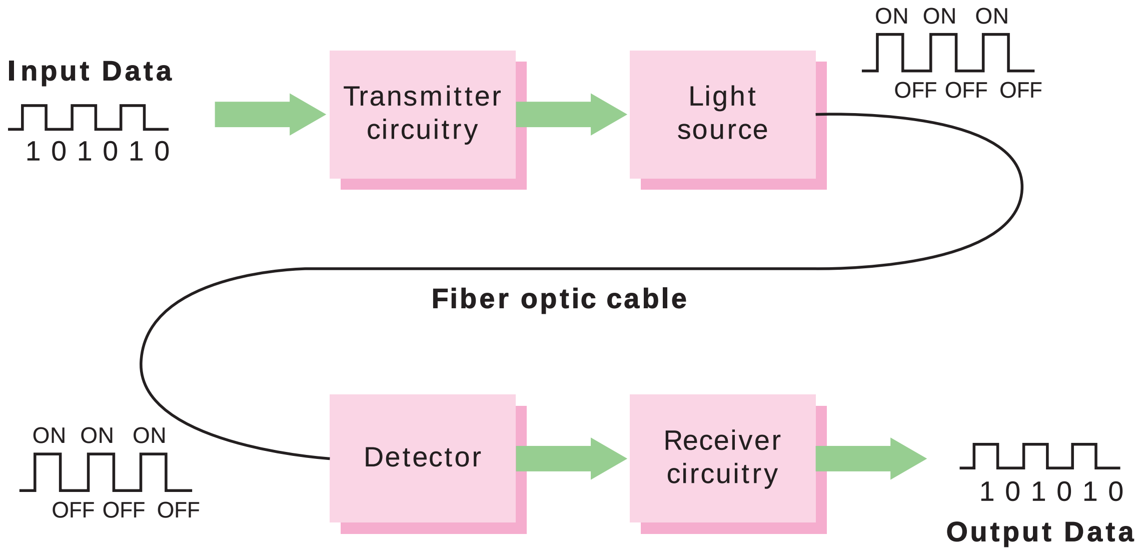

FIGURE 5.8 Working of Fiber Optic Communication

used as light sources. LEDs are used for short distances and low data rate communication. Laser diodes are used for long distances and high data rate communication.

5.5 Advantages and Disadvantages of OFC

5.5.1 Advantages of OFC

- Greater bandwidth than metal cables.
- Low power loss.
- Faster speed with less attenuation.
- Smaller size and less weights.
- Greater information carrying capacity.
- Higher security.
- Electrical insulator.

5.5.2 Disadvantages of OFC

- Difficult in splice.
- Highly susceptible.
- Expensive to install

5.6 Applications of OFC

Some of the main applications of an OFC are summarized below.

Communications

Voice, data and video transmission are the most common uses of fiber optics and these include,

- Telecommunication.
- Local Area Network.
- Industrial control systems.
- Avionic systems.
- Military common control and Communication systems.
- Hydrophones are used for seismic and SONAR application.

Sensors

- Sensors are used to measure various physical qualities like strain, pressure, temperature and other physical parameters.

Light guides

- Light guides are used in medical and other applications where bright light needs to be shined on a target without a clear line of sight path.

Optical Gyroscope

- Optical gyroscope with OFC has been developed and widely used for navigation purpose in aero planes.
- Optical fiber illumination is also used for decoration purposes.

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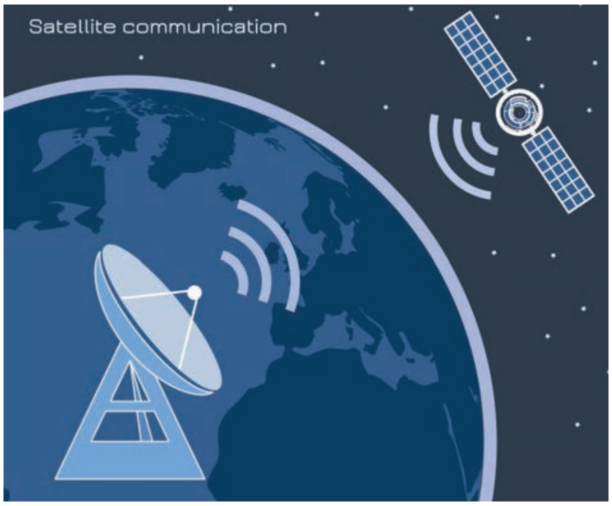
5.7 Satellite Communication



5.7.1 Satellite

Normally in the solar system the planets are termed as satellites to Sun. Because the planets are revolving around the Sun in a particular orbit. Likewise each planet is having one or more small planets called sub-planets which revolving that particular planet in a defined orbit. These sub-planets are called as Natural satellites.

> **DO YOU KNOW?**
> **How do satellites get power?**
>
> The sun is the main energy source for satellites. That is why all satellites have solar panel mounted on them. Each panel contains array of thousands of small solar cells which are made of silicon.

5.7.2 Types of Satellites

Satellites are classified into two types

1. Natural Satellites
2. Artificial Satellites (Man-Made)

5.7.3 Natural Satellites

Any planet in the solar system which goes around a particular planet is called Natural Satellites. In the solar system there are six planetary satellite systems containing 185 known natural satellites.

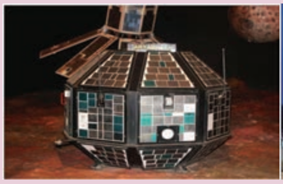
> **DO YOU KNOW?**
> Which is the natural satellite to the earth… its nothing but "Moon"..

5.7.4 Artificial Satellites

Artificial Satellite are man-made objects(satellites) orbiting the Earth and other planets in the Solar system. Artificial Satellites are used to study the Earth, other planets to help us to communicate and even to observe the distance universe. Example Aryabhata, Baskara, Rohini, INSAT 1A, IRS…

HISTORY OF ARTIFICIAL SATELLITE

The first artificial satellite was Sputnik – 1 launched by the Soviet Union on 4th October 1945. It may also carry message recording, playback and programming facilities. The signals received by the receiver are generally weak. They are amplified by the receiver and then televised. Sputnik-2 was launched on 3rd November 1957 and carried the first living passenger into orbit, a dog named Laika. India's first Satellite, Aryabhata was launched in the year 1975. Now approximately 2000 artificial satellites are revolving around the earth for communication purposes.



Aryabhata (1975)

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> **DO YOU KNOW?**
> So far how many satellites are launched by India?
>
> So far India launched 93 satellites.

What do artificial satellites do?

Satellites are launched into space through rockets. A satellite orbits the earth while its speed is balanced by the pull of Earth's gravity.

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Artificial satellites are further classified into two type

1. Active Satellites
2. Passive Satellites

Active Satellites

An active satellite carries an antenna system, a transmitter, a receiver and a power supply. It works as microwave repeater or transponder in the sky. Figure 5.9 shows the active satelliets system.

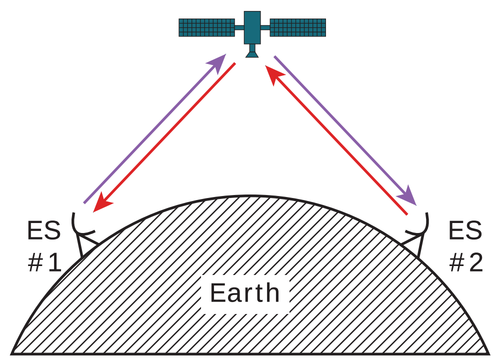

FIGURE 5.9 Active Satellite

Passive Satellites

A passive satellite is a metal coated plastic balloon or metallic sphere that works as a passive reflection. It reflects the microwave signal from one region of the earth to another region. Figure 5.10 shows the passive satellites system.

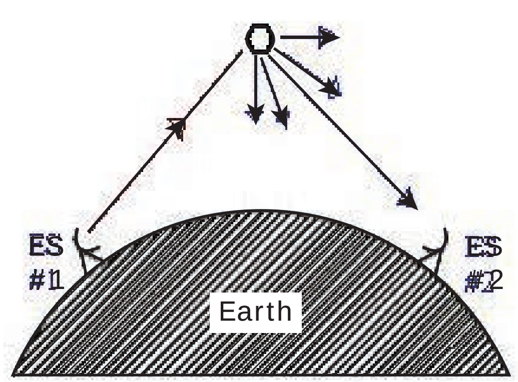

FIGURE 5.10 Passive satellites system.

5.7.5 Space Communication

In satellite communication, electromagnetic waves are used as carrier signals. These signals carry the information such as audio, video or any other signal between ground and space and vice-versa. Since satellite communication happens through space, it is also known as Space Communication.

5.7.6 Need of Satellite Communication

Two kinds of propagation are used in earlier communication.

1. Ground wave propagation
2. Sky wave propagation

Ground wave propagation

Ground wave propagation is suitable for frequencies upto 30 MHz. This method of communication makes use of the troposphere conditions of the earth.

Sky wave propagation

Suitable bandwidth for this type is broadly between 30 MHz to 40 MHz and it makes use of the ionosphere properties of the earth.

The station distance is limited to few thousands kilometers in both Ground Wave propagation and Sky Wave propagation. Satellite communication over comes this limitation.

5.7.7 Satellites Classifiction

Satellites can be classified by their function since they are launched into space to do a specific job. The satellite must be designed specifically to fulfill its role.

The most important satellites are

1. Communication Satellites
2. Astronomical Satellites
3. Navigation Satellites
4. Bio Satellites
5. Weather Satellites
6. Remote Sensing Satellites
7. Nano Satellites
8. Earth Observation Satellites

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5.7.8 Communication Satellites

Communication satellites are artificial satellites that relay received signals from an earth station and then retransmit the signal to other earth stations. They commonly move in a geostationary orbit. Communication satellites are placed in three earth orbits.

1. Geostationary Earth Orbit
2. Medium Earth Orbit
3. Low Earth Orbit

Satellites in Geostationary Earth Orbit (GEO) enable to get fax, video conferencing, Internet, long distance fixed phone service, television broadcasting and broadband multimedia service are provided all over the globe.

Satellites in Medium Earth Orbit (MEO) are used for mobile cell phone communication, fixed phones and other personal communications.

Satellites in Low Earth Orbit (LEO) are used paging fax, ship tracking, fixed ordinary phones, broad band multimedia, and monitoring of remote industrial spots.

Besides, Communication Satellites are helping in long way during natural calamities. In the aftermath of the earthquake the satellites pictured and helps the search and rescue teams to keep in touch with one another and were also able to maintain international communications.

5.7.9 Working of Communication Satellite

A satellite is a body that moves around another body in a particular path(orbit). A communication satellite is nothing but a microwave repeater station in space. It is helpful in telecommunications.

A repeater is a circuit which increases the strength of received signal and then transmits it. But, this repeater works as a transponder. (it changes the frequency band of transmitted signal from the received one).

The frequency with which the signal is sent into the space is called as Up-link frequency. Similarly with which the signal is sent by the transponder to earth station is called as Down-link frequency. The fig 5.11 and fig 5.12 illustrates the concept clearly.

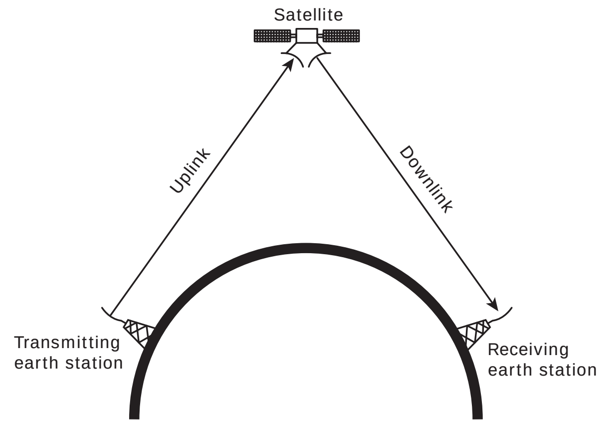

FIGURE 5.11 Working of communication Satellite

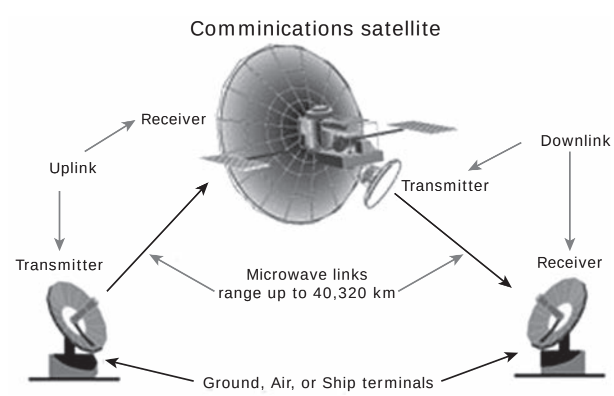

FIGURE 5.12

The transmission of signal from first earth station to satellite through a channel is called as Up-link. Similarly the transmission of signal from satellite to second earth station through a channel is called Down-link. This action can be done in vice-versa.

Earth stations send the information to satellites in the form of high powered, high frequency (GHz) range signals. The satellite receives and re-transmits the signals back to earth where they are received by other earth stations in the coverage area of the satellite.

Astronomical Satellites

Astronomical Satellites are used for observation of distance planets, galaxies and other outer space objects. These are used to monitor and image space.

Navigation Satellites

A satellites navigation or SATNAV system is a system that uses satellites to provide autonomous geo – spatial positioning. The system can be used for providing position, navigation or for tracking the position of something fitted with a receiver (satellite tracking). A satellite navigation system with global coverage may be termed a global navigation satellite system (GNSS).

Bio Satellites

Bio satellites are satellites designed to carry living organisms generally for scientific experimentation.

Weather Satellites

Weather satellites are type of satellites that is primarily used to monitor the weather and climate of the earth. These Satellites are polar orbiting satellites, covering the entire earth asynchronously or geo stationarily, hovering over the same spot on the equator.

Remote Sensing Satellites

Remote sensors collect data by detecting the energy that is reflected from Earth. These sensors can be on satellites. Remote sensor scan be either passive or active. Passive sensors respond to external stimuli. They record natural energy that is reflected or emitted from the earth's surface. Remote sensing satellites are usually put into space to monitor resources important for humans. It might track animal migration watch agricultural crops for weather damages or see forests fire and deforestation.

Nano Satellites

Nano Satellite are very small satellites which weigh less than 10 kg. It uses MEMS (Micro – Electro – Mechanical system) technology. It is widely used in laser communication.

Earth Observation Satellites

Earth Observation Satellite is intended for monitoring of earth surface in visible, NIR and MIR electromagnetic waves with the resolution of 8 meters for the purpose of agricultural, search of minerals and energy resources, land tenure, forestry, water resources control, monitoring of situation in emergency areas.

5.7.10 Application of Satellite Communication

- Military Communication
- Tele Communication
- Satellite phone
- VSAT (Very small aperture terminal)
- Cable TV
- DBS (Direct Broadcast satellite - DTH)
- GPS (Global Positioning System)
- Satellite Internet
- Weather forecasting
- Photography
- Navigation etc…..

5.8 Microwave Communication

Sending and receiving the signal via microwaves is called Microwave Communication. It is also known as "line of sight" Communication.It should be composed of voice, data, television, telephony or radio signals. Microwaves are also emitted by natural objects as well as from space.

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Microwave is a part of electromagnetic spectrum, comprising the bands between 300 MHz and 300 GHz. Microwave Communication is used for point to point communication. It requires a direct line of sight path between the transmitter and receiver. Microwave communications avoid the need for a physical connection between the transmitter and receiver.

DO YOU KNOW?

What is the meaning of microwave?

Microwave means "very Short Wave"

Microwave communication would generally require a repeater, which is placed in every few tens of miles of distance between the transmitter and the receiver. When satellites are used for microwave communication rather than for broadcasting purposes, highly directive antennas are essential to provide the required acts as a repeater in microwave communication.

The satellites acts as a repeater in microwave communication. Figure 5.13 shows the microwave communication.

5.8.1 Advantages of Microwave Communication

- It has larger bandwidth and hence large amount of information can be transmitted using it.
- It helps to manage crowded spectrum with the use of high selective receivers.
- The channels will not overlap or do not cause interference to nearby channels.
- Wired communication is not possible in hilly remote areas where there is microwave communication is suitable choice in that place.

5.8.2 Disadvantages of Microwave Communication

- Microwave Communication is limited to line of sight mode only, other modes of communication are not possible.
- It is difficult to implement lumped components such as resistors, inductors and capacitors at microwave frequencies.

5.8.3 Application of Microwave Communication

Microwave Communications are used in the following fields.

- Wireless communications (space, cellular, phones, Bluetooth, satellites….)
- Radar and Navigation (to detect aircraft, ship, space craft, weather formation, etc…..)
- Remote sensing (land surface …)
- RF Identification (security, product tracking, animal tracking…)
- Broadcasting (mobile phones and WiFi….)
- Heating (baking, food process, ovens, drying….)
- Bio-medical applications (diagnostics)

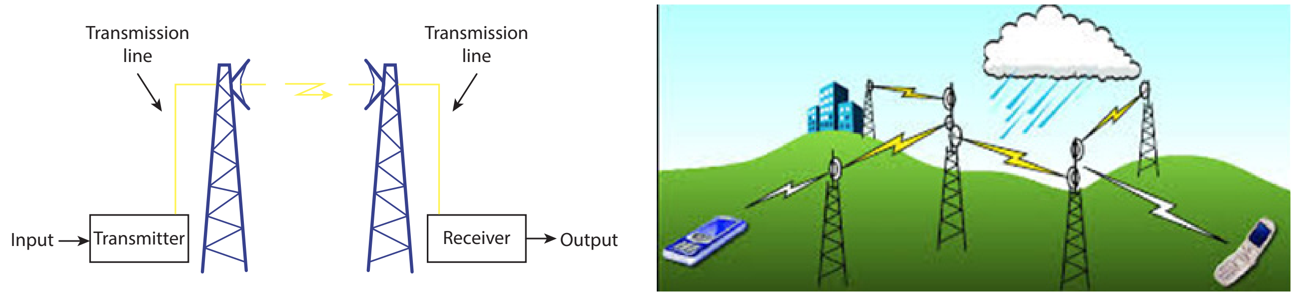

FIGURE 5.13 Microwave Communication

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5.9 Radar systems

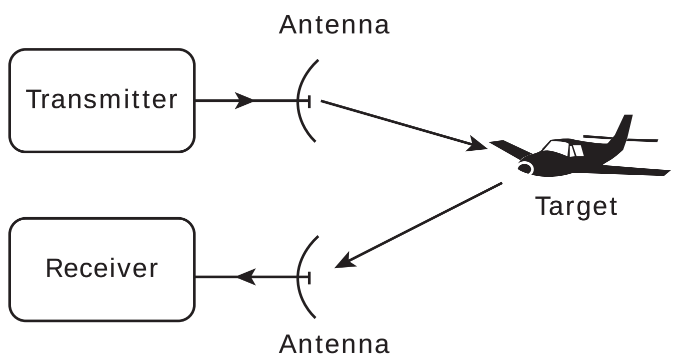
Radar stands for Radio Detection And Ranging. It is a type of radio system where radio frequency signals are used to determine the position of speed of an object. Often the objective is passive, so the reflection of RF signal from the object is used to find the speed or velocity of the object. Radar is used for a variety purposes including weather monitoring, air traffic control, speed enforcement astronomy, navigation and military application. Figure 5.14 shows the block diagram of Radar.

Transmitter

The radar transmitter produces the short duration RF pulses of energy that are sent to the space by the antenna.

Duplexer

The duplexer alternatively switches the antenna between the transmitter and receiver so that only one antenna can be used for both transmission and reception. This switching is necessary because the high power pulses of the transmitter would destroy the receiver if energy were allowed to enter into the receiver.



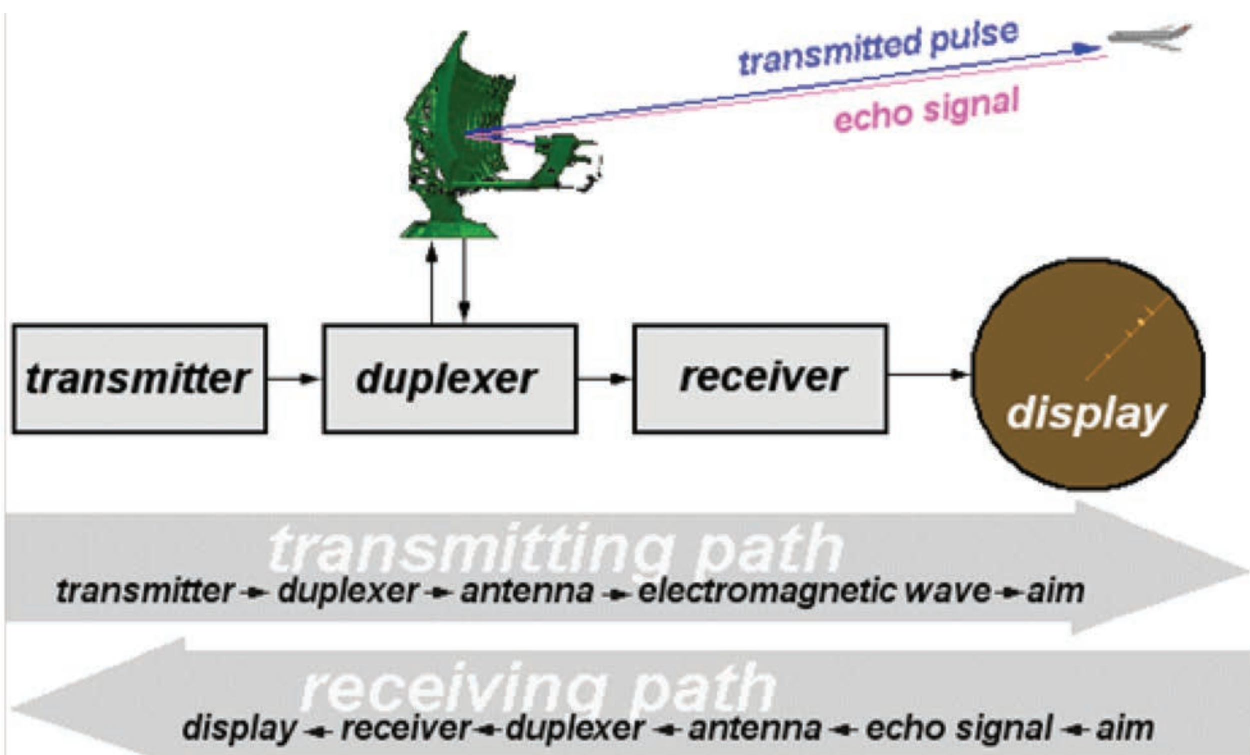


FIGURE 5.14 Tthe block diagram of RADAR

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Receiver

The receivers amplify and demodulate the received RF- signals. The receiver provides usable signals on the output.

Radar antenna

The antenna transfers the transmitter energy to the signals in space with the required distribution and efficiency.

Indicator

The indicator should present a continuous, easily understandable, graphic picture of the relative position of radar target to the observer.

The radar screen displays the echo signals as bright blimps.

5.9.1 Types of RADAR

The following flow charts shows the different types of Radars

5.9.2 Applications of Radar

- **Air Traffic Control (ATC)**

  Radar are used for safety controlling of the air traffic

- **Air Craft Navigation**

  The weather avoidance radars and ground mapping radars are employed in aircrafts to avigate it properly in all the conditions .

- Ship Navigation and safety

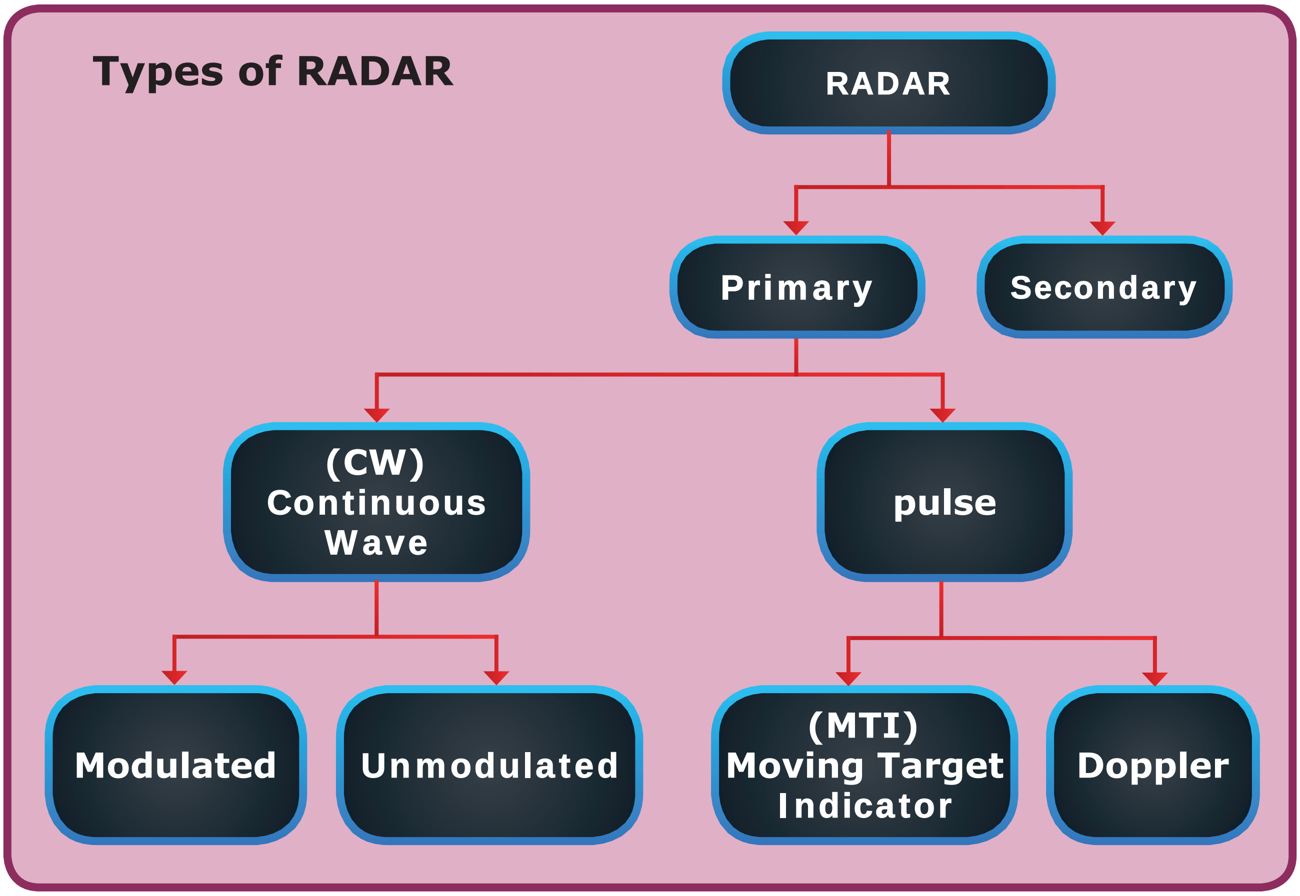
  Radars are used for beaconing and used an aid of navigation and also used to find the depth of sea.

- Space

  Radars are used for docking and safely landing of spacecrafts.

- Remote Sensing and Environment

  They are employed in remote sensing for detecting weather conditions of the atmosphere and tracking of planetary conditions



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- Law Enforcement

  High way police force widely uses radars to measure the vehicle speed for safety regulation.

- Military area

  They are used in Air, Naval and Ground for defense purposes.

5.10 SONAR Technology

SONAR (Originally an acronym for Sound Navigation And Ranging) is a technique that uses sound propagation.Sonar uses the echo principle by sending out sound waves under water or through the human body to locate objects.

When man or animal or machine makes a noise, it sends sound waves into the environment around it. Those waves bounced back after fitting any nearby objects, and some of them reflect back to the object that made the noise. SONAR works using, this echo principles.

A method or device detecting or locality objects especially underwater by means of sound waves sent out to be reflected by the objects also a device for detecting the presence of a vessel (such as a submarine) by the sound, it emits in water. Figure 5.15 shows the SONAR technology.

5.10.1 Types of SONAR

They are two types of SONAR

1. Active SONAR
2. Passive SONAR

Active SONAR

Active SONAR is emitting pulses of sound and listening echoes. It sends out sound pulses. Then receives the returning sound echo.

Passive SONAR

It is essentially listening for the sound made by vessels. It receives sound echoes without transmitting their own sound signals.

5.10.2 Uses of Active SONAR

- Detecting and tracking submarines, ships, etc (under- water combat)
- Mapping the ocean flour (navigation / Surveillance)
- Detecting under water mines

5.10.3 Uses of Passive SONAR

Listening to the noise from enemy submarines, surface vessels etc over long range.

Many animals use echo – location for hunting and navigation purposes.

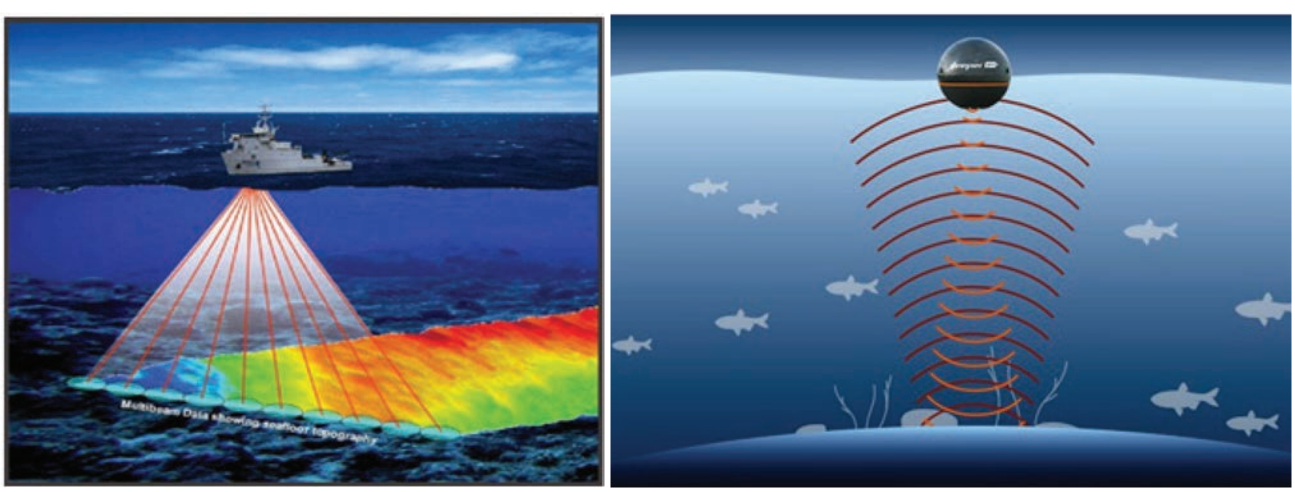

FIGURE 5.15 SONAR Technology

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5.10.4 Applications of SONAR

- To detect, track and destroy enemy ships and submarines.
- Detecting underwater mines.
- To determine navigational location.
- Mapping the Ocean floor.
- In research it is used to find animal location and tracking.
- In medical, it is used in sonography and auditory research.

5.11 Tsunami System

5.11.1 What is Tsunami?

A Tsunami is a series of fast moving waves in the ocean caused by powerful earthquakes or volcanic eruptions. A tsunami has a very long wavelength. It can be hundreds of kilometres long.

5..11.2 Need of Tsunami Warning System

The east and west coasts of India and the island regions are likely to be affected by tsunamis generator mainly due to earthquakes in the subductions zones. Hence there was a need for developing tsunami warning system.

5.11.3 Tsunami Warning System

Tsunami warning system is used to detect tsunami in advance and issue warnings to prevent losses of life and property damage

It is made up of two equally important components

1. A network of sensors to detect tsunamis.
2. A communication infrastructure to issue timely alarms to permit evacuation of the costal areas.

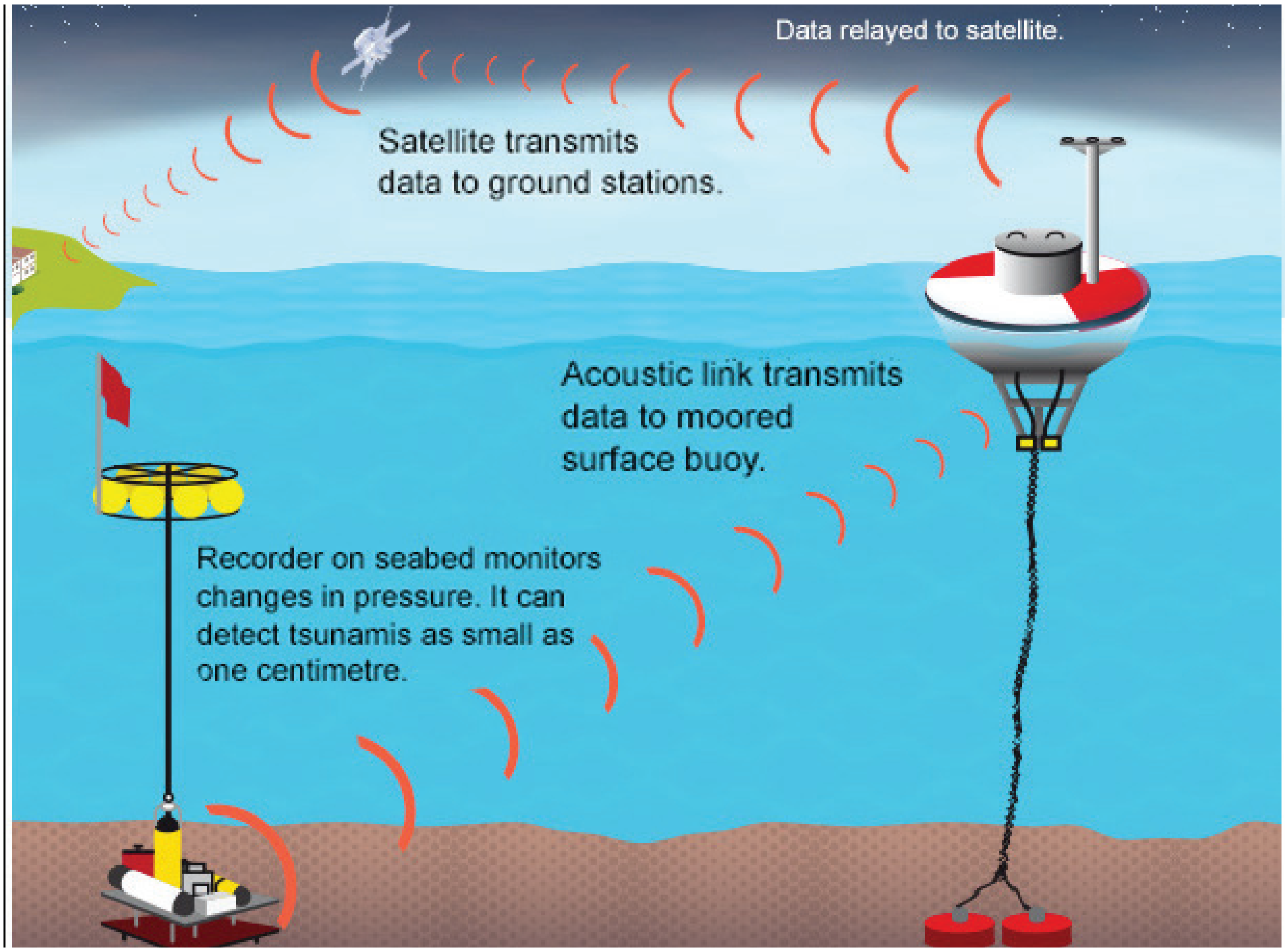

FIGURE 5.16 (a) Tsunami warning system

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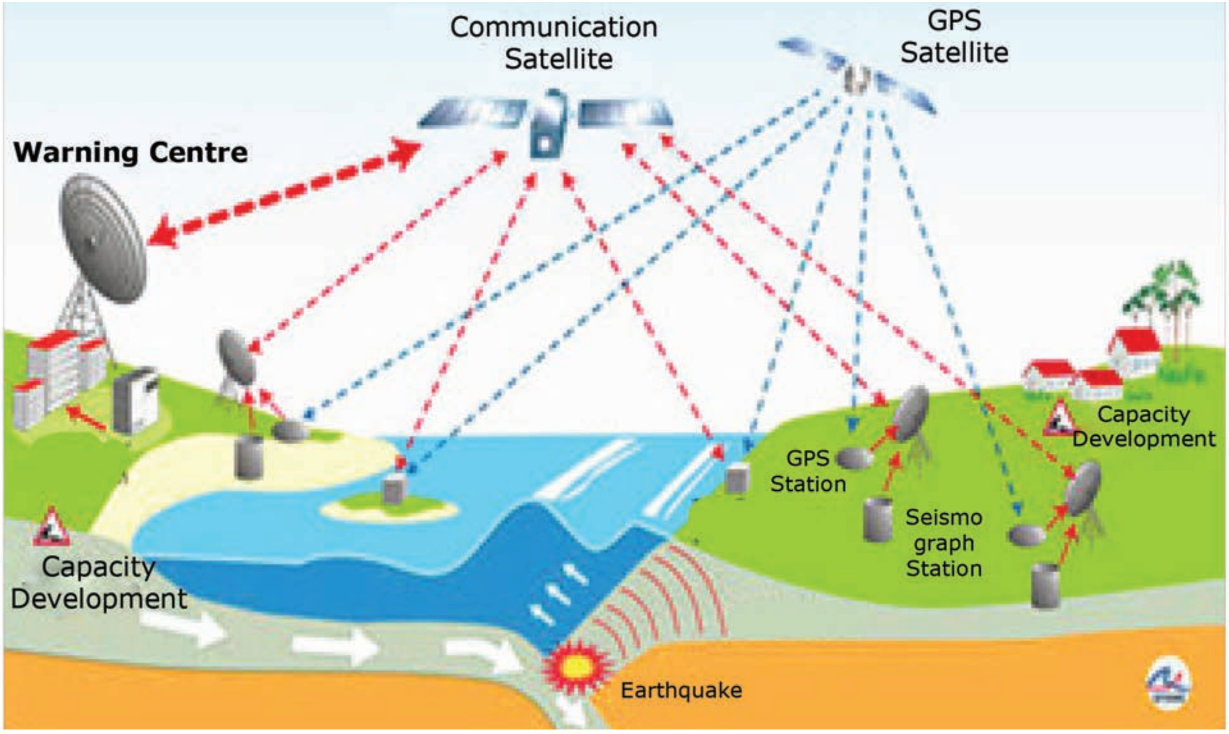


FIGURE 5.16(b) Tsunami warning system

There are two types of tsunami warning systems

1. International tsunami warning systems
2. Regional warning systems

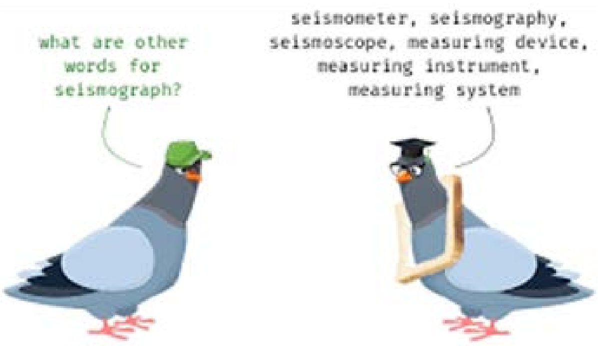
Figure 5.16 shows the Tsunami warning system.

DO YOU KNOW? Where is the tsunami warning system located in India?

Answer: In Hyderabad

5.12 Seismograph and Avionics

5.12.1 Seismograph



A Seismograph is a device for measuring the movement of the earth and consists of a ground-motion detection sensor, called a seismometer, coupled with a recording system.

A Seismograph is an instrument which is used to detect and record earthquake. Generally it consists of a mass attached to a fixed base. During an earthquake, the base moves and the mass does not.

The motion of the base with respect to the mass is commonly transferred into an electrical voltage. Figure 5.17 shows the seismograph.

The electrical voltage is recorded on paper, magnetic tape or recording medium. This record is proportional to the motion of the seismometer mass relative to the earth but it can be mathematically converted to a record of the absolute motion of the ground.

The magnetude of an earthquake is determined by recording of the seismic waves resulting from the vibration generator by the seismic source. Sensitive seismograph, which greatly magnify these ground motions that can detect strong

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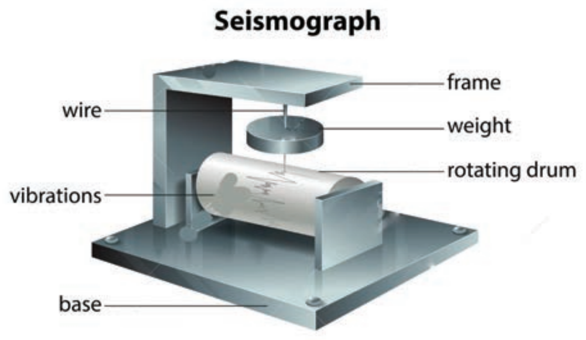

FIGURE 5.17 Seismograph

earthquakes from sources anywhere in the world. The time, locations and magnitude of an earthquake can be determined from the data recorded by seismograph station.

5.12.2 Avionics system

Avionics are the electronic Systems used on aircraft, artificial satellites and space craft. Avionic system included communications, navigations, the display and magnet of multiple system and the hundreds of systems that's are fitted to aircraft to perform individual function.

DO YOU KNOW?

How does the word Avionics come from?

The word avionics comes from Aviation + electronics

5.12.3 Aircraft AVIONICS

The cockpit of an aircraft is a typical location for avionic equipment, including control, monitoring, communication, navigation, weather, and anti-collision systems. The majority of aircraft power their avionics using 14- or 28volt DC electrical systems; however, larger, more sophisticated aircraft (such as airliners or military combat aircraft) have AC systems operating at 400 Hz, 115 volts AC. A separate international organisation called Airlines Electronic Engineering Committee (AEEC) prepare the International standards for Avionics equipment. Figure 5.18 shows the Cockpit of flight Airbus A380.

5.12.4 Communications

Communications connect the flight deck to the ground and the flight deck to the passengers. Onboard communications are provided by public-address systems and aircraft intercoms.

The VHF aviation communication system works on the airband of 118.000 MHz to 136.975 MHz. Each channel is spaced from the adjacent ones by 8.33 kHz in Europe, 25 kHz elsewhere. VHF is also used for line of sight communication such as aircraft-to-aircraft and aircraft-to-ATC. Amplitude modulation (AM) is used, and the conversation is performed in simplex mode. Aircraft communication can also take place using HF (especially for trans-oceanic flights) or satellite communication.

5.12.5 Navigation

Air navigation is the determination of position and direction on or above the surface of the Earth. Avionics can use

FIGURE 5.18 The cockpit of flight Airbus A380

satellite navigation systems (such as GPS and WAAS), ground-based radio navigation systems (such as Ominidirectional Range (VOR) or LORAN), or any combination thereof. Navigation systems calculate the position automatically and display it to the flight crew on moving map displays. Older avionics required a pilot or navigator to plot the intersection of signals on a paper map to determine an aircraft's location; modern systems calculate the position automatically and display it to the flight crew on moving map displays.

5.12.6 Monitoring

The first hints of glass cockpits emerged in the 1970s when flight-worthy Cathode Ray Tube (CRT) screens began to replace electromechanical displays, gauges and instruments. A «glass» cockpit refers to the use of computer monitors instead of gauges and other analog displays. Aircraft were getting progressively more displays, dials and information dashboards that eventually competed for space and pilot attention. In the 1970s, the average aircraft had more than 100 cockpit instruments and controls.

Glass cockpits started to come into being with the Gulfstream GIV private jet in 1985. One of the key challenges in glass cockpits is to balance how much control is automated and how much the pilot should do manually. Generally they try to automate flight operations while keeping the pilot constantly informed.

5.12.7 Aircraft Flight-Control System

DO YOU KNOW?

Who invented autopilot System

Autopilot was first invented by Lawrence Sperry during World War I

Aircraft have means of automatically controlling flight. Initially Autopilot system was developed to fly bomber planes steady enough to hit accurate targets from even 25,000 feet. Nowadays most commercial planes are equipped with aircraft flight control systems in order to reduce pilot error and workload at landing or take off.

The first simple commercial auto-pilots were used to control heading and altitude and had limited authority on things like thrust and flight control surfaces. In helicopters, auto-stabilization was used in a similar way. The first systems were electromechanical. The advent of electronic (fly by wire) and electro-actuated flight surfaces (rather than the traditional hydraulic) has increased safety.

5.12.8 Collision-Avoidance Systems

To supplement air traffic control, most large transport aircraft and many smaller ones use a Traffic Alert and Collision Avoidance System (TCAS), which can detect the location of nearby aircraft, and provide instructions for avoiding a mid-air collision. Smaller aircraft may use simpler traffic alerting systems such as TPAS, which are passive (they do not actively interrogate the transponders of other aircraft) and do not provide advisories for conflict resolution.

To help avoid Controlled Flight into Terrain (CFIT), aircraft use systems such as Ground-Proximity Warning Systems (GPWS), which use radar altimeters as a key element. One of the major weaknesses of GPWS is the lack of «look-ahead» information, because it only provides altitude above terrain «look-down». In order to overcome this weakness, modern aircraft use a Terrain Awareness Warning System (TAWS).

5.12.9 Flight recorders

Commercial aircraft cockpit data recorders, commonly known as "black

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boxes", store flight information and audio from the cockpit. They are often recovered from an aircraft after a crash to determine control settings and other parameters during the incident.

5.12.10 Weather Systems

Weather radar

Weather systems such as weather radar (typically Arinc 708 on commercial aircraft) and lightning detectors are important for aircraft flying at night or in instrument meteorological conditions, where it is not possible for pilots to see the weather ahead. Heavy precipitation (as sensed by radar) or severe turbulence (as sensed by lightning activity) are both indications of strong convective activity and severe turbulence, and weather systems allow pilots to deviate around these areas.

LEARNING OUTCOME

At the end of this chapter, the students can learn about

- The principle of OFC.
- Advantages and disadvantages of OFC.
- The difference between OFC and cable communication.
- The different types of satellite and its applications.
- The basic function of RADAR and SONAR.
- The application of Avionics and Seismograph.

GLOSSARY

Optical fiber	A glass or plastic fiber that has the ability to guide light along its axis
Cable	One or more optical fibers enclosed, with strength members in a protective
Multi mode fiber	An optical fiber that has a core large enough to propogate more than one mode of light
Orbit	The path a satellite takes while travelling around the earth.
Down link	The signal that comes down a satellite to an earth station.
Earth station	An installation located on the earth's surface and intented for communication with one or more satellites.
Repeater	A device that amplifies incoming electrical signals and retransmits them towards the earth station(s) at a different frequency.
Transponder	A transmitter – receiver device that transmits signals automatically when it receives pre – determined signal.
Duplex	A term meaning two way communication
Uplink	The signal that transmits an earth station to a satellite.

Part – A (1 Mark)

I Multiple choice Questions

1. The principle of OFC technology was ________
   a. Electromagnetic induction
   b. Internal reflection
   c. Electro motive force
   d. Mutual inductance

2. The core diameter of step index single mode is ________
   a. 5 µm & 10 µm
   b. 1 µm & 20 µm
   c. 30 µm & 40 µm
   d. 2 µm & 5 µm

3. The diameter of step index multimode is ________
   a. 62.5µm/125 µm
   b. 72.5µm/125 µm
   c. 32.5µm/125 µm
   d. 42.5µm/125 µm

4. Which of the following fiber has higher bandwidth?
   a. Step index single mode
   b. Step index multimode
   c. Graded index multimode
   d. None of the above

5. ________ is the primary source of power for satellites
   a. Sun
   b. Light
   c. Heat
   d. None of the above

6. Solar cells in satellites mostly made up of ________
   a. Silicon
   b. Germanium
   c. Copper
   d. Aluminium

56AZQ

7. The first Indian artificial satellite was ________
   a. Sputnik-1
   b. Apple
   c. PSLV-1
   d. Aryabhata

8. The name of dog travelled in sputnik-2 was
   a. Leno b. Laika
   c. Lucy d. Leha

9 ________ is widely used in laser Communication
   a. Bio Satellites
   b. Weather Satellites
   c. Nano Satellites
   d. Earth observation Satellites

10. Microwave Communication is also called ________
    a. Satellites Communication
    b. Optical fibre Communication
    c. Line of sight Communication
    d. Space Communication

11. Microwave frequency ranges were ________
    1. 1 GHz to 30 GHz
    2. 100 KHz to 30 MHz
    3. 550 KHz to 1650 KHz
    4. 300 MHz to 300 GHz

12. ________ works as microwave repeater.
    a. Amplifier b. Satellite
    c. Antenna d. SONAR

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13. Radar is used to determine location or speed of an ________

a. Ship
b. Object
c. Wave
d. Metal

14. SONAR uses ________ principles by sending out sound waves under water.

a. Electromagnetic
b. Electromotive
c. Echo
d. Mutual inductance

15. A seismograph is an instrument to detect and record ________

a. Weather report
b. Earthquake
c. Tsunami
d. Natural resouces.

Part – B (3 Marks)

II Answer in one or two sentences

1. What are fiber optics?
2. What are the basic elements of fiber optics?
3. How is optical fiber classified?
4. What is RADAR?
5. Write about the types of RADAR.
6. Write the uses of Earth observation satellite.
7. Define the uses of Tsunami Warning System.
8. Define: Seismograph.
9. Write short notes on an Avionics.
10. Write about weather satellite?

Part – C (5 Marks)

III Answer in a paragraph

1. How does OFC work?
2. What are the advantages and disadvantages of OFC?
3. What are the uses of RADAR?
4. Explain about Microwave communication.
5. List out the applications of SONAR.

Part – D (10 Marks)

IV Answer in One Page (Essay type Question)

1. Explain briefly the difference between optical fiber and co-axial cable.
2. What are the applications of OFC?
3. Draw the block diagram of RADAR and explain.
4. Explain about any five artificial satellites.

ANSWERS

1. (b)	2. (a)	3. (a)	4. (c)	5. (a)
6. (a)	7. (d)	8. (b)	9. (c)	10. (c)
11. (d)	12. (b)	13. (b)	14. (c)	15. (b)

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