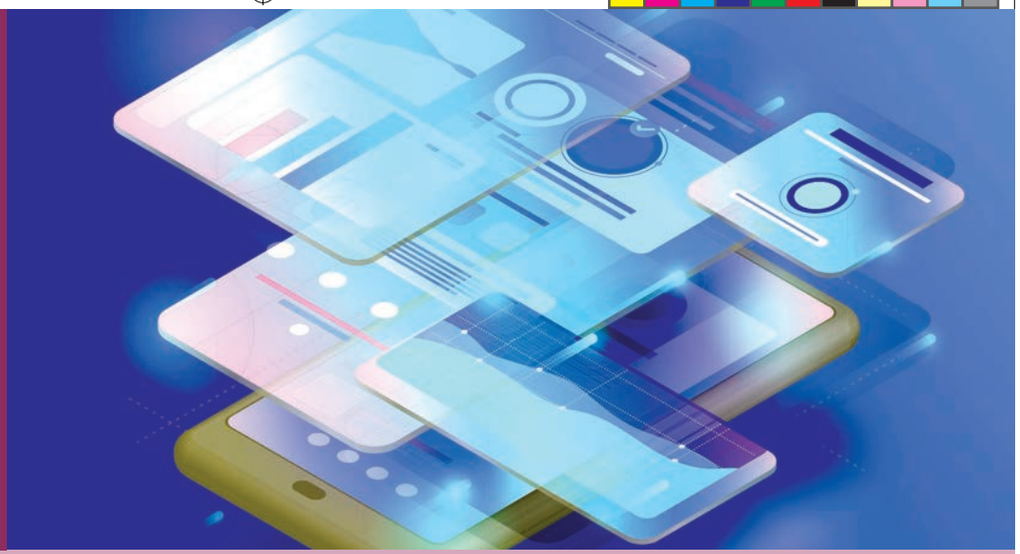
CHAPTER 4



Communication Devices and their Technologies

LEARNING OBJECTIVE

In this chapter, a student can understand the working principle of the following communication devices:

- Pagers
- Walkie Talkies
- Cell Phones

A4651B

CONTENT

Introduction

Any device used to transfer information is called a communication device. Human beings have been enjoying the benefit of communication devices for the past 100 years. The first communication tool developed by human is the telegraph at the end of 19th century.

DO YOU KNOW?

Scientist Samuel F.B. Morse was the first person, who developed the first communication machine called Telegraph

The technology used in Telegraph to transfer information from one end to other is called Morse-Code. Then, Alexander Graham Bell developed the first phone to transfer the sound. Subsequently, the world witnessed the arrival of Radio invented by Marconi. First Television broadcast happened in the year 1928 in New York, America. The later part of the 20th Century (1970 – 80) witnessed the arrival of Cell phone. During the 21st century, the cell phone is taking over the World.

Cell phones are powerful, portable and modern personal communication devices with numerous useful features. The characteristics of the modern device are smaller, lighter and having more functionality. Smart phone is one type of cell phone with extra computing functionality and connectivity capabilities. It enhances communication and allows the user to download and install application.

THINK ABOUT THIS
Do you know your mobile phone is a smart phone or a Non-smart phone?

4.1 Transmission Modes

Transmission is the backbone of all communication devices. There are three modes of transmission and is categorized in the block diagram shown in Figure 4.1

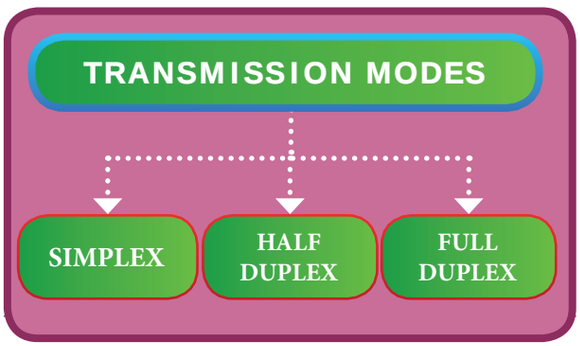


FIGURE 4.1 Different Mode of Transmission

Transmission modes describe the direction of flow of signal between two connected devices. The main differences among the three modes are given here. In a Simplex mode of transmission the communication is unidirectional, whereas in Half Duplex mode of transmission, the communication is two directional and the channel is alternatively used by the connected devices. On the other hand, in the Full Duplex mode of transmission, the communication is bi-directional and the channel is used by both the connected devices simultaneously.

4.1.1 Simplex

In a Simplex transmission mode, the communication between the sender and receiver occurs only in one direction. That means, the sender can only transmit the data and receive the data. The receiver cannot reply in reverse to the sender. Simplex is like a one-way road in which the traffic moves only in one direction, no vehicle from opposite direction is allowed to enter. The entire channel capacity is utilized by the sender. The best example for Simplex transmission is Pager.

FIGURE 4.2 Front view of a Pager.

The Simplex transmission mode can be better understand with an example of electronic device, called Pager as shown in Figure 4.2. A pager is a small telecommunication device that receives alert signals and/or short messages. A miniature, short range wireless receiver captures a message, usually accompanied by a beep. So, the device is known as "beeper". A pager consists a miniature keyboard and a Liquid Crystal Display (LCD) screen that can display several lines of text and/or simple graphics having the size of a pocket calculator. This instrument is not in use today.

4.2 Half Duplex

In a Half-Duplex transmission mode, the communication between sender and receiver occurs and both can transmit and receive the information. But, only one is allowed to transmit at a time. Half-Duplex is still a one-way road, in which a vehicle travelling in opposite direction of the traffic has to wait till the road is empty.

The entire channel capacity is utilized by the transmitter, transmitting at the particular time.

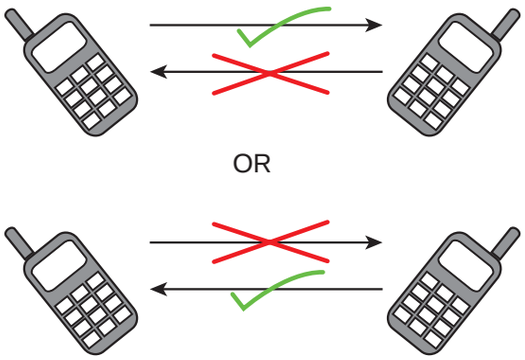


FIGURE 4.3 Half Duplex Transmission mode

Half-Duplex can be understood with an example of Walkie-Talkies. As the speaker at both the end of Walkie-talkies can speak, but they have to speak one by one. Both cannot speak simultaneously

Walkie-Talkies work up to 27.2 Kilometres range. Obviously, this distance is dramatically reduced by obstacles such as buildings and mountains.

4.2.1 Walkie-Talkie

Walkie-talkie is a hand-held two-way radio transceiver based on the principle of Half-Duplex communication. Multiple Walkie-talkies use a single radio channel, i.e., only one radio on the channel can transmit at a time, although any number can listen. The transceiver is normally in the receiver mode. When the user wants to talk, he/she presses a "Push-To-Talk" (PTT) button that turn-off the receiver and turn-on the transmitter. Typical Walkie-talkies resemble a telephone handset, possibly slightly larger but, still a single unit with an antenna mounted on the top of the unit. In the case of the cell phone, the earpiece is only loud enough to be heard by the user, whereas a Walkie-talkie has a built-in speaker that can be used to hear the user's immediate nearby region. Hand-held transceivers may be used to communicate between each other, or to vehicle mounted base stations.

Walkie-Talkie was invented in 1937, by Canadian **Donald Hings** (1907-2004) and around the same time by American inventor Alfred Gross (1918-2000). Both men saw their invention developed for military use during World war-II.

WALKIE-TALKIE USING FREQUENCY MODULATION

A walkie-talkie is a Radio communication device that transmits and receives voices through radio channels. The physical body looks similar to that of a cordless phone and contains

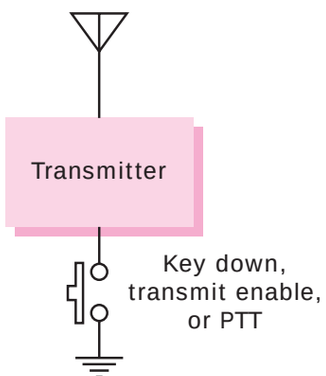


FIGURE 4.4 Typical control of Transmitter

Microphone, speaker, antenna and the Push-To-Talk button. It works on batteries and is one of the easiest modes of communication between people of set distance from each other. A transmitter is a unit is shown in Figure 4.4 that generates an RF signal, when power and control are applied along with audio. A transceiver is a system that contains transmitter, receiver, antenna control, power supply, and switching component as shown in Figure 4.5.

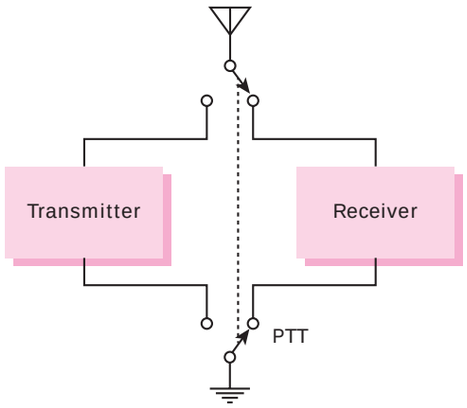


FIGURE 4.5 Typical control of Transceiver.

PTT refers to "Press-To-Talk" or "Push-To-Talk". When the PTT button is pressed, the receiver is disabled and the transmitter is keyed-on, and audio is presented to the transmitter as FM modulated signal. PTT is the three ways toggle switch and with the advent of miniaturization, it is modified by combining the PTT line with audio thus eliminating a wire.

Microphone

In Walkie-Talkie, Electrets condenser is used as a microphone, which is shown in Figure 4.6. This is a small condenser microphone with a miniature amplifier inside the element. The amplifier is used to enhance the power of the signal to driver the transmitter. The audio signal outputted on the diaphragm is converted into a small electrical signal, which appears at the junction of the resister and capacitor.

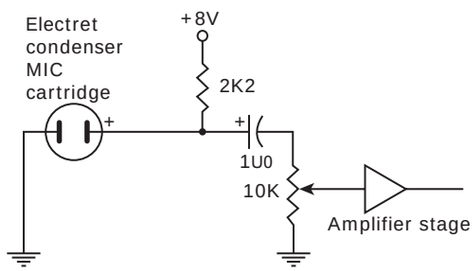


FIGURE 4.6 Electret Condenser using circuit.

The bias voltage applied to the microphone input jack is fed back to the voice coil, which actually offset or "move" the diaphragm slightly but may not have any adverse effect on the audio, since the DC resistance of the dynamic element is usually less than 150 ohms and the voltage across the element is less than a volt.

PTT Control

The circuit shown in Figure 4.7 describes the operating principle of hand held PTT circuit.

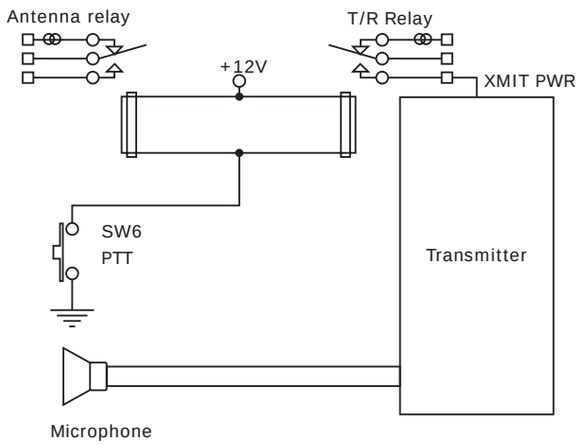


FIGURE 4.7 Hand-held PTT circuit

When the PTT button is activated, one or two relays close. One relay mutes the receiver and enables the transmitter. Another relay switches the antenna from the receiver to the transmitter mode. The reason for using the two relays is that one relay switches power and the other relay switches the antenna from the receiver to the transmitter. Microphone audio is applied to the transmitter as modulated signal.

The circuit shown in Figure 4.8 is an FM type transceiver. When the PTT button is pressed, the circuit is closed and the audio/control line voltage between R1 and R2 drops from the power supply level to a voltage of approximately 2 to 5 volts. The transistor Q1 senses this drop, thereby switches on and activates the relay K1, which in turn activates the transmitter. Audio is varied on the same line and is amplified and fed to the modulation circuit of the transmitter. Capacitor C_1 blocks the DC voltage to the next stage.

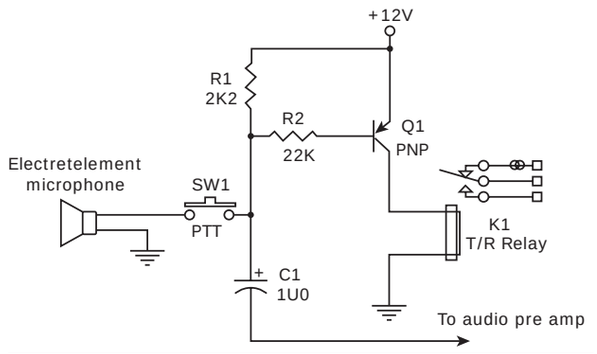


FIGURE 4.8 FM type Transceiver

This circuit is the example of interfacing external equipment to single line control transceivers.

Wi-Fi and Bluetooth technology allows duplex mode which means that transmission and reception can occur simultaneously. The transmission is always on and the power of such devices is in milli-watts(MW). Very high power will cause the device to heat up quickly and would drain out the battery. Less power means that the transmission range is also very short (around 10 meters).Walkie-talkies work on a Half-Duplex channel, the power range depends on the model opted and it can range from 2-7 Watts and accordingly the transmission range lies anywhere between 2-8 kilo-meters. All Walkie-talkies need a frequency bandwidth to work; these devices are work on the free range allowed by the government (27MHz). This band interferes with the noise generated by the electronic gadgets like computer monitors, generators and two wheeler engines.

Transmitter and Receiver

An electronic gate is used to transmit the signal to the antenna. The receiver is always closed, when the transmitter is on. The transmitter end user always says "Roger" or "Over" to mark the end of the sent signal and releases the "push-To-Talk" button before the receiver starts communicating.

DO YOU KNOW?

Walkie-talkies are Half-Duplex device not like mobile phone. Which means only one can talk other can listen at a same time. Now what happened if both the person tried to talk simultaneously? Channel got jammed and no one can able to listen. So, Walkie-talkie users often follow this as a protocol whenever a person completes his talking he said "over" and "over & out".

Figure 4.9 shows the parts of the Walkie-Talkie hand-set and their functions are summarized below:

FIGURE 4.9 Parts of Walkie-Talkie

4.2.2 Parts of a Walkie-Talkie

1. ANTENNA

   Sends and receives radio waves

2. LCD DISPLAY

   Shows channel number, battery life etc.,

3. MONITOR

   Switches the Walkie-talkie to monitoring mode so it can be used as a listening device or baby monitor.

4. MENU SELECT BUTTONS

   Marked with plus (+) and minus (-) symbols

5. MENU BUTTON

   Used for changing functions and settings. There is a provision to lock

the keypad to prevent the channel or other settings from changing accidentally while the radio is in the user's pocket.

6. LOUD SPEAKER

   For making the audible sound.

7. PUSH-TO-TALK BUTTON(PTT)
8. ON/OFF switch and volume control
9. LED indicator light shows when channels are busy
10. MICROPHONE

    Unlike some models, Walkie-talkie has separate Loudspeaker and Microphone.

11. TRANSMIT CALL TONE

    This sends a tone signal to other radios on the same channel alerting them that the user wants to talk.

Applications

1. Military and Police organizations use the handheld radios for variety of purposes.
2. These are widely used among amateur radio operators

Advantages

1. These are robust, easy-to-use, and simple.
2. Lots of people need to listen and only needs to talk at once.

Disadvantages

1. The Analog units are most inexpensive
2. They are not designed for communication over longer ranges.
3. Users are hearing additional noises on the two-way radios or other conversations (interference with radios)
4. The device will stop working when the battery runs down.
5. Discrete communication is the problem of the device. Normally when someone transmits a message everyone can hear it.

4.3 Full Duplex

In a Full-duplex transmission mode shown in figure 4.10, the communication between the sender and the receiver occurs, simultaneously. The duplex transmission mode is like a two-way road in which traffic can flow in both the direction at the same time. Here, the entire capacity of the channel is shared by both the transmitted signal, travelling in opposite directions by sharing the channel capacity in two different ways. In this mode of communication, the user physically separates the link in two parts, viz. one for sending and other

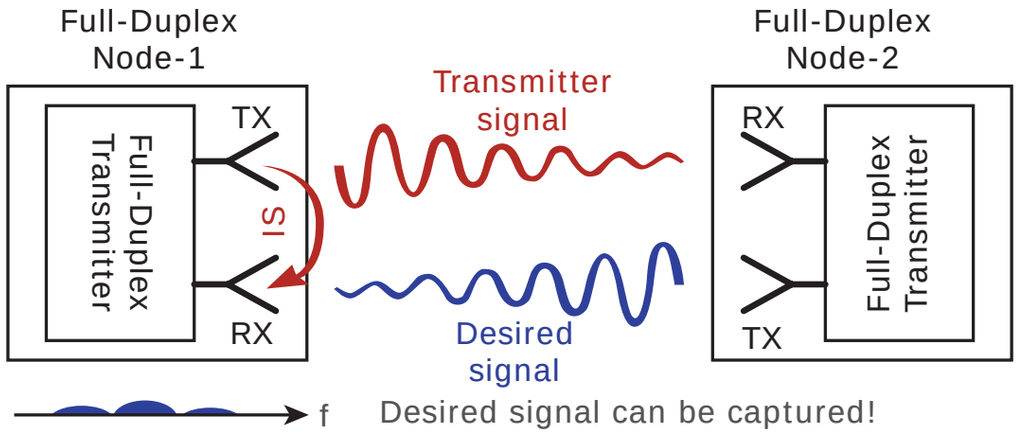


FIGURE 4.10 Full Duplex Transmission Mode

TABLE 4.1 Comparison Among Simplex, Half Duplex and Full Duplex Modes			
Comparison Parameter	**Simplex**	**Half Duplex**	**Full Duplex**
Direction of communication	Unidirectional	Bidirectional	Bidirectional
Send/receive Options	A sender can send data but cannot receive	A sender can send as well as receive the data but one at a time	A sender can send as well as receive the data simultaneously
Performance	Poor performance than the Half Duplex and Full Duplex modes	Better performance than simplex mode but inferior to full-duplex mode	Superior performance among the three modes
Example	Keyboard and Monitor	Walkie-Talkie	Telephone

receiving. Then, the user lets the capacity of a channel to be shared by the two signals travelling in opposite directions. Full Duplex can be understood with an example of a Cell phone. When two people communicate over a cell phone, both are free to speak and listen at the same time. Table 4.1 lists the comparison among the three types of communication modes.

From the Table 4.1, it is clear that the Full Duplex transmission modes offer better performance and also increases the throughput of the bandwidth.

4.4 Cell Phone

A cell phone is a portable device that access to cellular radio system. It has many names like, mobile phone, smart phone or telephone. This device is classified into two categories.

1. Simple device
2. Smart device

In simple devices, the user can access to make and receive the calls and send/receive the messages. While smart devices have the facility to access the internet with the above said two facilities.

4.4.1 Basic Principle of Cell Phones

A cell phone is a two-way radio, consisting of a radio transmitter and a receiver as shown in Figure 4.11. The cell phone converts the received voice into an electrical signal, which is then transmitted as radio waves to the nearest cell tower. Then, the network of cell towers relays the radio wave to the dialed cell phone, which converts back the radio wave to an electrical signal and then to sound waves. In the basic form, a cell phone works just like a Walkie-talkie.

In additional to the basic function of the voice calls, most modern cell phones come with additional features such as web surfing, camera, games, messaging and music. Smart phones can perform similar functions of a portable computer.

What is Cellular Network?

A cellular Network, also known as a mobile network is a network of mobile base stations that provide coverage for the user to establish phone calls, text messages and data services (Mobile internets).

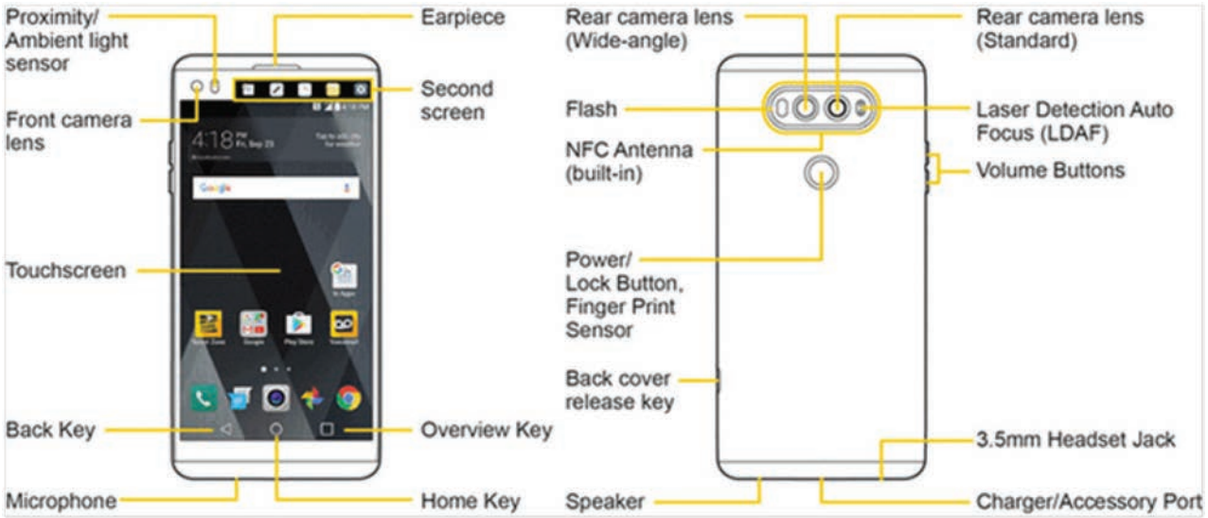


FIGURE 4.11 Parts of a Cell phone

4.4.2 Radio Waves

FIGURE 4.12 Radio waves (EMF)

Cell phones use radio waves for communication purposes as shown in Figure 4.12. Radio waves transmit digitized voice or data in the form of oscillating electric and magnetic fields, called the electromagnetic field (EMF). The rate of oscillation is called frequency of radio waves, which carry the information and travel in air at the speed of light. Cell phones transmit radio waves in all directions. The waves can be absorbed and reflected by surrounding objects before they reach the nearest cell tower. For example, when the mobile phone is placed near to user's head during a call, a portion of the emitted energy is observed into user's head and body. In this event, much of the cell phone's EMF energy is wasted and no longer available for communication. In the following sections, the various components of the cell phone communication are presented.

4.4.3 Antenna

Cell phone contain at least one radio antenna in order to transmit or receive radio signals. An antenna converts an electric signal to the transmitting radio wave and receiver. Some cell phones use one antenna as the transmitter and the receiver, while others have multiple transmitting or receiving antennas. Figure 4.13 shows a Cell phone antenna.

FIGURE 4.13 Cell Phone Antenna

An antenna is a metallic element (such as copper) having particular size and shape for transmitting and receiving specific frequencies of the radio waves. Older generation cell phones have external or extractable antennas, while modern

What is SAR?

Specific Absorption Rate (SAR) is the guidelines created for measuring the rate at which the body tissue absorbs radiation during cell phone operation. It is set at a maximum of 1.6 watts/kilogram of radiation energy absorbed by the body. Over exposure of cell phone radiation might cause cancer.

cellphones contain more compact antennas built inside the device. It is important to understand that any metallic components in the device (such as the circuit board and the metal frame) can interact with the transmission antenna(s) and contribute to the pattern of the transmitted signal. Many modern smart phones also contain more than one type of antenna. In addition to the cellular antenna, they may also have Wi-Fi, Bluetooth and/or GPS antennas.

How To Limit The SAR?

The SAR limit is based upon a cell phone call that averages 30 minutes when the cell phone is held at the ear. Holding a phone away from the body or using a wired earpiece lowers the amount of radiation absorbed. Text messaging rather than talking, further reduces the radiation dosage.

4.4.4 Connectivity

The magnitude of the received signal from the cell tower is called the "signal strength" which is commonly indicated by "bars" on the cell phone as shown in Figure 4.14. The connectivity between a cell phone and its cellular network depends on both signals and is affected by many factors, such as the distance between the phone and the nearest cell tower, the number of obstacles/ hindrance between them and the type of wireless technology (e.g. GSM or CDMA).

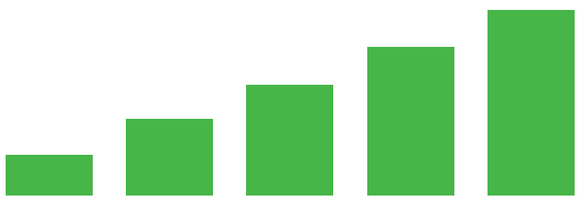


FIGURE 4.14 Cell phone Signal Strength Image

A poor reception (fewer bars) normally indicates a long distance and/or much signal interruption between the cell phone and the cell tower.

Activity

Dial the USSD code *#07# and check the radiation level or SAR value of your Smartphone.

Dial the USSD code *#06# and check the IMEI number of your Cell Phone

In order to conserve battery life, a cell phone will vary the strength of its transmitted signal and use only the minimum necessary energy to communicate with the nearest cell tower. When user cell phone has poor connectivity, it transmits a stronger signal in order to connect to the tower, and as a result user's battery drains faster. That's why good connectivity not only reduces dropped calls, but also saves battery life.

GSM means Global System for Mobile communication. When it was first developed, it was called by a French name have the meaning "Group Special Mobile". GSM was later renamed to its current name by the European Telecommunication Standard Institute (ETS) when it gained worldwide acceptance and became the European standard.

4.5 Working Principle of a Cell Phone

To communicate with a mobile phone, it is necessary to be within the range of the base station of the operator and receive a radio signal of sufficient quality. This is indicated by the bars on the display screen of the phone. Today, they are often accompanied bya sign (for example,"4G", "3G" or "E" for EDGE) specifying the type of technology available in the area.

When making a call on a mobile, the first thing the phone does is search for the nearest signal from the base station

antenna of its operator and establishes a radio link with it. To receive a call, the principle is the same, except that it is the base station antenna that needs to establish the connection. And in this case, to route the call, the operator needs to know the network cell of the recipient. This is why, when they are switched on, even some times when not being used for calls, mobiles 'report' to the network and update their applications (for smart phones) at regular intervals.

4.5.1 Mobile Phone Technologies

Cellular technology is one of the mobile technologies that gave mobile phones the name "cell phone". Cellular technology basically refers to having many small interconnected transmitters. The other main concept of cellular technology was that it has "multiple access", meaning it places multiple voice or data connection into a single radio channel.

Types of Cellphone Technologies

Many people use mobile phones, but do not know about the technology variances. In India, many mobile phones runs based on GSM and CDMA networks only. Now-a-days 4G is extremely growing in India, which operates mainly based on LTE Network technology. An overview of the important and widely used mobile network technologies in India and across the world is presented in the following sections.

4.5.2 GSM (Global System For Mobile Communication)

GSM is the original 2G standard launched in 1991. It was the first major mobile technology. The Figure 4.15 GSM protocol was initially based on time division, meaning calls take turns using the radio signal.

GSM is the global technology authenticates SIM cards and performs simultaneously voice and data transmission.

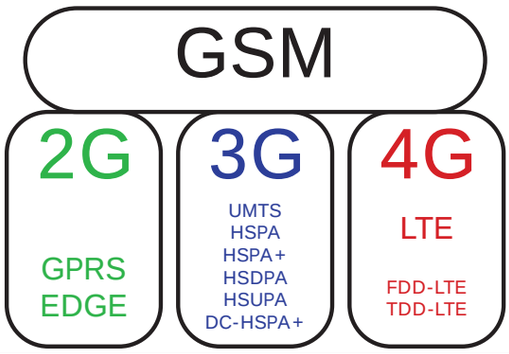


FIGURE 4.15 GSM protocol

3G GSM is better for world travellers, which covered most of the countries but, weak in rural locations. GSM traditionally work on 900, 1800 and 1900MHz and was initially designed, only for circuit switched voice service, which is a combination of FDD (Frequency Division Duplex) and TDD (Time Division Duplex).

4.5.3 GPRS (General Packet Radio Service)

GPRS is the service provided by the GSM network as shown in Figure 4.16. This is a packet data transport-based service, which provides mobile internet over a mobile device. This uses same radio interface of the mobile used to make calls.

GPRS support Nodes are devised in to two

1. SGSN: Serving GPRS Support Node in VPLMN (Visited Public Land Mobile Network) for GPRS functionality in GSM network.
2. GGSN: Gateway GPRS Support Node between Mobile and Internet.

4.5.4 Global Positioning System (GPS)

GPS is a space-based satellite Navigation system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed Line-of-Sight to four or more GPS Satellites. The system

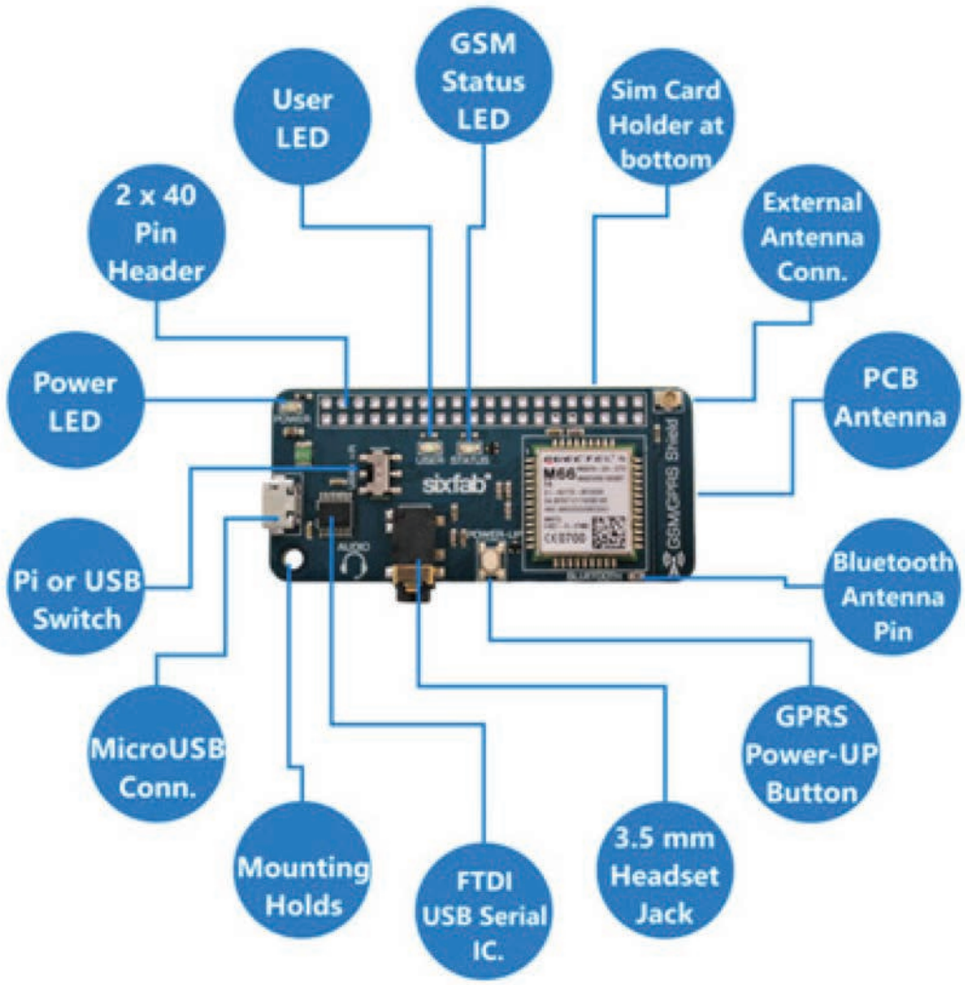


FIGURE 4.16 GPRS service provider

provides critical capabilities to military, civil and commercial users around the world. It is maintained by the United States Government and is freely accessible to anyone with a GPS receiver. Figure 4.17 shows the representation of GPS.

FIGURE 4.17 Space based satellite Navigation System

The GPS is made up of a network of 24 satellites placed into orbit by US Department of Defences. GPS was originally intended for military applications but, in the 1980s, the US Government made the system available for civilian use. GPS works in any weather conditional, anywhere in the world and 24 hours a day. There are no subscription fees or setup charges to use GPS.

Major Differences between GPS and GPRS

1. GPS(Global Positioning System) will give you location in terms Latitude and Longitude.
2. GPRS will allow user to transfer data over cellular networks.

4.5.5 SDMA (Space Division Multiple Access)

SDMA uses physical separation methods that permit the sharing of wireless channels. User's cell sites are spaced from one another to avoid interference. The method is widely used in cellular radio systems. In addition to spacing, directional antennas are used to avoid interference. Most cell sites use three antennas to create 120° sectors that allow frequency sharing (Fig.4.18 (a)). New technologies like smart antennas or adaptive arrays use dynamic beamforming to shrink signals into narrow beams that can be focused on specific users, excluding all others (Fig.4.18 (b).

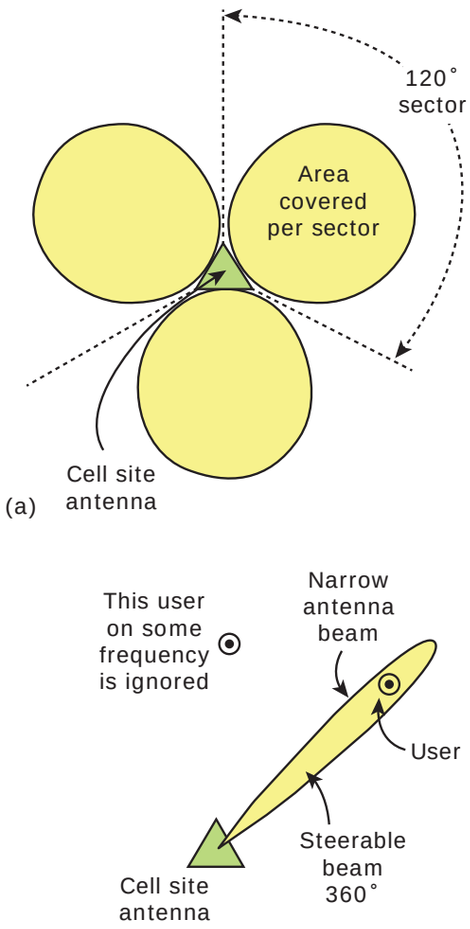


FIGURE 4.18 Physical separation methods

4.5.6 TDMA (Time Division Multiple Access)

TDMA is a technology used in digital wireless cellular telephony communication. TDMA allocates each user a different time slot on a given frequency as shown in Figure 4.19(a). TDMA divides each cellular channel into three time slots as shown in Figure 4.19(b) in order to increase the amount of data that can be carried. TDMA used by Digital-American Mobile Phone Service (D-AMPS), Global System for Mobile Communications (GSM) and Personal Digital Cellular (PDC). Each of these systems implement TDMA in somewhat different and potentially incompatible ways. TDMA is also used for Digital Enhanced Cordless Telecommunication (DECT). TDMA technology was more popular in Europe, Japan and Asian countries, whereas CDMA is widely used in North and South America. But now a day both technologies are very popular through out of the world.

Advantages of TDMA

- TDMA can easily adapt to transmission of data as well as voice communication.
- TDMA has an ability to carry 64 kbps to 120 Mbps of data rates.
- TDMA allows the operator to provide services like fax, voice-band data, SMS and bandwidth-intensive applications such as multimedia and video conferencing.
- Since TDMA technology separates users according to time, it ensures that there will be no interference from simultaneous transmissions.
- TDMA provides users with an extended battery life, since it transmits

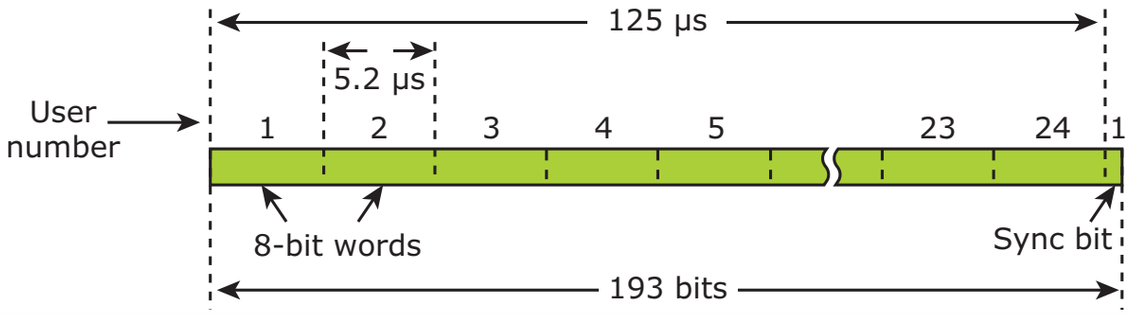


FIGURE 4.19(a) TDMA time slots allocation

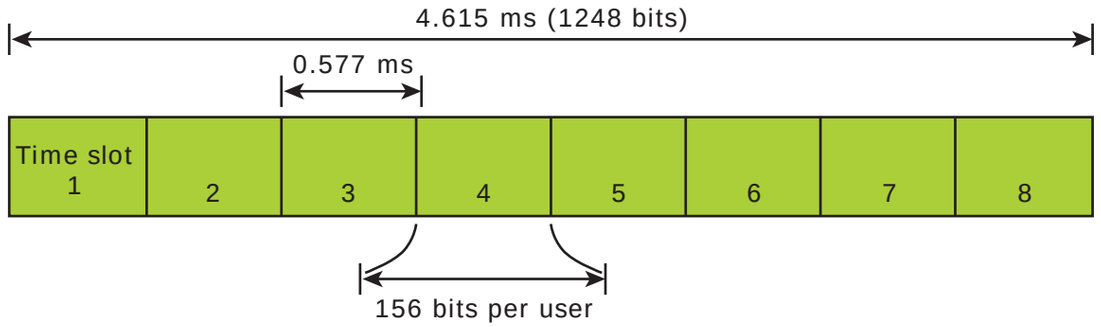


FIGURE 4.19(b) Time slot allocation to individual channel of TDMA

only portion of the time during conversations.

- TDMA is the most cost-effective technology to convert an analog system to digital.

Disadvantages of TDMA

- Disadvantage using TDMA technology is that the users have a predefined time slot. When moving from one cell site to other, if all the time slots in this cell are full the user might be disconnected.
- Another problem in TDMA is that it is subjected to multipath distortion. To overcome this distortion, a time limit can be used on the system. Once the time limit is expired the signal is ignored.

4.5.7 FDMA (Frequency Division Multiple Access)

FDMA is the process of dividing one channel or bandwidth into multiple individual bands, each for use by a single user as shown in Figure 4.20. Each individual band or channel is wide enough to accommodate the signal spectra of the transmissions to be propagated. The data to be transmitted is modulated on to each subcarrier and all of them are linearly mixed together.

- FDMA divides the shared medium bandwidth into individual channels. Subcarriers modulated by the information to be transmitted occupy each sub-channel.
- The best example of this is the cable television system. The medium is a single co-axial cable that is used to broadcast hundreds of channels of video/audio programming to homes.
- Original aerospace telemetry systems used an FDMA system to accommodate multiple sensor data on a single radio channel. Early satellite systems shared individual 36 MHz bandwidth transponders in the 4GHz to 6GHz range with multiple voice,

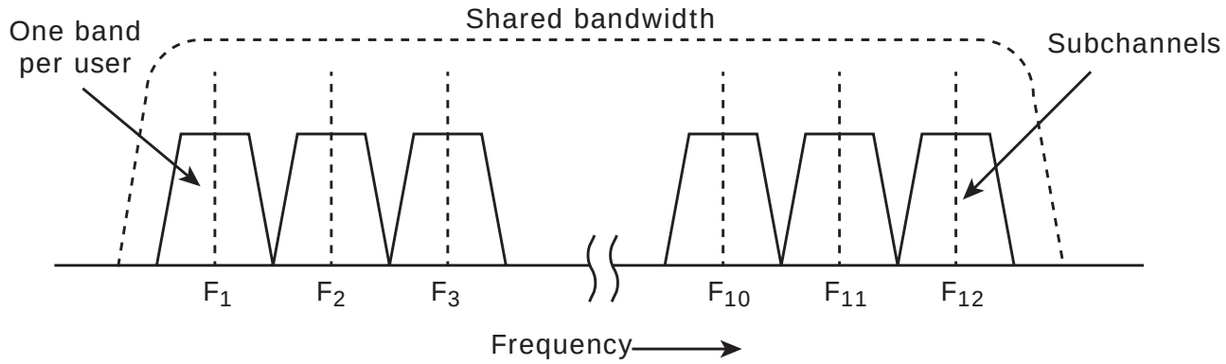


FIGURE 4.20 Channel or bandwidth.

video, or data signals via FDMA. Today, all of these applications use TDMA digital techniques.

4.5.8 CDMA (Code Division Multiple Access)

Code Division Multiple Access (CDMA) is a digital wireless technology that uses spread-spectrum techniques. CDMA does not assign a specific frequency to each user. Instead, every channel uses the full available spectrum. Individual conversations are encoded with a pseudo-random digital sequence. CDMA consistently provides better capacity for voice and data communications than other commercial mobile technologies, allowing more subscribers to connect at any given time and it is the common platform on which 3G technologies are built. Simply, FDMA (Frequency Division Multiple Access) with TDMA is CDMA. CDMA is based on encoding multiple connections with different keys and then decoding them on the receiving end. Figure 4.21 shows block diagram of the CDMA technology.

The following are two main CDMA – based carriers,

1. Verizon
2. Sprint

CDMA is better for large, rural areas and has traditionally not able to do voice data at the same time. CDMA authenticates the device itself.

Advantages of CDMA

- One of the main advantages of CDMA is that dropouts occur only when the phone is at least twice as far from the base station. Thus, it is used in the rural areas where GSM cannot cover.
- Another advantage is its capacity; it has a very high spectral capacity that it can accommodate more users per MHz of bandwidth.

Disadvantages of CDMA

- Channel pollution, where signals from too many cell sites are present in the subscriber's phone but none of them is dominant. When this situation arises, the quality of the audio degrades.
- When compared to GSM, it has lack of international roaming capabilities.
- The ability to upgrade or change to another handset is not easy with this technology because the network service information for the phone is put in the actual phone unlike GSM, which uses SIM card.
- Limited variety of the handset, because at present the major mobile companies use GSM technology.

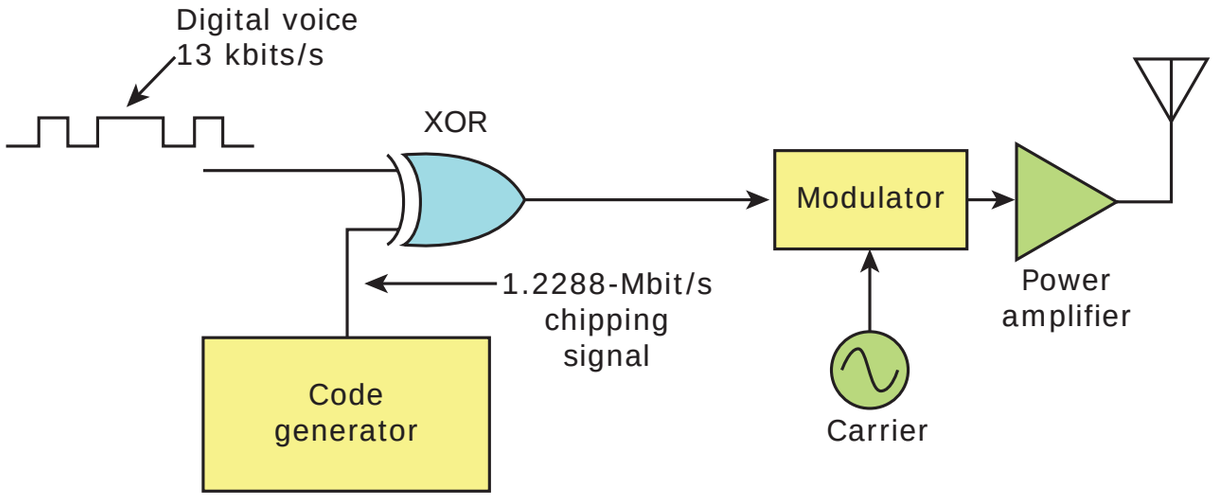


FIGURE 4.21 CDMA Block diagram

4.5.9 UMTS (Universal Mobile Telecommunication System)

UMTS (Universal Mobile Telecommunication System) is a so-called "third-generation (3G)," broad band, packet-based transmission of text, digitized voice, video, and multimedia at data rates up to and possibly higher than 2 megabits per second (Mbps), offering a consistent set of services to mobile computer and phone users irrespective of their location in the world. Based on the Global System for Mobile (GSM) communication standard, UMTS is the planned standard for mobile users around the world by 2002. Once UMTS is fully implemented, computer and phone users can be constantly attached to the Internet as they travel and have the same set of capabilities irrespective of the location. Users will have access through a combination of terrestrial wireless and satellite transmissions. Until UMTS is fully implemented, users can have multi-mode devices that switch to the currently available technology (such as GSM 900 and 1800) where UMTS is not yet available.

4.5.10 MMTel IMS (Multimedia Telephony over Internet protocol Multimedia Subsystem)

MMTel is a new technology to provide voice, video and other telephony services over LTE network (VoLTE). MMTel uses IMS (Internet protocol (IP) Multimedia Subsystem) to deliver voice, video and chat services to user. Additionally, it specifies the way to share images, videos and files in real time.

MMTel standard is a joint project by 3GPP (3rd Generation Partnership Project) and ETSI/TISPAN (European Telecommunications Standards Institute/ Telecoms and Internet Converged Services and Protocols for Advanced Networks). It is considered as the evolution of stereo typed fixed and mobile telephony service, which is mostly dependent on circuit-switched technologies. MMTel is designed for All-IP (Internet Protocol) networks with support for legacy system.

TABLE 4.2 Features of various mobile phone technologies

Approach	SDMA	TDMA	FDMA	CDMA
Idea	Segment space into cells/sectors	Segment sending time into disjoint time-slots, demand driven or fixed patterns	Segment the frequency band into disjoint sub-bands	Spread the spectrum using orthogonal codes
Terminals	Only one terminal can be active in one cell/ one sector	All terminals are active for short periods of time on the same frequency	Every terminal has its own frequency. Uninterrupted	All terminals can be active at the same place at the same moment. Uninterrupted
Signal separation	Cell structure, directed antennas	Synchronization in the time domain	Filtering in the frequency domain	Code plus special receivers
Advantages	Very simple, increase capacity per km2	Established, fully digital, flexible	Simple, established, robust	Flexible, less frequency planning needed, soft handover
Disadvantages	Inflexible, antennas typically fixed	Guard space needed (multipath propagation), synchronization difficult	Inflexible, frequencies are a scarce resource	Complex receivers, needs more complicated power control for senders
Comment	Only in combination with TDMA, FDMA or CDMA useful	Standard in fixed networks, together with FDMA/SDMA used in many mobile networks	Typically combined with TDMA (Frequency hopping patterns) and SDMA (frequency reuse)	Still faces some problems higher complexity. Lowered expectations; will be integrated with TDMA/FDMA

4.6 Generation of Cellphone Technologies

Evaluation of Cell phone Technologies, Mobile wireless technologies is a system used by cellular telephone manufacturers and service providers to classify wireless communication into several generations; each generation is characterized by new frequency bands, higher data rates and non–backward compatible transmission technology. In the recent past, mobile wireless technologies have undergone technology evolution from 0G TO 7G.

4.6.1 0G

This is the generation which came before cell phones mobile telephony technology. They were introduced before the first generation of cellular telephones, therefore labelled zero generation systems. Such technologies include radio telephones mostly used in cars. Mobile radio telephone systems came before modern cellular mobile telephony technology.

4.6.2 1G (14.4 Kbps)

It is an old, analog mobile telephony type. Outdated some 10-15 years' ago. It transmits and receives voice only. The cell phones used was big in size and had poor battery life.

4.6.3 2G (9.6/14.4 Kbps)

2G was digital rather than analog. 2G capabilities are achieved by allowing multiple users on a single channel via

multiplexing. 2G cellular phones are used for data along with voice. 2G introduced Encryption technology for data transfer. There were GSM and CDMA version of 2G.

2.5G

2G cellular technology with GPRS is called 2.5G. It provides the usages of E-mails, web browsing and camera facilities.

E (or) EDGE (or) 2.75 G

'E' stands for EDGE (Enhanced Data Rule for GSM Evolution) also called the Enhanced GPRS. The network design is almost unchanged, but the data speed is increased noticeably. Transmission of data rate above 100Kbps is called 2.75 G.

4.6.4 3G (500 – 700 Kbps)

The 3G rollout of GSM and used CDMA. 3G introduced higher transfer rates, up to 200Kbps and later versions could achieve multiple Megabits per second. 3G has multimedia services support along with live video streaming, which makes it more popular. In 3G, universal access and portability across different device types are made possible (Telephone, PDC etc.). In the 3G Network, the UMTS (Universal Mobile Telecommunications System) is used. The UMTS is a completely different technology from GSM and EDGE. Also, WCDMA (Wideband Code Division Multiple Access) is used in 3G.

DO YOU KNOW?

Why Mobile Phone has 10 Digit numbers?

The number of digits in a mobile phone number decides the maximum mobile phones the user can have without dealing the country code.

H (or) H+

This is mainly a transport layer protocol used for increasing the speed in 3G technology that use W-CDMA called HSPA (High Speed Packet Access). HSPA is evolved by combination of two technologies. HSPA + is an upgrade of the HSPA.

1. HSDPA (High Speed Downlink Packet Access)
2. HSUPA (High Speed Uplink Packet Access)

4.6.5 4G

The major advantage of 4G is mobile broadband internet services provided to internal systems such as laptops, wireless modem, etc., Speeds for 4G are further increased to keep up with data access a demand used by various services. High definition streaming is now supported in 4G. Increases bandwidth available for voice and data communications by using radio interface combined with a number of network improvements. It is the upgrade path for GSM and CDMA based networks.

DO YOU KNOW?

Why 4G is called 'MAGIC'?

M – Mobile Multimedia,

A – Anytime, Anywhere,

G – Global Mobile Support,

I – Integrated wireless solutions

C – Customized Personal Service.

LTE (Long Term Evalution)

4th Generation Network called LTE, often called 4G LTE, is the currently used network standard and is quite different from 2G and 3G. LTE is designed only as data network. LTE brought very high bandwidth to mobile devices, hotspots and peripherals. So that, its data transfer becomes fast.

AWS (Advanced wireless Services)

AWS is also referred to as UMTS band IV. It used microwave frequencies in two segments. Frequency range of 1710 to

1755MHz is used for uplink and 2110 to 2155 MHz is used for downlink.

XLTE

XLTE provides a minimum of double the bandwidth of LTE. XLTE ready devices automatically identifies both the 700 MHz and the AWS spectrum in XLTE cities. It leads by Verizon in 2014. XLTE is faster than LTE.

VoLTE

VoLTE (Voice Over LTE) service in 4G connection will handle the user's internet traffic, while making/receiving a voice call. VoLTE is a voice technology that works over the LTE data connection rather than 3G voice bands. It has extremely high voice quality, which requires that both the participants are using VoLTE and are in VoLTE enabled areas. It also includes the ability to make video calls.

4.6.6 5G

Currently there is no 5G technology deployed but under testing. When this become available it will provide very high speeds to the consumers. It would also provide efficient use of available bandwidth. The 5th Generation network called NR (New Radio) of simple 5G. It adds support for microwave frequencies with LTE, previously unused in mobile telephony (currently 28 and 36 GHZ planned) much wider channel bandwidths (up to 400MHz carriers) and adaptive antenna technology, allowing for very narrow radio beams focusing RF rays in the direction of mobile phone locations. Initially, 5G will work simultaneously with 4G, so a mobile phone will maintain a parallel connection with both 4G and 5G radio access networks in what we called as EN-DC (EUTRAN / New Radio Dual Connectivity). The 5G radio would allow for speeds of 1Gbps and above.

4.6.7 6G

Future 6G integrates 5G with satellite network for global coverage. It will give ultra-fast internet access used to create more smart homes / cities.

4.6.8 7G

7G works on space roaming and it will convert the world completely wireless.

4.7 Other Special Technologies

In recent years, other technologies have emerged and enriched the mobile functionalities.

4.7.1 Wi-Fi

Wi-Fi is the technology for radio wireless local area networking of devices such as personal computers, gaming console, televisions, printers and mobile phones, etc. Wi-Fi compatible devices can connect to the internet via a WLAN and wireless access point. Such an access point (or Hot spot) has a range of about 20 meters (66 feet) indoors and a greater range outdoors. Hot spot coverage can be as small as a single room with walls that block radio waves.

Wi-Fi most commonly uses the 2.4 GHz (12cm) (UHF) and 5.8 GHz (5cm) SHF radio bands. These wavelengths work best for line-of-sight Wi-Fi calling when the user calls to a phone number over the internet. It is different from VoLTE. The calls are going over the network. Also, promises the ability to swap seamlessly between Wi-Fi and wireless phone network. The symbol for Wi-Fi in mobile phones is shown in Figure 4.22.

TABLE 4.3 Comparison among various generations of Mobile Phone Technology					
Parameter	**1G**	**2G**	**3G**	**4G**	**5G**
Period	1980 -1990	1990 – 2000	2000 – 2010	2010 -2020	2020 - 2030
Bandwidth	150/900 MHz	900 MHz (25 MHz)	100 MHz	100 MHz	100 x BW/ unit area
Frequency	Analog signal (30 kHz)	Digital 1.8 GHz	1.6 – 2.0 GHz	2 -8 GHz	3 – 300 GHz
Data Rate	2 Kbps	64Kbps	144Kbps – 2 Mbps	100 Mbps – 1 Gbps	1 Gbps and above
Property	Bad voice quality,first wireless technology, poor Battery life	Digital,allows text message.	Digital Broad band with increasing speed.	High speed, supports all IPs, high Security, Better Usage	High Speed, Faster Data Transmission, More Efficient
Technology	Analog Cellular	Digital Cellular (GSM)	CDMA, MTS, EDGE.	LTE,VoLTE, WIFI	WORLD WIDE WEB
Size	Big	Medium	Medium	Small	Very Small

FIGURE 4.22 Symbol of Wi-Fi

4.7.2 Blue Tooth

Blue Tooth is a wireless technology used to transfer data between different electronic devices. The distance of data transmission is small in comparison to other modes of wireless communication. This technology eradicates the use of cords cables, adaptors and permits the electronic devices to communicate wirelessly among each other. Figure 4.23 shows the symbol of Blue Tooth.

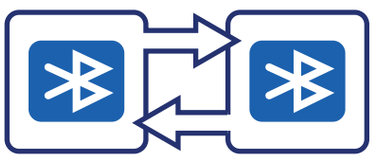


FIGURE 4.23 Symbol of Blue Tooth

Key features of Blue Tooth technology

1. Less complication
2. Less power consumption
3. Available at cheaper rate
4. Robustness

Blue tooth technology permits hands free headset for incoming voice calls, ability of printing, fax and automatic synchronization of PDA.

Classification

Various types of Blue tooth technology are available in the market, which helps the consumers to communicate wirelessly. The different types of Blue tooth devices are PC cards, radios, dongles and head sets, Laptops and other internet enabled equipment use Blue tooth technology such as wireless mouse and keyboard to communicate wirelessly. Music players like iPods, Music phones, or other MP3 players make use of stereo headphones.

Advantages of the Bluetooth

- Wireless – Bluetooth works without cable.
- Low energy consumption – Bluetooth uses low power signals and thus requires little energy.
- Bluetooth Technology is inexpensive– Bluetooth is cheap to manufacture.
- Sharing voice and data –Bluetooth allows devices to share voice and data communications.

Disadvantages of the Bluetooth

- Bluetooth devices cannot be connected with more than one device at the same time, because it finds problem in discovering another devices.
- Bluetooth has a range of 15 to 30 feet. The small range is a disadvantage for some who may want to use a Bluetooth device outside of the 30-foot radius.
- Bluetooth uses the battery power of a particular device in order to operate.
- Many cell phone makers send phones with Bluetooth powered off in order to maximize the battery life of the phone.

4.7.3 Hotspot

A Hotspot is a physical location where people may obtain internet access, using Wi-Fi technology, through a Wireless Local Area Network (WLAN) using a router connected to an internet service provider.

Hotspot is classified into two,

1. Public Hotspot
2. Private Hotspot

Public Hotspot

Public Hotspot may be created by business for use by customers such as Railway stations, Airport, etc., It is typically created from wireless access points (AP) configured to provide internet access, controlled to some degree by the venue. It connects the user's Laptop or Tablets to the Internet.

Private Hotspot

Private Hotspot may be configured on a smartphone or tablet with a Mobile network data plan to allow internet access to other devices. If both the Hotspot device and the devices accessing it are connected to the same Wi-Fi Network.

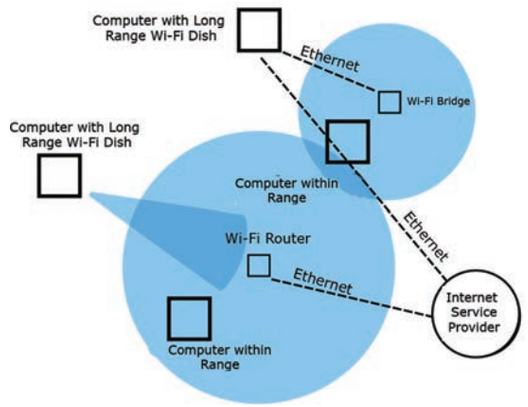


FIGURE 4.24 Hotspot Process

With a mobile Hotspot, user can create an Internet connection for up to five cell phone devices on a 3G phone and up to 10 on a 4G LTE smartphones. After a few quick steps, the phone creates its own secure Wi-Fi network, which user devices can join. There is no need for a USB cable, and multiple user can share user phone's mobile data plan.

4.7.4 Near Field Communication (NFC)

NFC enables short range communication between compatible devices. This requires at least one transmitting device and another to receive the signal. NFC device will be considered either passive or active.

Passive NFC devices include tags and other small transmitters that can send information to other NFC devices without the need for a power source of their own.

Active devices are able to send and receive data and can communicate with each other as well as passive devices. Smart phones are by far the most common form of active NFC device.

Just like Bluetooth and Wi-Fi, and all manner of another wireless signals, NFC works on the principle of sending information over radio waves. NFC is another standard for wireless transitions. The transmission frequency for data across NFC is 13.56 MHz. User can send data at either106, 212 or 424 Kbps. NFC has three distinct modes of operation.

1. **Peer-toper mode**
   This is most common use in smart phones. In this mode, exchange of information switches between active (when sending) and passive modes (when receiving).
2. **Read and write mode**
   This mode is a one-way data transmission. The active device, possibly user smartphone, links up with another device in order to read information from it.
3. **Card Emulation**
   The NFC device can function as a smart or contactless credit card and make payments or tap into public transport systems.

4.7.5 Radio Frequency Identification (RFID)

Radio-Frequency Identification (RFID) is the use of radio waves to read and capture information stored on a tag attached to an object. A tag can be read from several feet away and does not need to be within direct Line-of-sight of the reader to be tracked.

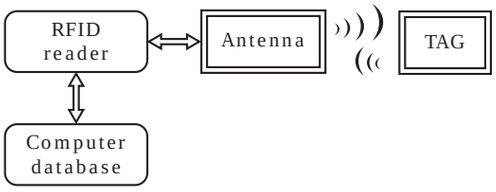


FIGURE 4.25 Parts of RFID System

A RFID system is made up of two parts as shown in Figure 4.25.

1. Tag or Label
2. A Reader.

Tag or Labels

There are embedded with a transmitter and a receiver. The tags have two parts.A microchip is used to store and process information, and an antenna is used to receive and transmit the signal. The tag contains the specific serial number for one specific object.To read the information encoded on a tag, a two-way radio transmitter-receiver called an interrogator or reader emits a signal to the tag using an antenna. The tag responds with the information written in its memory bank. The interrogator will then transmit the results to an RFID computer program.

Reader

The stored information on the RFID tags are scanned by the RFID reader. It cannot find a specific pair, but they can tell how many of each pair are on the shelf and which pairs need to be replenished. The reader can learn all of this information without having to scan each individual item.

DO YOU KNOW?

The first Mobile Phone was the Motorola Dyna TAC 8000X invented in 1983 by Martin Copper, a senior employee at Motorola. It could only store 30 contacts with a weight of around 1.1Kg and offered talk time of 30 minutes. Its retail price was roughly $3999. The first mobile phone call was placed to Dr. Joel S. Engel of Bell Labs by Martin Cooper.

4.8 Types of Mobile Applications

Mobile Applications are three types and are summarized below:

Native application: Native App installed from application store like Android's Google play and Apple's App store. This type of application which can be installed into your devices is known as native application. Example, WhatsApp, Angry birds, etc.,

Web application: Web applications run from mobile web browsers like Chrome, Fire box, Opera, Safari etc., using Mobile networks or Wi-Fi. Web browser applications are m.facebook.com, m.gmail.com, m.Yahoo.com, m.rediffmail.com, etc.

Hybrid Application: Hybrid apps are combination of native app and web app. They can run on devices or offline and are written using web technologies like HTMLS and CSS, (e.g.) eBay, Flipkart, etc.

DO YOU KNOW? More than 90% of adults have their mobile phone within arm's reach all the time

4.9 Benifits of Hexagons Used in Call Coverage of Cellular Network

While designing a network, two things are kept in mind.

1. A tower in cell should provide equal signal in that cell.
2. No block spots. Black spots are those areas where you won't get any signals.

Square

Won't create black spots. But distance from its centre to corner is higher than distance in any side. This will create issues in providing equal level of signals at every point.

Circle

Since distance from centre to any point in the circle would be same, so there won't be any issue in providing equal level of signals at every point. But, when we arrange circles together, many areas would be created which won't be covered by any circle. These areas are called BLOCKSPOTS, where signals from nearby could be received

Hexagon

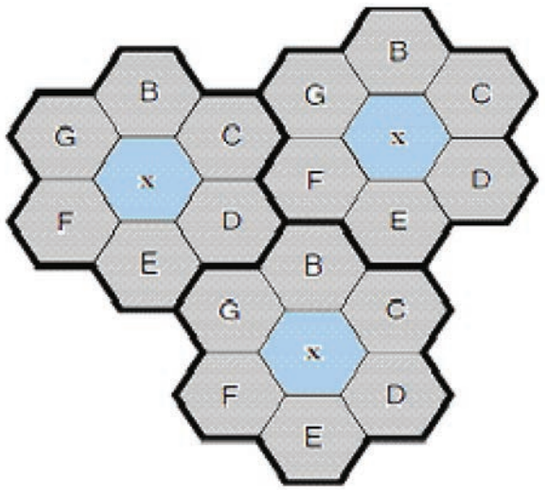


FIGURE 4.26 Hexagon

Hexagon or the beehive structure overcomes all the above said issues. Its distance from centre to any point is the same and it can be arranged in such a way that no block spots are created.

4.10 Parts of Cell Phone

Figure 4.28 shows the block diagram of a cell phone, which helps us to understand the functions of a Cell phone's circuit.

A cell phone handset comprises of two sections viz., RF and Baseband and is described as follows.

4.10.1 RF

RF refers to Radio Frequency, the mode of communication for wireless technologies of all kinds, including cordless phones, Radars, Ham radios, GPS, radio and television broadcasts. RF technology is part of our lives; we scarcely notice it for its ubiquity. From baby monitors to cell phones, Blue tooth to remote control tags, RF waves are all around us.

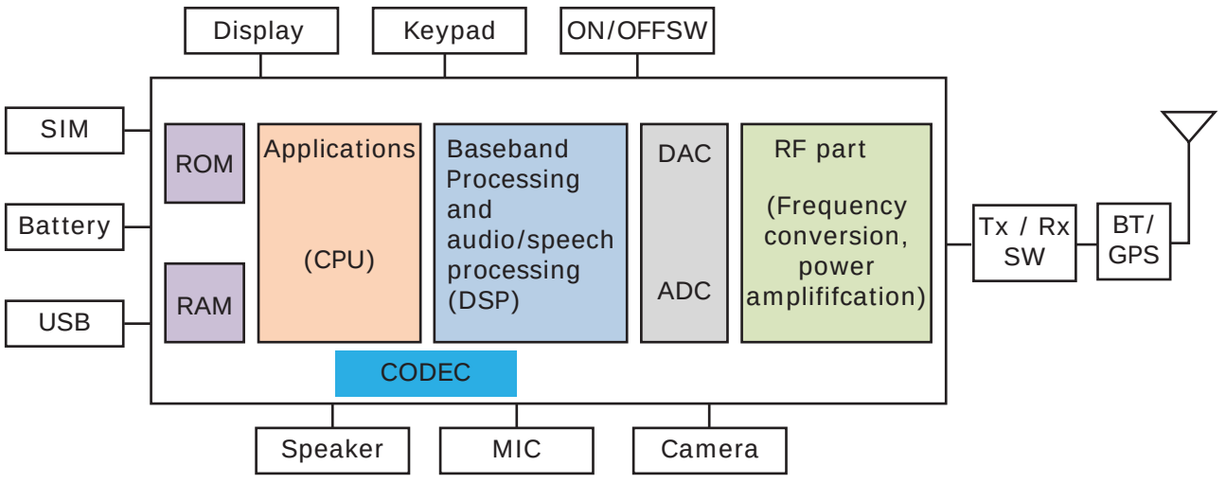


FIGURE 4.27 Components of a Cell Phone

RF waves are electromagnetic waves which propagate at the speed of light or 186000 miles per second (300000 km/s).

4.10.2 Base Band

In signal processing, baseband describe signals and systems whose range of frequencies is measured from zero to a maximum bandwidth or highest signal frequency as shown in Figure 4.29. It is sometimes used as a noun for a band of frequencies starting at zero. In telecommunication, it is the frequency range occupied by a message signal prior to modulation. It can be considered as a synonym to low pass.

DO YOU KNOW?

An interesting thing is that nearly 90% of the mobile phones in Japan are water proof, as the people of Japan are very fond of mobile phones that they use it even in the shower.

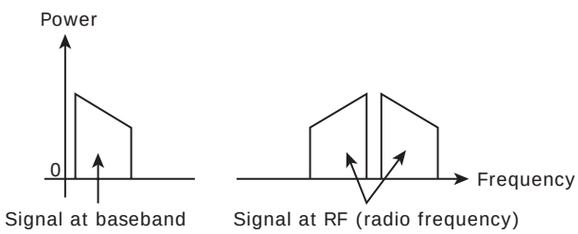


FIGURE 4.28 Base Band Spectrum

Base band is also sometimes used as a general term for part of the physical components of a wireless communications product. Usually, it includes the control circuiting (microprocessors), the power supply and amplifiers. A baseband processor is an IC that is mainly used in a mobile phone to process function of communication.

Basically, Baseband is also composed of two sections, the Analog and Digital processing sections.

Cell phones have three sections since baseband is divided into two functions as above, while the RF section remains as a whole circuit section.

1. Radio Frequency section
2. Analog baseband processor
3. Digital Baseband processor

Radio Frequency Processing Section

The RF section is the part of the cell phone circuit known as RF Transceiver. It is the section that transmits and receives certain frequencies to a network and synchronizes the same to another phone. A simple mobile phone uses these two circuits to communicate with another mobile phone.

The RF

A radio section is based on two main circuits.

1. Transmitter
   A Transmitter is a circuit or device, which is used to transmit radio signals in the air.
2. Receiver
   A Receiver is simply like radios which are used to receiver transmissions(Radiation), which is spread in the air by any transmitter on a specific frequency.

The two-way communication is made possible by setting two transmitters and two receivers synchronized in such a way that transmitter in a cell phone is synchronized with the frequency of another cell phone's receiving frequency or vice versa. So, the first cell phone transmits the radiation in the air, while the other phone receives it. And the same process is present in the opposite side as well. So, these two Hand-held cell phones correspond to one another, more or less simultaneously.

"i-Phone is the king of Smartphones." But despite being the biggest seller, Apples' operation system doesn't actually dominate the smartphone market. Android is owned by 82.8% of users in the world.

4.10.3 Analog Baseband Processor

The analog baseband processing section is composed of different types of circuits. This section converts and processes the analog into digital (A/D) signal and digital into analog (D/A) signal.

Control Section

This is the section which acts as the controller of the input and output of any analog and digital signal.

The present Mobile Phones have more computing power than the computer used for the APOLLO II to land on the moon.

Power Management

A power management section in mobile phones is designed to handle energy consumed in mobile phones. There are two main sub sections in a single power section.

Power Distribution and Switching section

A power distribution section is designed to distribute desired voltages and currents to the other sections of a phone. These sections take power from a battery (3.6 Volts) and in some places the power is converted or stepped-down to various volts like 2.8V, 1.8V,1.6V, etc., while in other places it is stepped-up to higher voltages like 4.8V. This section is commonly designed around a power IC, which is used to distribute and regulate the voltage used in other components.

Charging Section

The charging section is based on a charging IC which takes power from an external source and feds to the battery to power-up again, when it is exhausted. This section uses convertibility of 6.4V from an external battery charger and regulates it to 5.8V,while givingto the battery. The battery is charged by this process and it is ready to use. A battery session is a time which is provided by the manufacturer of a cell phone for standby or talk time.

Audio codecs section

This section is where analog and digital audio properties are processed like the microphone, earpiece, speaker, headset, ring-tones and also the vibrator circuits.

4.10.4 Digital Baseband Processor

Digital Baseband processor section is used in mobile phones to handle data and output signal like switching, driving application commands, memory accessing and executing.

DO YOU KNOW?

How to test CPU usage on mobile devices?

There are various tools available in the market like Google play or app store from where you can install apps like CPU monitor use on, CPU stats, CPU-2 etc. This is an advanced tool which records historical information about processes running on your device.

Digital Base Band parts and sections are described below:

1. CPU (Central Processing Unit)

   The Central Processing Unit is responsible for interpreting and executing most of the commands from the user interface. It is often called the "brain" of the microprocessor, or the Central Processor. It includes Flash and Memory circuits, RAM(Random Access Memory), ROM(Read Only Memory), Bluetooth, Wi-Fi, Camera, Screen Display, Keypads, USB (Universal Serial Bus), SIM (Subscriber Identity Module) card, etc.

Every mobile phone has a different concept and design in various aspects, but the methods and operational flow are all exactly the same. It differs on how and what certain IC chips and parts are being used and installed in a certain mobile phone circuitry.

4.11 Mobile Phones Functions

There are varieties of designs and functions are available in Mobile Phones. But, the most common functions of mobile phones include voice, communications, data and some other common applications.

4.11.1 Voice and Traditional Phone Functions

The primary function of a mobile phone is voice communication. Like traditional landline phones, mobile phones allow one user to call another and talk from afar. Functions related to voice communications include automatic redial, last number recall, caller ID logging of incoming and outgoing calls, speaker phone or hands free capabilities and speed dialling. Also, some phones are equipped with voice activated dialling and features like silent mode, which disables ringing or indicates incoming calls and alerts by vibration. Many mobile phones also feature the ability to block calls from unwanted numbers or customize ringtones to send an audible indication of the source of the incoming call.

4.11.2 Data Functions

Modern Mobile Phones offer some degree of text or data transfer as well with voice functions. User can send brief, typed message to other mobile phones and share files such as pictures and video or access the internet through the use of integrated web browsers and other internet applications optimized to function with a small screen.

DO YOU KNOW?

- 70% of mobile phones are manufactured in China.
- Around 80% of the world's population has a mobile phone.

4.12 Uses of Mobile Phones

The mobile phone is the user device, already started functioning as more than just communications device. Mobile serve as watches and alarm clocks. Mobile phones also have free games, calculators,

address book, contact list, calendar functions, radio, notepad, reminder services, etc. Owners also have tended to customise phones with their own ringtones, themes and wall papers. All the above functions are just for starters. Some of the more advanced functions in mobile phone are also presented here:

1. **Digital Camera**
   Phones capture pictures and let user save them to others and to computers.
2. **Audio Recorder**
   Mobile Phones can be used to record conversations or even brief notes to one self.
3. **Video recorder**
   Phones are becoming video cameras and can record video more than an hour.

In Mobile Phones, within 3 Minutes of delivery, 90% text messages are read.

4. **Multimedia Messaging**
   Everything recorded can be shared with others by using MMS.
5. **E-mail Client**
   The phone can be used to connect to any POP or IMAP server and to allow receiving and sending email.
6. **Web Client**

What is Web Service?
It is a component used in software to perform the task of interfacing between one program to another.

Phones can also browse website, via a WAP and/or HTML browser. Most websites may not look great on the small screen. But, it is still possible to connect to any website.

7. **Document Viewer**
   It is increasingly possible to view documents on the cell phone in the popular MS office file format.

There are more mobile phones than PC, the ratio is 5 times. More than 4 billion people own mobile phones.

8. **Computer adjunct**
   For many, the cell phone has replaced the PDA as the complement to the computer with a remote desktop application; it also becomes possible to make the mobile phone a window to one's computer.
9. **Music player**

What are the MT and MO in SMS?
Sending Message is known as MO (Message originate) and receiving the message is known as MT (Message Terminate)

The big things in 2005 are reckoned to be the combining of music capabilities on the mobile phone. While phones can play MP3, it can be used to play music streamed from the internet.

10. **Television**
    In India, all operators have been promoting many TV channels on the cell phone over next generation network like EDGE.
11. **Wallet**
    The phone can also be used to pay for purchases like a credit or debit card. There is already a billing relationship that exists between the subscriber and the operator and that can be used to make payments to merchants.
12. **Bar code and QR code readers**
    Phone also have the facility to read bar and QR (Quick Response) codes and that can have very interesting applications in all field, especially commerce.

4.13 Advantages and Disadvantages of Cell Phones

4.13.1 Advantages

It helps in communicating with people around, while in working. Mobile Technology has made this possible and brought people together. User can easily go online with his mobile devices and reach across different countries of the world. It is made to make user work easy and helps to become more productively and efficient. Since the mobile technology is growing rapidly, the technicians have ample sources of earning through mobile repairing.

74% of Smartphone users use their mobile phone to help with shopping, of which 79% ultimately making a purchase. Mobile Phone users mostly spend their time on games and social networking (49% and 30%, respectively)

1. **Instant Communication**
   It has paved the way to SMS, text messaging call, video chat and apps that allow people to instantly communicate to everyone across the globe.
2. **Web Surfing**
   These devices are integrated with mobile browsers that enable them to research and access websites anytime and anywhere. It is convenient for people to surf the web and have easy access to information.
3. **Camera**
   Camera plays an important role in taking selfie, posting photos in social media, etc. That's why the smartphone manufacturers releases the phones equipped with best camera configurations.
4. **Entertainment**
   Smartphones are also viewed as a source of entertainment. Watching movies and reading e-books, games, music are also convenient through cell phones.
5. **Education**
   Smart phone also aid education, especially in children with easy access to information and helpful content. Children can have a more interactive learning through watching education applications. They can also easily surf the internet, if they want to search something about a topic.
6. **Productivity Apps**
   Smart phones can do almost everything with the help of APPs. The functionality of apps varies from each other such as photo and video editor, ticket booking, online store, payment system, data analysis, personal assistant, etc.
7. **GPS**
   Smartphones are equipped with Global Positioning system (GPS). This technology allows people to locate certain addresses and area all around the world.
8. **Privacy**
   With smartphones user can do whatever they want without anyone knowing it. User secure all with a password. Online transaction can also be done through smartphones.
9. **Alarm Notes &reminder**
   User can also add notes and reminders in user mobile phone in the favour of user help.
10. **Data Transfer**
    User can easily transfer data from one device to another device. User photos, documents, videos and other important documents are easily transferred from one device to another device within seconds. User can also store data in it.
11. **More Utilities**

All the features are now available in one device viz., Calendar, Calculator, built-in-Torch, etc.

Do you know the full form of various extensions?

apk – Android Application Package file
exe – Executable files
ipA – iOS App Store Package
prc – Palm Resume Compiler
jad – Java Application Describer
adb – Android Debug Bridge
Aapt – Android Asset Packing tool

4.13.2 Disadvantages

Use of internet makes it dangerous for user to secure users' phones from viruses. Using a mobile phone, always make user connected and available to people, which sometimes becomes a headache because user is answerable every time. Accidents are caused daily due to the distractions caused because of mobile devices.

1. **Costly**
   It can be expensive, since the user wants data connectivity and therefore the user needs to maintain the data plan.
2. **Addiction**
   When user wakes up in the morning, the user has the habit of checking his/her phone. This problem may lead to a serious addition, which may include addiction to games, social media, etc.
3. **Privacy threads**
   Even if smartphones are made private. Still there are security risks and threads everywhere. Hacker are always present and virtual viruses are potent. Smartphones are vulnerable to these threats when user accesses the internet. Thus, user needs to be extra cautions of opening sites and link.
4. **Extra work**
   Smartphones are widely used in business. Users are working an extra workload which does not even exist before.
5. **Uncensored content**
   Children can see, intentionally or not the uncensored content including violence pornographic content, etc. If user have children, make sure the user regulate their use of smartphones.
6. **Poor social interaction**
   People no longer interact with people outside as they tend to spend more time with their smartphones.
7. **Distraction**
   Despite the productivity, smartphones can really be distracting. When users attend to the notifications, users shall find themselves attached to the phone.
8. **Brain Damage**
   Medical field claims that the radiation from Mobile Phone causes brain damage. Smartphones are also found to have a negative impact on users' health. Smartphones emit radio frequency energy which can be absorbed by the tissues in the body. Sleep deprivation is also one of the common bad effects of using smartphones. Moreover, phones produce HEV light, which can damage user eyes' retina.
9. **Study Loss**
   Students are subjected to very high loss due to very bad attention in their studies. This is the biggest disadvantages for students.
10. **Stolen of Data**
    If users have personal images, videos or files, etc., in their devices, other peoples can easily steal their images and videos. An android mobile

phone is easy to copy data from one device to another but; IOS operating system has little safety.

Cell Phone Dictionary

1G	First Generation in Mobile Telephony
2G	Second Generation in mobile Telephony
3G	Third Generation in Mobile Telephony
4G	Fourth Generation in Mobile Telephony
BGA	Ball Grid Array
BSI	Battery Status Indicator
CDMA	Code Division Multiple Access
CPU	Central Processing Unit
DCT	Digital Core Technology
GSM	Global System for Mobile Communication
IMEI	International Mobile Equipment Identity
PDA	Personal Digital Assistant
PFO	Power Frequency Oscillator
PCB	Printed Circuit Board
RAM	Random Access Memory
RF	Radio Frequency
ROM	Read Only Memory
RTC	Read Time Clock
Rx	Receive/Receiver (Receiving Station)
SMD	Surface Mount Device
Tx	Transmit/Transmitter (Transmitting Station)
UEM	Universal Energy Manager
VCO	Voltage – Controlled Oscillator.

LEARNING OUTCOME

A student will understand the working principle of the following communication devices, in this chapter.

1. PAGERS
2. WALKIE TALKIES
3. CELL PHONES

GLOSSORY

Push-To-Talk	Push-To-Talk, also known as Press-To-Transmit, to switch from voice reception mode to transmit mode.
Electret Microphone	Type of Electrostatic capacitor based Microphone Electret = Electricity + Magnet.
G	Short for General Packet Radio Service (GPRS) or Generation
EDGE	Enhanced Data rated for GSM
H+	Refers to Evolved High Speed Packet Access (HSPA+)
LTE	Long Term Evaluation Having higher data speed.
VoLTE	Stands for Voice over LTE.

GPRS	General Packet Radio Service. Packet oriented mobile data standard on the 2G and 3G cellular communication network.
GPS	Global Positioning System
SDMA	Space Division Multiple Access
TDMA	Time Division Multiple Access
PDMA	Polarization Division Multiple Access
DP-QPSK	Dual Polarization Quadrature Phase Shift keying
D-AMPS	Digital-American Mobile Phone Service
GSM	Global System for Mobile Service
PDC	Personal Digital Cellular
DECT	Digital Enhanced Cordless Telecommunication
CDMA	Code Division Multiple Access
WCDMA	Wideband Code Division Multiple Access
FDMA	Frequency Division Multiple Access
WDMA	Wavelength Division Multiple Access
WDM	Wavelength Division Multiplexing
Transceiver	Transmit and Receive functions, the device is a Transmitter-Receiver. Similar devices include transponders, Transvertors and Repeaters.
Transponders	A device that receives a signal, and emits as a different signal in response with Telecommunications.
OFDMA	Orthogonal Frequency – Division Multiple Access
UMTS	Universal Mobile Telecommunication System
MM Tel IMS	Multimedia Telephony over Internet Protocol (IP) Multimedia Subsystem
CSMA-CD	Carrier Sense Multiple Access with collision Detection
LAN	Local Area Networks
CSMA-CA	Carrier Sense Multiple Access with Avoidance
Wi-Fi	Is a local area wireless technology
Bluetooth	Bluetooth is a wireless technology used to transfer data between different electronic devices.

NFC	Near Field Communication (NFC) enables short range communication between compatible devices.
RFID	Radio-Frequency Identification is the use of radio waves to read and capture information stored

QUESTIONS

Part – A (1 Mark)

I Multiple choice Questions

1. Who developed the first communication machine
   a. Samuel F.B Morse
   b. Canadian Donald Hings
   c. Alfred Gross
   d. None of the Above
2. Walkie talkies work up to
   a. 27.2 Kilometers
   b. 58 Kilometers
   c. 18 Kilometers
   d. None of the Above
3. Who invented the walkie talkie
   a. Canadian Donald Hings
   b. Martin copper
   c. Samuel F.B Morse
   d. None of the Above
4. The magnitude of the received signal from the cell tower is called
   a. Signal strength
   b. Bars
   c. Wave length
   d. None of the above
5. Who invented the first mobile phone?
   a. Martin copper
   b. Alfred Gross
   c. Samuel F.B Morse
   d. None of the above
6. Beeper is the example of _____ Transmission mode
   a. Hulf duplex
   b. Simplex
   c. Full duplex
   d. None of the above
7. Which device invented during world war II
   a. Cell phone
   b. Pagerb.
   c. Walkie talkie
   d. None of the above
8. Which condenser is used as a microphone in communication devices
   a. Electrolyte condenser
   b. Gang condenser
   c. Electret condenser
   d. None of the above
9. Walkie talkies are work on the ___
   a. 7 KHz
   b. 10-18 KHz
   c. 27 MHz
   d. None of the above
10. Baby Monitor is used in _____
    a. UPS

b. Computer

c. Walkie Talkie

d. None of the above

11. TDMA has an ability to carry _____ of data rates

a. 64 kbps to 128 kbps

b. 240 kbps

c. 30 kbps to 48 kbps

d. None of the above

12. FDMA is the best example of _____ system

a. Cable Television

b. CCTV

c. LED TV

d. None of the above

13. OFDMA (Orthogonal Frequency _ Division Multiple Access) is the access used in

a. VOLTE

b. LTE

c. E

d. None of the above

14. Internet protocol (IP) Multimedia sub system is

a. UMTS

b. RFID

c. MMTelIMS

d. None of the above

15. Enhanced GPRS is called _____

a. EDGE

b. 2.5 G

c. OG

d. None of the above

16. Hot spot has a range of about

a. 150 feet

b. 66 feet

c. 17 feet

d. None of the above

17. Wi – fi most commonly uses bands

a. UHF band

b. VHF band

c. SHF & UHF band

d. None of the above

18. NFC has _____ distinct mode of operation

a. 3

b. 10

c. 7

d. None of the above

19. 26 MHz Crystal Oscillator is also called _____

a. Simple silicon

b. Piezo electric crystl

c. Network crystal

d. None of the above

20. If _____ is faulty, there will be a software problem in mobile phone

a. RAM

b. ROM

c. CPU

d. None of the above

Part – B (3 Marks)

II Answer in one or two sentences

1. What are the types of transmission mode?

2. What is PTT?

3. Write Application of walkie-talkie

4. What is the major Difference between GPS and GPRS?

5. Write the expansion of LTE, XLTE, VOLTE
6. What is FDD, TDD? Define.
7. What are the common functions of mobile phone?
8. What are the disadvantages of CDMA
9. Write Three applications of cell phone
10. What are the benefits of hexagons used in cellular network

Part – C (5 Marks)

III Answer in a paragraph

1. Tabulate the comparison of Transmission modes
2. Draw the front & back panel of a cell phone and mention it parts.
3. Explain Hotspot and Wifi
4. Draw a diagram of RFID system and explain its parts.
5. Write the advantages and disadvantages of cell phone

Part – D (10 Marks)

IV Answer in One Page (Essay type Question)

1. Discuss about the Generation of cell phone technologies.
2. Explain the Bluetooth technology with its classification, advantages and disadvantages?
3. Draw a block diagram of a simple cell phone and explain its functions.
4. Explain about cell phone applications.

ANSWERS

1. (b)	2. (a)	3. (a)	4. (a)	5. (a)
6. (b)	7. (c)	8. (c)	9. (c)	10. (c)
11. (a)	12. (a)	13. (b)	14. (c)	15. (a)
16. (b)	17. (c)	18. (a)	19. (c)	20. (b)