# WIRELESS COMMUNICATIONS   CHAPTER **6**

## After completing this lesson, you will be able to:

- Know the advantages and disadvantages of wireless networks.
- Define radio signals, radio transceiver, access point and line of sight communication.
- Differentiate between short distance and long distance wireless communication.
- Describe types of short distance wireless technologies (Wi-Fi, Wi-Max, Bluetooth and Infra-red).
- Describe types of long distance wireless communication. (Cellular Communication and Global Positioning System).
- Define mobile communication
- Identify features and limitations of mobile communication system.

## UNIT INTRODUCTION

Wireless communication is an important area in telecommunications and networking. This unit is dedicated to wireless communication systems. It defines commonly used wireless communication terminology and presents contents about the types of signals, devices and architecture used for creating wireless communication networks. It defines short distance and long distance wireless communication and describes the technology used for it.

## 6.1 INTRODUCTION

**Q.1   Give a brief introduction of wireless communication.**

**Answer**

### Wireless Communication

Wireless communication is a term used to describe communications between two or more devices without any physical connection. The wide spread use of mobile telephone, various satellite services, and now the wireless Internet and wireless LANs are generating incredible changes in telecommunications and networking. Wireless communication refers to technology that transmits information over short or long distance without using connecting wires. It is alternative to using network cables. The demand for wireless communication is rapidly increasing today.

## 6.1.1 WIRELESS NETWORKS

**Q.2   State the term "wireless". Describe important mediums of transmission of data and information.**

**Answer**

### Wireless

The term wireless refers to the communication or transmission of information over a distance without requiring wires, cables or any other electrical conductors.

Today, the term wireless refers to a variety of devices ranging from smart phones to laptops, tabs, computers, printers, etc..

### Important mediums of transmission of data

Wireless communication network is one of the important mediums of transmission of data or information to other devices.

### Transmission of information

In wireless networks, the information is transmitted through the air, without requiring any cables, by using wireless network technology.

**Q.3** Name some important wireless technologies. Also describe the functions of wireless network.

**Answer**

## Important wireless technologies

Some important wireless technologies are as follows:

> Satellite      > Microwave > Wi-Fi      > Wi-MAX      > Infra-red

## Functions of wireless network

A wireless network enables people to communicate and access applications and information without wires. This provides freedom of movement and the ability to extend locations to different parts of a building, city, or nearly anywhere in the world. Wireless net works allow people to interact with e-mail or browse the Internet from a location the way they prefer.

Many types of wireless communication systems exist, but a distinguishing attribute a wireless network is that communication takes place between computer devices.

These devices include Personal Digital Assistants (PDAs), laptops, personal computers (PCs), servers, and printers. Computer devices have processors, memory, and a means of interfacing with a particular type of network. In most cases, wireless networks transfer data, such as e-mail messages and files, but advancements in the performance of wireless networks is enabling support for video and voice communications as well.

A wireless network is shown in Fig 6.1.



Fig. 6.1 Wireless Network

## 6.1.2 ADVANTAGES AND DISADVANTAGES OF WIRELESS NETWORKS

**Q.4** Write down the advantages and disadvantages of wireless network.

**Answer**

## Advantages of Wireless Networks

1. Wireless networks can easily add users without having to change the physical connection.
2. Wireless networks provide robust security protections. Traffic of a wireless network can be filtered or simply blocked very easily.
3. Using wireless networks users are no longer tied to a specific location, as were with a wired connection. With a laptop computer or mobile device, access can be available at different locations.
4. In most of the wireless networks, users can connect automatically if they are within the range.
5. Setting up a wireless network can be much more cost effective than buying and installing cables. Because wireless networks eliminate or reduce wiring costs
6. Adding new computers to a wireless network is very easy. We can easily expand wireless network with existing equipment, while a wired network might require additional wiring.
7. Wireless networks provide remote access to the company's key applications and resources help employees to get the job done while they are away from the company.

## Disadvantages of Wireless Networks

1. The main disadvantage of the wireless network is security breach. Intruders (hackers) can tap into a wireless network relatively easier than a wired network.
2. Another disadvantage is about its coverage that somewhere users might face problems of range of signals.
3. Sometimes wireless networks speed can be slower than wired networks because of the low signals.
4. Because wireless networks use radio signals and similar techniques for transmission they are susceptible to interference from magnetic or electronic effects.
5. Wireless signal energy weakens rapidly as the signal passes through the environment consisting of trees, buildings, etc.
6. In wireless networks, bad weather also plays a role in weakening the signals.

## 6.1.3 WIRELESS NETWORK TERMINOLOGY

**Q.5   Write a note on radio signal.**

Answer

### Radio Signal

A radio signal or radio wave is an electromagnetic wave propagated by an antenna. Radio waves have different frequencies and tuning a radio receiver to a specific frequency you can pick up a specific radio signal.

### Parts of Radio Frequency Systems

All the Radio Frequency (RF) systems consist of the following two components:

➢ Transmitter
➢ Receiver



Fig. 6.2 Communication using radio signal

### Working of Radio Frequency Systems

A transmitter transmits a radio signal to a receiver, which listens for the signal and receives it. RF systems include a set of rules that define how the transmitter and receiver communicate. For example, a rule set can specify that the transmitter must communicate with the receiver at a specific frequency. Early radio signals were analogue but today most of the radio signals are digital.

**Q.6   Briefly explain radio transceiver.**

Answer

### Radio Transceiver

A transceiver is a device, which can transmit and receive a radio signal and have a common circuitry in a single housing. In case of radio, the transmitter and the receiver are separated. The radio broadcasting station is basically a transmitter and the radio is a receiver. But in many cases, like cell phone, the device serves the both functions. Therefore, a cell phone is a transceiver. A radio transceiver is shown in Fig.6.3.

Fig.6.3 Radio Transceiver

## Q.7 Write a note on wireless access point.
**Answer**

### Wireless Access Point

A Wireless Access Point (WAP) is a device that allows wireless devices to connect to a wired network using Wi-Fi. The access point connects to the wired network and then broadcasts signals wirelessly to all the other wireless devices such as laptop computers as shown in Fig.6.3.
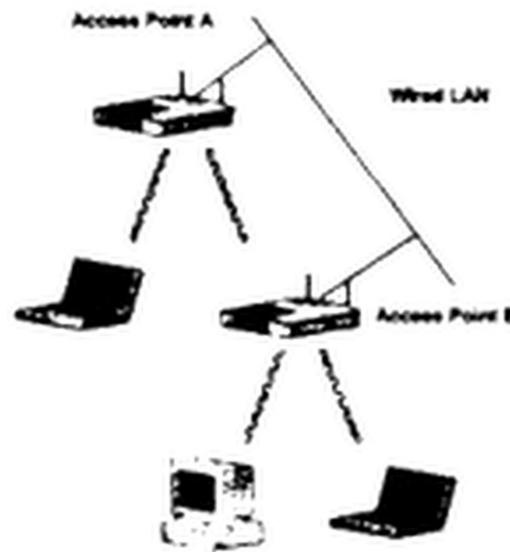


Fig.6.3 Network using Wireless Access Point

For computers to communicate over a wireless network, they must support the wireless    LAN protocol called Wi-Fi. Today many computers some fully equipped with integrated Wi-Fi, so they are ready to get connected to the wireless access point.

## Q.8 Briefly explain LOS communication.
**Answer**

### Line of Sight Communication

In Line of Sight (LOS) communication, the transmitter and receiver antennas are in line of sight as shown in Fig.6.4.



Fig 6.4 Line of Sight Communication

Line of sight communication is used in high frequency communication where the signals cannot pass through structures and hills. For long distance communication, transmitters are installed on high buildings, mountaintops or high towers. Relay stations (boosters) are used to amplify the signals and retransmit from station to station.

## 6.1.4 SHORT AND LONG DISTANCE WIRELESS COMMUNICATIONS

**Q.9  Explain short and long distance wireless communications.**

**Answer**

Wireless communication may be differentiated based on the region it covers into short distance and long distance wireless communication.

### 1. Short Distance Wireless Communication

Short distance wireless communication consists of very short distance of few meters (Infra-red) to a distance of up to 50 Km (Wi-Max).

### Types of Short Distance Wireless Communications

Following are the types of short distance wireless communications:

➢ Wi-Fi

➢ Wi-Max

➢ Bluetooth

➢ Infra-red

### 2. Long Distance Wireless Communication

Long distance wireless communication comprises of distances above 50 Km using either cellular communication methods or Global Positioning Systems, which utilizes satellites.

## 6.2 SHORT DISTANCE WIRELESS COMMUNICATION
## 6.2.1 WI-FI

**Q.10 State the characteristics of Wi-Fi.**

**Answer**

Wi-Fi (Wireless Fidelity) is a wireless communication system very commonly used at home and office. It is also called WLAN (Wireless LAN). It is a popular wireless networking technology, which uses radio waves to provide wireless high-speed Internet and network connections. Wireless networks are easy to setup and are inexpensive. In Wi-Fi, information travels over the air. These networks are extremely limited in range due to low power of transmissions allowing users to connect only within close proximity to a router or signal repeater. Wi-Fi is common in home networking applications, which provides portability without any need of cables. Wi-Fi networks need to be secured with passwords for security purposes in order not to be accessed by others.

## 6.2.2 WI-Max

**Q.11 Write a note Wi-Max.**

**Answer**

Wi-Max (Worldwide Interoperability for Microwave Access) is a wireless network that provides public network service to users. It is very similar to Wi-Fi but covers a big range of 40 to 50 Km. Wi-Max creates a Metropolitan Area Network (MAN) and provides a wireless alternative to Cable TV and DSL Internet connection. It provides service just about anywhere you go within a city. It transmits information through microwave and uses a more complex technology than Wi-Fi.

## 6.2.3 BLUETOOTH

**Q.12 Briefly explain Bluetooth.**

**Answer**

Bluetooth is a short-range and low speed wireless communication technology. Its range is around 10 meters with the data transfer rate up to 723 Kbps and it consumes low power. It provides a way to connect and exchange information between devices such as mobile phones, laptop computers, PCs, printers, digital cameras, and video game consoles. Bluetooth can be used to replace cables between the PC and the linking devices such as printers, keyboards, mouse, etc..

## 6.2.4 INFRA-RED

**Q.13 What is infra-red? Describe its applications?**
**Answer**
**Infra-red**

Infra-red (IR) waves are extremely high frequency waves which are used for short range communication.

**Applications of Infra-red Technology**

Some common applications of Infra-red technology are listed below.

1. Car locking systems use Infra-red technology for automatic locking and unlocking the doors of cars.
2. Modern Computers have Infra-red enabled mouse, keyboards, and printers.
3. Home security systems have Infra-red enabled burglar alarm system.
4. Remote control system in TVs, Toys, etc uses Infra-red technology.

## 6.3 LONG DISTANCE WIRELESS COMMUNICATION

**Q.14 Define long distance wireless communication.**
**Answer**

Long Distance wireless communication systems provide services that are not possible with the use of cables. It includes cellular and global positioning systems.

## 6.3.1 CELLULAR COMMUNICATION

**Q.15 Explain cellular communication.**
**Answer**
**Cellular Communication**

Cellular communication refers to wireless communication systems that divide a geographical region into sections called cells. Each cell has a Base Station (BS) at the center that contains a transceiver and controller that provides radio communication to mobile phones.

**Base Station**

In cellular communication, each mobile phone uses a separate temporary radio frequency (channel) to talk to the Base Station (BS). The BS talks to many mobile users at the same time as shown in Fig.6.5.
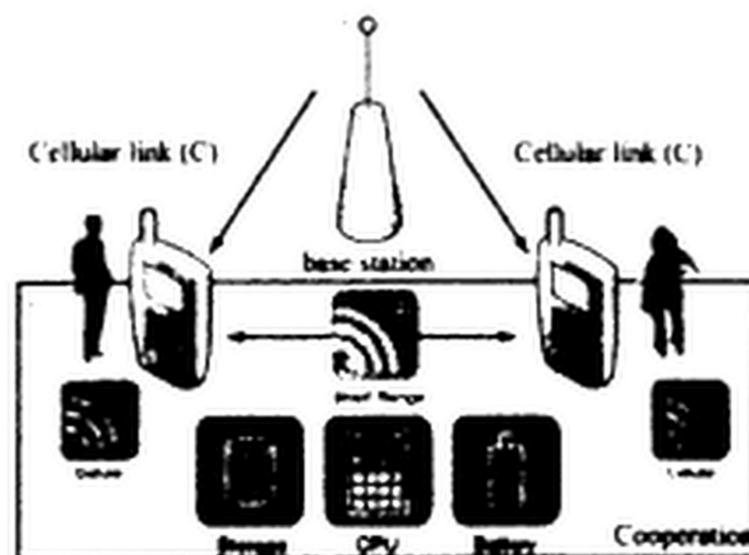


Fig 6.5 Cellular communication network

Channels use a pair of frequencies for communication. One frequency, the uplink is used for the mobile phone to communicate with the BS and another frequency for the downlink for BS to communicate with the mobile phone.

## Basic Concept of Cellular Communication

The basic concept of cellular communication is that it reuses the radio frequency by the cell that is at a distance where there is no interference of the other.

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### 6.3.2 GLOBAL POSITIONING SYSTEM

**Q.16 What is meant by GPS? Describe its uses.**
**Answer**
**Global Positioning System**

Global Positioning System (GPS) is a radio navigation system that allows people on land, in sea or in the air to determine their exact position, 24 hours a day anywhere in the world in all weather conditions.

Global positioning system is shown in Fig 6.6.



Fig.6.6 Global Positioning System

**Uses of GPS**

GPS are used for navigation, on airplanes, ships, ground vehicles, and by individuals. Also the relative positioning and time data is used to study the movement of tectonic plates to understand the earthquakes, astronomical observations, telecommunications, etc..

**Q.17 Define satellite and state its uses.**
**Answer**
**Communication In Modern Era**

In the modern era of communication, satellites are widely used.

**Satellite**

A satellite is a relay station, which is placed into orbit by humans. They are sometimes called artificial satellites to distinguish them from natural satellites such as the moon.

**Uses of satellites**

Satellites are used for various purposes such as military and civilian earth observation satellites, communication satellites, navigation satellites, weather satellites, and research satellites. The orbits used by the satellites may be defined as Geostationary Earth Orbit, Medium Earth Orbit or Low Earth Orbit

**Q.18 Describe the classification of satellite system in detail.**
**Answer**
**Classification of Satellite System**

Satellite Systems can be classified based upon their orbits into the following three types:

➢ Geostationary Earth Orbit (GEO)

➢ Medium Earth Orbit (MEO)

➢ Low Earth Orbit (LEO)

## 1. Geostationary Earth Orbit (GEO)

A Geostationary Earth Orbit (GEO) or Geostationary Orbit is an orbit directly above the earth's equator (at 0° latitude), with a period equal to the earth's rotational period. An object in a geostationary orbit appears to be fixed in the sky if observed from the earth. Communication satellites and weather satellites are generally placed in geostationary orbits, so that the satellite earth antennas (placed on earth) that communicate with them do not have to track them, but can be placed permanently at the fix position where they stay.

## 2. Medium Earth Orbit (MEO)

A Medium Earth Orbit (MEO) is located above low earth orbit (altitude of 2,000 kilo meters) and below geostationary earth orbit (altitude of 35,786 kilo meters). The satellites placed in this orbit are generally used for navigation, such as the Global Positioning System at an altitude of 20,200 km. For example, GLONASS (a Russian satellite-based navigation system) is at an altitude of 19,100 Km and GALILEO (a European Union (EU) satellite-based navigation system) is at an altitude of 23,222 Km from the earth.

## 3. Low Earth Orbit (LEO)

A Low Earth Orbit (LEO), also known as low orbit, is generally defined from the earth's surface up to an altitude of 2,000 km. But the commonly used definition for LEO is from 160 km to 2,000 km above the earth surface. Less energy is required to place a satellite into a low earth orbit and it requires low power amplifiers for communication. Therefore, this orbit is used for many communication applications. Most of the satellites, like the International Space Station, the Space Shuttle, and the Hubble Space Telescope are all exist in Low Earth Orbit.

## 6.4 MOBILE DEVICE COMMUNICATION

**Q.19 What is mobile communication?**
Answer

### Mobile communication

Mobile communication involves the use of mobile devices such as mobile phones, smart phones, PDAs and laptop and tablet computers. Mobile communication devices give the freedom to communicate with others or access information everywhere. These devices improve our efficiency and productivity.

## 6.4.1 REQUIREMENTS OF MOBILE COMMUNICATION

**Q.20 Which components are required for mobile communication.**
Answer

### Components of Mobile Communications

Communication between mobile phones is established by connecting to a cellular network as shown in Fig.6.7.
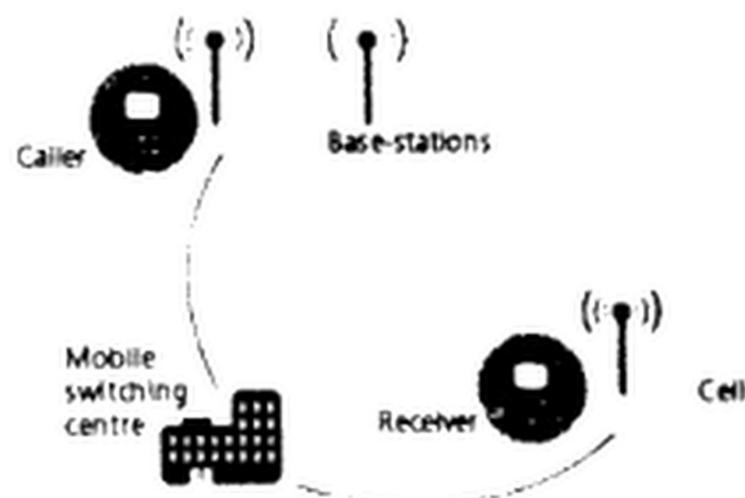


Fig.6.7 Mobile Phone Network

The following are the components required for mobile communications:

➢ Mobile phone
➢ Base station
➢ Switching node
➢ Landline telephone network

### 1. Mobile phone

Mobile phone is a device that allows making and receiving calls over a cellular network. Modern mobile phones also support services such as text messaging, MMS, email and Internet.

### 2. Base station

Base station communicates with many mobile phones at the same time. It is equipped with a transceiver and antenna for transmitting and receiving signals from mobile phones. It is responsible for handling traffic and signaling between mobile phones.

### 3. Switching node

Switching node is a component of cellular network that carries out switching and mobility management functions for mobile phones on network of base station. Switching nodes are owned and deployed by mobile phone operators and allow mobile phones to communicate with each other and telephone landline network

### 3. Telephone Landline

Telephone Landline Network is a wired Public Switched Telephone Network (PSTN) that is connected with cellular network to provide communication between mobile phone and telephone on PSTN

## 6.4.2 FEATURES AND LIMITATIONS OF MOBILE COMMUNICATION SYSTEMS

Q.21 Describe the features and limitations of mobile communication systems.
Answer
Following are the features and limitations of mobile communication system.

### Features of mobile communication systems

1. Mobile devices readily access information from the World Wide Web. The validity and accuracy of information cannot be guaranteed since anybody can easily upload any information on Web sites unlike books that undergo a process of scrutiny before publication.
2. Mobile Internet users copy and paste information from Web sites without the permission of publisher and this is violations of property rights.
3. Daily use of mobile computing devices will eventually make people more dependent on them instead of relying on their own potentials.

### Limitations of mobile communication systems

1. Without proper protection, hackers can install spyware on other's mobile devices for capturing credit card information, account login details and password, which can be very harmful.
2. Wireless mobile communication has the limitation of low processing capability, high error rate and low storage availability
3. Handheld mobile devices have the limitations of small display, low memory, limited battery power and limited CPU power.

## 6.4.3 ARCHITECTURE FOR COMMUNICATION OVER MOBILE DEVICES

Q.22 Explain the architecture for communication over mobile devices.
Answer
### Architecture for Communication over Mobile Devices

The Mobile Device Communication Architecture includes the following wireless data communication capabilities:

> Web Protocol Stack
> Wireless Markup Language (WML)
> Wireless Application Protocol (WAP)

## 1. Web Protocol Stack (HTTP/TCP/IP)

Web Protocol Stack consists of TCP/IP and HTTP. Its purpose is to allow two computers to communicate with each other over the Internet. When a message is sent over Internet, it is translated from text form to electronic signals at the source computer and then translated back to text form at the destination computer. Every computer needs protocol stack to communicate over the Internet and it is usually built in the operating system such as Windows. The protocol stack used for the Internet is known as TCP/IP protocol stack. Fig. 6.8 shows how message is sent over Internet from source to destination computer over Internet.
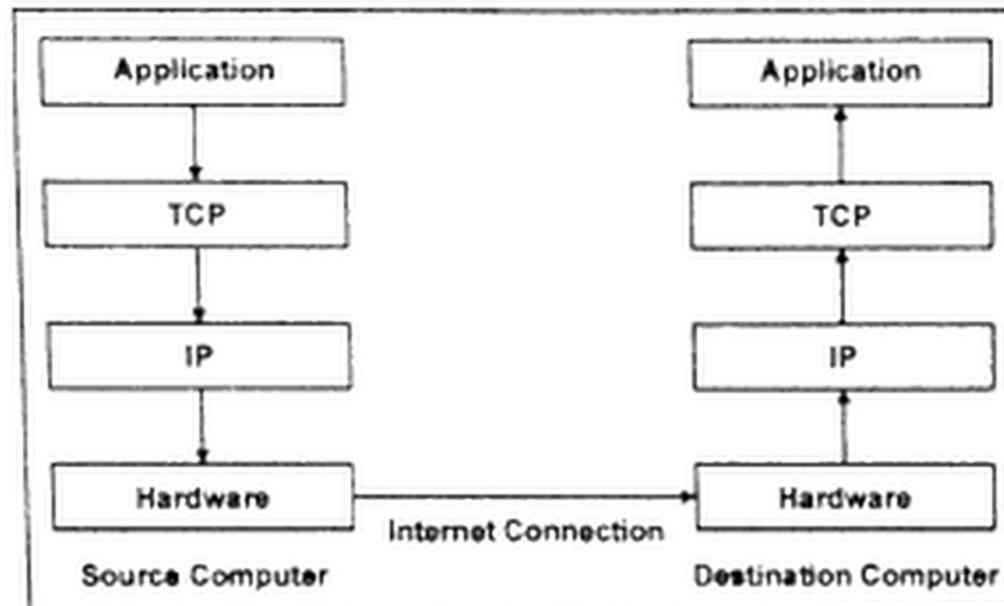


Fig.6.8 Working of Web Protocol Stack

## 2. Wireless Markup Language (WML)

Wireless Markup Language is based on HTML and XML and it delivers Internet contents to small wireless devices. such as browser-equipped mobile phones and other handheld devices. These devices have very small displays, slow CPUs, limited memory capacity, low bandwidth and restricted user-input capabilities. WML demands less memory and processing power from browsers than HTML. WML also includes features that support relatively small display sizes of today's wireless devices.

## 3. Wireless Application Protocol (WAP)

WAP consists of multiple protocols that provide Internet access to mobile users of wireless phones and other wireless devices such as pagers and personal digital assistants (PDAs). Today, it has become the standard for providing data and voice services to wireless hand-held devices.

## 🔑 KEY POINTS

☞ Wireless communications technologies receive transmit information using electromagnetic waves.

☞ A Transceiver is a device, which can transmit and receive a radio signal and has a common circuitry in a single housing.

☞ A Wireless Access Point (WAP) is a device that allows wireless devices to connect to a wired network using Wi-Fi.

☞ In Line of Sight Communication, the transmitter and receiver antennas are in line of sight and it uses high frequency communication where the signals cannot pass through structures and hills.

☞ Short distance wireless communication consists of very short distance of few meters to a distance of up to 50 Km. Wi-Fi, Wi-Max, Bluetooth and Infra-red are the types of short distance wireless communications.

☞ Long distance wireless communication comprises of distance above 50 Km. using either cellular communication or global positioning system.

- Wi-Fi is Wireless Local Area Network (WLAN)
- Wi-Max wireless network has a range of 40 to 50 Km. It provides wireless alternative to Cable TV and DSL.
- Bluetooth provides a short-range wireless connection to exchange information between devices such as mobile phones, laptops, printers and digital cameras.
- Infra-red waves are extremely high frequency waves used by remote controls for television, VCR and other similar devices.
- Cellular communication divides a geographical region into sections called cells and has a Base Station (BS) at the center. The BS contains a transceiver and controller that provides radio communication to mobile phones.
- Global Positioning System (GPS) is a radio navigation system that allows people on land, in sea or in the air to determine their exact position.
- Geostationary Earth Orbit is an orbit directly above the earth's equator with a period equal to the earth's rotational period.
- Medium Earth Orbit is located above low earth orbit and below geostationary earth orbit, is generally used for navigation.
- Low Earth Orbit is located up to an altitude of 2,000 Km from the earth's surface. Less energy is required to place a satellite into a low earth orbit and it requires low power amplifiers for communication.
- Wireless Markup Language (WML) is a markup language used to deliver Internet contents to small wireless devices such as mobile phones and other hand-held devices.

# EXERCISE

## Q1.  Select the best answer for the following MCQs.

i. Which of the following has a range of 40 to 50 Km?
    A  Wi-Fi          B  Wi-Max          C  Bluetooth          D  Infra-red

ii. Which of these uses extremely high frequency waves for short range communications?
    A  Wi-Fi          B  Wi-Max          C  Bluetooth          D  Infra-red

iii. Which of these is used for communication between mobile phones, laptop computers and digital cameras?
    A  Wi-Fi          B  Wi-Max          C  Bluetooth          D  Radio Signal

iv. Which of these is positioned from 160 to 2,000 Km above the earth surface?
    A. Geostationary Earth Orbit          B. Medium Earth Orbit
    C. Low Earth Orbit          D. GALILEO

v. Which orbit is located directly above the earth's equator?
    A  Geostationary Earth Orbit          B. Medium Earth Orbit
    C  Low Earth Orbit          D. GALILEO

vi. What is a fixed station in a cellular wireless network called that provides local coverage for mobile communication?
    A. Base station          B. Satellite
    C. Mobile Terminal          D. Global Positioning System

vii. What is used to create web pages?
    A. HTML          B. HTTP          C  WAP          D. TCP

viii. What is HTTP?
    A. Markup language          B. Protocol for mobile phones
    C. Application layer protocol          D. Transport layer protocol