Modern Day Communication

Objectives

After going through this module the learners will be able to

- Understand the meaning of short range radio communications
- Know that an antenna can increase the receiving area
- Appreciate the application of short range communication in factories, villages, stadiums, townships and societies
- Know about basic internet and world wide web

Content Outline

- Unit Syllabus
- Module Wise Distribution of Syllabus
- Words You Must Know
- Mobile Phones
- Mobile Towers
- Meaning of 3G ,4G , 5G
- Role of Mobile Companies
- Summary

Unit Syllabus

Unit 10 Communication Systems

Chapter 15 Communication System

Elements of a communication system (block diagram) bandwidth of signals speech , TV and digital data) bandwidth of transmission medium ,propagation of electromagnetic waves in the atmosphere, sky and space wave propagation, satellite communication, need for modulation , types of modulation, amplitude modulation, production of amplitude modulated wave, detection of amplitude modulated wave, Internet and mobile phones

Module Wise Distribution of Unit Syllabus - 6 Modules

Module 1	• History of communication • Special vocabulary

	• Signals and band width
Module 2	• Propagation of electromagnetic wave • Ground wave • Sky wave • Space wave • Satellite communication
Module 3	• Modulation • Need for modulation • Types of modulation • Amplitude modulation AM • Frequency modulation FM • Meaning of tuner frequencies 98.3FM
Module 4	• Amplitude modulation • Modulation index • Production of amplitude modulated wave • Detection of amplitude modulated wave • Applications of amplitude modulation
Module 5	• Short range communications • Increasing the area of influence using antenna • Use in factories, villages, towns for police work • Internet • Internet servers
Module 6	• Mobile phones • Mobile towers • 3G, 4G, 5G • Mobile companies, what do they do?

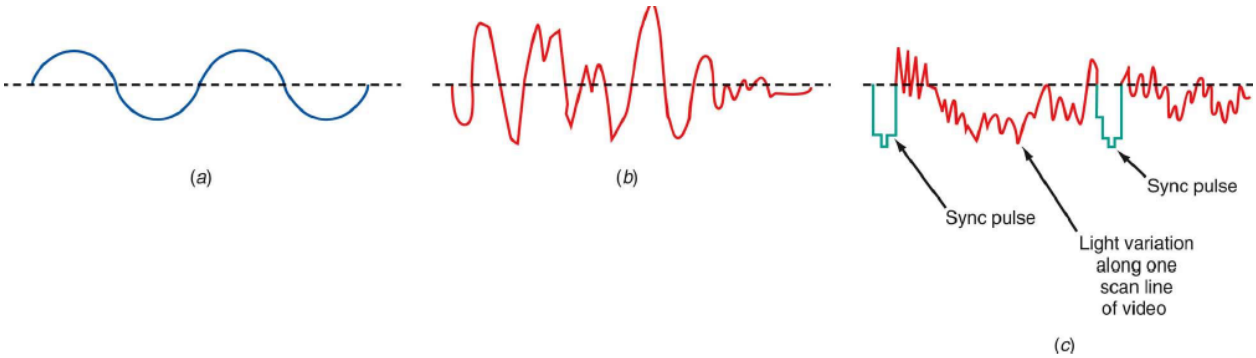
Module 6

Words You Should Know

- **Communication:** The process of putting across ideas through words and pictures.
- **Audio Communication:** Communication by means of speech/sound or messages that can be received by our ears

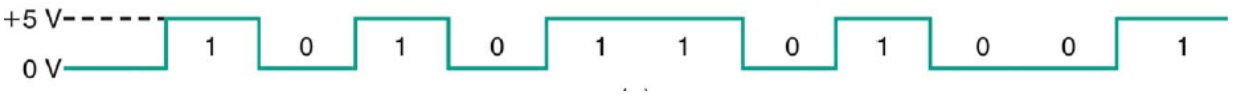
- **Video Communication-** Communication by means of pictures, still or moving or messages that can be received by our eyes.
- **Audio Video Communication-** Communication by means of speech/sound or messages that can be received by our ears
- **Device-** an apparatus designed for special functions
- **Mode of Transfer of Information-** method of transfer of information
- **Antenna-** a device designed to send out and receive electromagnetic waves.
- **Electromagnetic Waves-** The range of electromagnetic signals encompassing all frequencies is referred to as the electromagnetic spectrum
- **Frequency:** It is defined as the number of cycles per second or number of waves per second.
- **Wavelength** is the distance occupied by one cycle of a wave and is usually expressed in meters. Wavelength is also the distance traveled by an electromagnetic wave during the time of one cycle. The wavelength of a signal is represented by the Greek letter lambda (λ).
- **Transducer:** An electrical transducer may be defined as a device that converts some physical variable (pressure, displacement, force, temperature, etc.) into corresponding variations in the electrical signal at its output. For example, a microphone converts sound energy into electrical energy.
- **Signal:** Information converted in electrical form and suitable for transmission is called a signal. Signals can be either **analog or digital**.
- **Analog Signals are continuous variations of voltage or current. They are essentially single-valued functions of time. Sine wave is a fundamental analog signal.**
- **All other analog signals can be fully understood in terms of their sine wave components.**

  Sound and picture signals in TV are analog in nature.



Analog signals (a) Sine wave "tone." (b) Voice. (c) Video (TV) signal

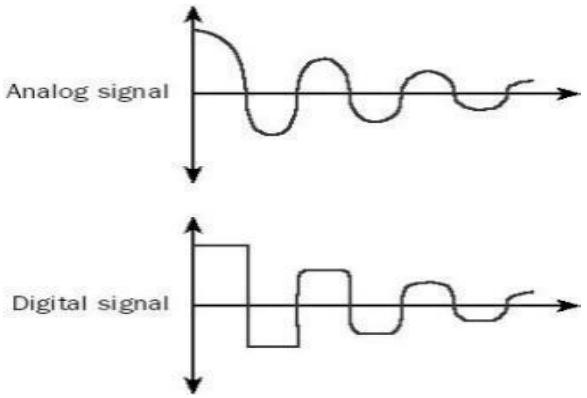
- **Digital signals are those which can take only discrete stepwise values.**
- **Binary system that is extensively used in digital electronics employs just two levels of a signal. '0' corresponds to a low level and '1' corresponds to a high level of voltage/ current.**



Digital signals (a) Telegraph (Morse code). (b) Continuous-wave (CW) code. (c) Serial binary code

- Technically speaking, a signal is a wave, amplitude or frequency of which varies with time and the signal can be analog or digital.
- **Noise:** These are unwanted signals having the same or similar frequency as that of the required signal. They distort the transmission and receiving process. A virus in a computer is an example of noise. A virus is an unwanted program in the same language in which your required program is, it disrupts your program.
- **Communication Channel:** The communication channel is the medium by which the electronic signal is sent from one place to another. Types of media include electrical conductors, Optical media, Free space, and System-specific media (e.g., water is the medium for sonar).
- **Transmitter:** It is the device that converts the information (message) into a form suitable for transmission. In the above example the online shopping company is the transmitter.

- **Receiver:** It is the device that retrieves the information from received signals. In the shopping example, you are the receiver. A **receiver** is a collection of electronic components and circuits that accepts the transmitted message from the channel and converts it back into a form understandable by humans. Receivers contain **amplifiers, oscillators, mixers, tuned circuits** and **filters**, and a detector that recovers the original intelligence signal from the modulated carrier.
- **Transceivers:** A **transceiver** is an electronic unit that incorporates circuits that both send and receive signals. Examples are: Telephones, Fax machines, radios, Cell, mobile phones, computers.
- **Amplification:** It is the process of increasing the strength of signal. Amplification compensates for attenuation. Amplification is done by an electronic circuit.
- **Attenuation:** It refers to loss in strength of signal while propagating from transmitter to receiver Signal **attenuation,** or degradation, exists in all media of wireless transmission. It is usually proportional to the square of the distance between the transmitter and receiver.



- **Range:** It is the maximum distance that a signal can travel with sufficient strength.
- **Band Width:** It is the frequency range over which a system works. It is calculated as the highest frequency – lowest frequency. For example, the human audio frequency range is 20 Hz to 20,000 Hz, so audio bandwidth = 20,000 – 20 = 19,980 Hz **Bandwidth is** that portion of the electromagnetic spectrum occupied by a signal. **Channel Bandwidth** refers to the range of frequencies required to transmit the desired information.
- **Bandwidth of transmission medium the transmission channels are of three types** Wires, free space and optical fiber.
- **Repeater:** repeater station is equipped with Receiver, Amplifier and Transmitter. The mobile phone towers in your area are repeater stations.

- **Communication Satellites** are repeater stations in space. They receive a signal from one ground station, amplify it and transmit it to another ground station.
- **Antenna:** It is the device through which transmission and receiving process are done. The dish connected to your TV set is an antenna in itself.
- **Carrier Wave:** A **carrier** is a high frequency signal that is modulated by audio, video, or data. A **radio-frequency (RF) wave** is an electromagnetic signal that is able to travel long distances through space.
- **Broadcasting** is the distribution of audio or video content to a dispersed audience via any electronic mass communications medium, but typically one using the electromagnetic spectrum (radio waves), in a one-to-many model.
- **Mode of EM Wave Propagation:** EM waves travel in three ways through the atmosphere, ground wave, sky wave and space wave.
- **The modulated wave is a combination of message signal and carrier wave.**

  A sinusoidal carrier wave can be represented as

  $c(t) = A_c \sin sin \left(\omega_c t + \theta\right)$

  Where,
  - $c(t)$ is the signal strength (voltage or current),
  - A_c is the amplitude,
  - ω_c (= 2πfc) is the angular frequency

    and
  - θ is the initial phase of the carrier wave.

  During the process of modulation, any of the three parameters,

  Viz $\mathbf{A_c}$**,** $\boldsymbol{\omega_c}$ **and θ,** of the carrier wave can be controlled by the message or **i**nformation signal.
- **This Results in Three Types of Modulation:**

  Amplitude Modulation (AM),

  Frequency Modulation (FM)

  Phase Modulation (PM),
- **Amplitude Modulation:** The process of varying amplitude of a high frequency carrier wave in accordance with the signal (code, voice or music) to be transmitted, keeping the frequency and phase of the carrier wave unchanged is known as amplitude modulation

An amplitude modulated wave has frequencies $(\omega_c - \omega_m)$, ω_c and $(\omega_c + \omega_m)$.

$(\omega_c - \omega_m)$ = Lower side band frequency

$(\omega_c + \omega_m)$ = Upper side band frequency.

Bandwidth of AM Wave = highest freq. - Lowest freq.

= USB - LSB

$= (\omega_c + \omega_m) - (\omega_c - \omega_m)$

$= 2\ \omega_m$

- **Modulation Index**

  $\mu = A_m/A_c$ is called modulation index in practice $\mu \leq 1$ to avoid distortion of signal.

- **Short Range Radio Communication**

  Wireless systems which use electromagnetic radio waves for sending the signal from source to observers.

Introduction

This module is for general information. It is not part of the syllabus and hence will not be evaluated means there would be no examination test based on this module.

Then why are we including it in the course? We should have included the latest development for all parts of the syllabus?

Our daily lives are filled with use of ever new communication devices and techniques. It is for this reason we are dedicating this module for general knowledge.

The rationale behind this inclusion is that we are increasingly using the internet on multiple devices. We hear words like GPS, 3G, 4G, 5G, mbps, GPS, Google map, Google search etc. living with ever new vocabulary and inventions which are the root of newer inventions is reason enough to devote some time to it.

Let Us Consider Some Words and Phrases

Bandwidth BW is that portion of the electromagnetic spectrum occupied by the signal. The signal may be data, audio, video or a mixture of these.

Channel Bandwidth refers to the range of frequencies required to transmit the desired information

Today virtually the entire **frequency spectrum** is being used. There is tremendous competition for frequencies, between companies, individuals, government services in

individual carriers and between the different nations of the world. The electromagnetic spectrum is the most precious resource.

Communication Engineering is devoted to making the best use of this finite spectrum. Great effort goes into developing communication techniques that minimize the bandwidth required to transmit given information and thus conserve spectrum space.

This provides more room for additional communication channels and gives other services to users.

Spectrum Management is the process of regulating the use of electromagnetic radio frequencies to promote efficient use for net social benefit.

Spectrum of frequencies typically refers to the full frequency range from **3 kHz to 300 GHz** that may be used for wireless communication.

Increasing demand for services such as mobile telephones and many others has required changes in the philosophy of spectrum management. Demand for radio frequency bands has soared due to technological innovation, such as 3G and 4G mobile services, and the rapid expansion of wireless internet services.

Since the 1930s, spectrum was assigned through administrative licensing. Limited by technology, signal interference was once considered as a major problem of spectrum use. Therefore, exclusive licensing was established to protect licensees' signals. This former practice of discrete bands licensed to groups of similar services. In many countries, it has given rise to a "**spectrum auction**" to improve the efficiency of spectrum use.

During the experimental process of spectrum assignment, other approaches have also been carried out, namely, **lotteries, unlicensed access**, and **privatization of spectrum.**

Governments and Spectrum Management

Most countries consider radio frequency spectrum as an exclusive property of the country. The RF spectrum is a national resource, much like water, land, gas and minerals.

The first sentence of the **International Telecommunication Union** (ITU) constitution fully recognises “the sovereign right of each country to regulate its telecommunication”. Effective spectrum management requires regulation at national, regional, and global levels.

Goals of spectrum management include: rationalize and optimize the use of the RF spectrum; avoid and solve interference; design short and long range frequency allocations;

Frequency Distribution or Management are specifications and guidelines necessary to ensure compatibility between transmitting and receiving equipment.

We have already talked about Simple one way systems called simplex these are

- AM and FM broadcasting
- TV Broadcasting
- Digital Messaging
- Cable Television
- Wireless Remote Control
- Paging Services
- Navigation and Direction-Finding Services
- Radio Astronomy
- Surveillance

Or

Two way systems called Duplex Telephones

- Two-Way Radio
- Radar
- Sonar
- Amateur Radio
- Citizens Radio
- Mobile Phones
- Computers

Terminology

Without going into any details we will just consider some commonly used terms in radio communication.

Internet

The internet is a global system of interconnecting computer /mobile networks that use the standard internet protocol suite (TCP/IP) to serve billions of users worldwide. It is a network of networks that consists of millions of private, public, academic business and government networks, both locally, country wise or internationally. They are linked by a number of electronic, wireless and optical networking technologies. The internet carries a vast range of information resources and services. This includes multimedia content, electronic mail, such as the interlinked hypertext documents of the **World Wide Web** (WWW) and the infrastructure to support IP internet protocol.

Application or Special Purpose Program or Apps

We are familiar with Facebook, Twitter, WhatsApp, Instagram, telegram, hike etc. are social networking sites

Uber, ola, paytm, YouTube, WeChat, LinkedIn, Pinterest, zomato, foodpanda, big basket, swiggy, Amazon, flipkart, myntra, snapdeal, infibeam etc.

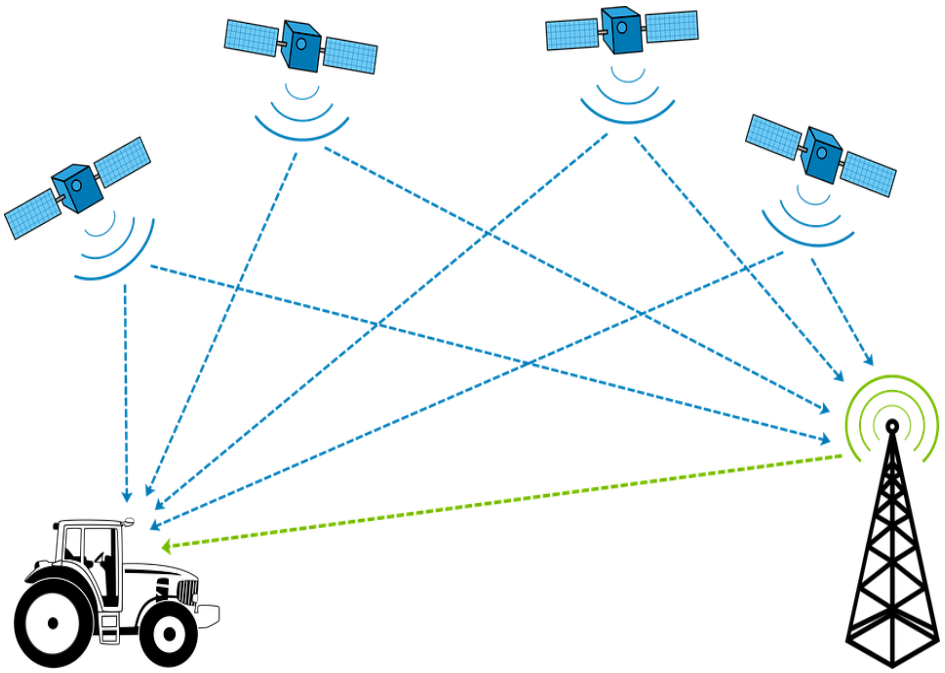
Cellular Telephony

A cellular telephone system links mobile subscribers into the public telephone system or another cellular subscriber.

Communication between the mobile unit and the cellular network uses radio communication. Hence, the subscriber is able to move around and stay connected. In each case the transmission of information to radio signal or modulation must take place and demodulation at the receiver end. Our channel of communication is wireless so space, sky waves are used. Also satellites help us in connecting with any one across the globe.

- **GSM** global system of mobile communication
- **CDMA code division multiple access**
- **GPRS general packet radio system**

GPS The global positioning system is a worldwide satellite-based radio navigation formed from a constellation of 24 satellites and their ground stations. It is used to determine accurate geodetic position and altitude on earth surface



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History of Mobile Telephony

The concept of mobile telephony was developed in 1970's and it was fully implemented in the following decade. In India it was introduced in 1996. The central concept of this system is to divide the city into suitable no. of small areas called **cells.** Each cell contains a low - power transmitter called *base station* (what you know by the name of mobile tower). Every base station (mobile tower) supports a large no. of mobile radios popularly called cell phones.Each cell has a service area of a few square kilometers or even less, depending upon no. of users.

A basic cell phone is a combination of radio transmitter and radio receiver just like a walkie – talkie. Your phone converts your voice into an electrical signal using a transducer. This low power electrical signal is transmitted by the antenna of your phone in the form of radio waves. The base station (mobile tower) nearest you will pick this low power RF (radio frequency) signal and transmit it to other base stations till it reaches the base station of your friend. This happens at the speed of light because radio waves travel with the speed of light being electromagnetic waves (em waves). The phone of your friend will receive this electrical signal and will again convert it into sound.

In every cell phone, the transmitting (speaking) frequency is different from receiving (listening) frequency to avoid interference between transmitted and received signal. Thus each mobile phone uses two frequencies.

A cell phone has a very small antenna and hence very low power dissipation. This means a cell phone can send signals to a very short range only. It is the huge mast (antenna) of a mobile tower (base station) that enables signals to travel longer distances – from one cell to another cell. If you are on the move, while talking on your cell phone, you are transferred from the base station of one cell to the base station of another cell. This process of transferring is called handover or handoff. This handover is carried out very rapidly, to the extent that you even do not notice it. The cell phones operate in the **UHF** range of frequencies, around 800 – 950 MHz.

How do mobile phones work?

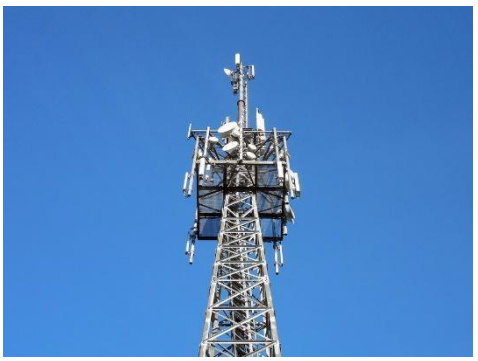
Imagine calling a friend on the other side of town. As you chat away, your phone converts your voice into an electrical signal, which is then transmitted as radio waves and converted back into sound by your friend's phone. A basic mobile phone is therefore little more than a combined radio transmitter and a radio receiver, quite similar to a walkie-talkie.

In order to remain portable, mobile phones need to have relatively compact antennas and use a small amount of power. This means that mobile phones can send a signal over only a very short range, just like a walkie-talkie.

The cellular network, however, enables you to spread the latest news and views around regardless of how far away your friends are. This is done by dividing up land into a patchwork of 'cells' – hexagonal areas of land each equipped with their own phone mast (also called a base station).

These huge phone masts pick up the weak signal from your phone and relay it onwards to another phone mast nearer to your friend. And if you are on the move while you talk, your phone switches masts as you go without interrupting your call

Mobile Towers or Base Stations



https://pixabay.com/en/transmission-tower-send-radio-1017149/

A mobile tower or base station is basically a repeater station. It receives a call to 'amplify' it and transmit it to another base station. So, a base station consists of an antenna, a transmitter, an amplifier and receiver. The cell phone tower is a large steel structure that is built hundreds of feet into the air on top of a building. The average height of a mobile tower varies from 150 to 250 feet above ground level. Antenna is mounted on the tower from which connecting cables run down the tower equipment box containing receiver, amplifier and transmitter. This equipment box is a sealed box.

This is how the signal travels to other base stations till it reaches the desired base station of your friend.

A single tower can have more than one antenna of different operators (service provider companies). The no. of towers in a locality depends upon the population density and topology (geographical conditions) of the area.

Do cell towers have health risks?

A cell phone emits EM radiations of 1-2 watt and a tower emits EM radiations of 60 watts. The frequency used in mobile communication corresponds to the microwave. The low power radiations from towers match with the radiations emitted by our brains. The World Health Organization (WHO) has classified EM radiation from mobile phones/towers, Wi-Fi etc. as "possibly" risky. The scientists and doctors are divided on this issue. So, it is still a question of debate.

3G , 4G , 5G Meaning and Uses

The alphabet G in 2G, 3G, 4G … means "Generation". 2G means 2nd generation, 3G means 3rd generation, 4G means 4th generation and so on. Higher the number, higher is the

bandwidth and speed of uplink and downlink. Of wireless networks like the internet, TV, radio broadcast.

1G: It was the first of the generation series. It supported only the analog radio signals. Only text messages and calls could be made on this network. It could not support the picture messages. This was a confined network, within the country only. So, it lacked global coverage.

2G: It is the second of the generation series and was launched in digital format. It was launched in 1991 with a max. Speed of 384Kbps for download and 60 Kbps for upload. Due to digital nature the quality of calls and messages was much better than 1G. Videos can also be sent on this network. The biggest advantage of this network was to enable interconnectivity throughout the world. This made it internet friendly and enabled various mobile phone service providers to connect themselves globally.

3G: This one is the third generation of wireless communication. It is also digital in nature. It was launched in 2001 with a max. speed of 56 Mbps for download and 22 Mbps for upload. This network has excellent speed so more data files can be transferred in a shorter time. It was upgraded in 2008 and enabled video calling and high definition HD TV, games etc. on mobile phones. The internet surfing is much better on this network.

4G: The first 4G network was introduced in 2007 in South Korea. As opposed to earlier generations, 4G does not support the traditional cell-switching telephony services. It requires services at 1 Gb ps. It enabled high speed net browsing, HD mobile TV, video conferencing, 3D TV on mobile.

5G: It is a proposed service yet to be implemented. The maximum speed is aimed at 35 Gbps. The features of 5G include device to device communication, better battery consumption, and larger overall coverage.{5 G service was launched in India on 1st October 2022}

Role of Mobile Network Service Provider Companies or Telecom Companies

In India some of the popular mobile companies are: BSNL, Bharti Airtel, Vodafone, Idea, and reliance telecommunication service, Reliance Jio Infocomm Limited

These companies are called mobile network operators (MNO) or simply cellular companies. Let us now discuss how these companies work:

- The company files an application to the government requesting to provide mobile phone services. The government then issues a license and band of frequencies (spectrum) to the company.

- After getting the license, the company appoints the staff, builds the infrastructure i.e. erects towers, purchases and installs the equipment.
- After the completion of infrastructure the services are started. A nominal cost is fixed for the services.
- Company generates bills and collects payments from the users.

Summary

This simply means humans need to communicate with each other. Over time local citizens have become global citizens. There is high demand to communicate accurately and at a high speed with any one across the globe and beyond. Using radio waves this task already makes the signal move at the speed of light. It is the transducers and channels that are continuously undergoing changes, innovation and development for better and better communication
So this is it 'Science at the service of mankind'.