

Main purpose of an electronic communications system is to transfer information from one place to another.

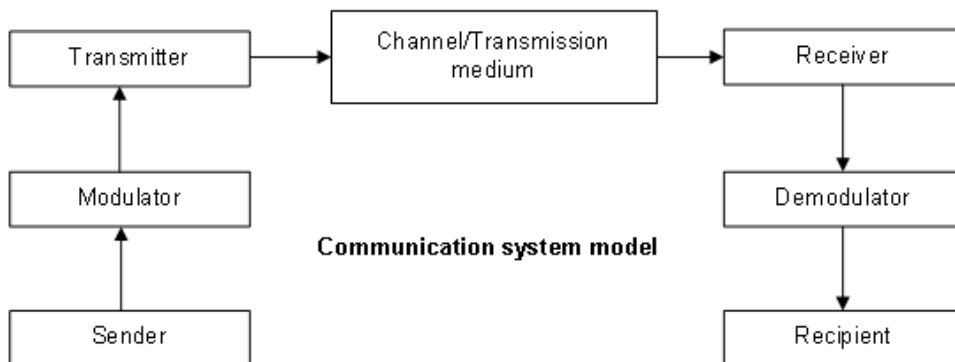
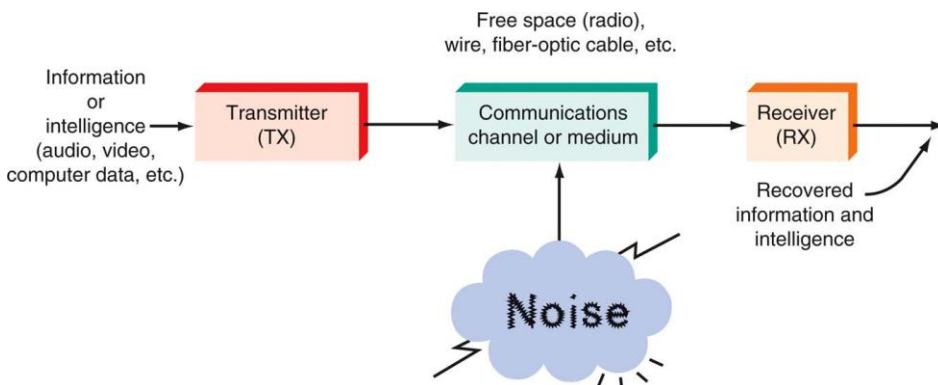
- Electronic communications can be viewed as the transmission, reception and processing of information between two or more locations using electronic circuit/device

- Communication is the process of exchanging information.
- Main barriers are language and distance.
- Contemporary society's emphasis is now the accumulation, packaging, and exchange of information.
- Methods of communication:
 - Face to face
 - Signals
 - Written word (letters)
 - Electrical innovations:
 - Telegraph
 - Telephone
 - Radio
 - Television
 - Internet (computer)

Communication Systems Basic components:

- Transmitter
- Channel or medium
- Receiver
- **Noise** degrades or interferes with transmitted information

Communication Systems



- **Transmission channel** – physical link between the communicating parties
- **Modulator** – transform the source signal so that it is physically suitable for the transmission channel
- **Transmitter** – introduce the modulated signal into the channel (also act as amplifier)
- **Receiver** – Detect the signal on the channel and amplify it (due to the attenuation)
- **Demodulator** – Get the source signal (original) from the received signal and pass it to the recipient

Transmitter

- The **transmitter** is a collection of electronic components and circuits that converts the electrical signal into a signal suitable for transmission over a given medium.
- Transmitters are made up of oscillators, amplifiers, tuned circuits and filters, modulators, frequency mixers, frequency synthesizers, and other circuits

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
 - System-specific media (e.g., water is the medium for sonar).

Receivers

- 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 **demodulator** or 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
 - Handheld CB radios
 - Cell phones
 - Computer modems

Attenuation

- Signal **attenuation**, or degradation, exists in all media of wireless transmission. It is proportional to the square of the distance between the transmitter and receiver.

Noise

- **Noise** is random, undesirable electronic energy that enters the communication system via the communicating medium and interferes with the transmitted message.

Communication / Transmission Mode

- ❖ Electronic communications are classified according to whether they are
 - One-way (simplex) or two-way (full duplex or half duplex) transmissions
 - Analog or digital signals.

Simplex System : the system capable of sending information in one direction only where only the sender can send the information and only the recipient can receive the information

- The simplest method of electronic communication is referred to as **simplex**.
- This type of communication is one-way. Examples are:
 - Radio
 - TV broadcasting
 - Beeper (personal receiver)

Full-duplex System : Information can be carried in both direction at the same time. The 2 directions of information travel are independent of each other. (e.g. ordinary/mobile phone systems, computer systems)

- Most electronic communication is two-way and is referred to as **duplex**.
- When people can talk and listen simultaneously, it is called **full duplex**. The telephone is an example of this type of communication.

Half-duplex System : the system capable to carry information in both direction, but only one direction is allowed at a time. The sender transmits to the intended receiver, and then reverse their roles

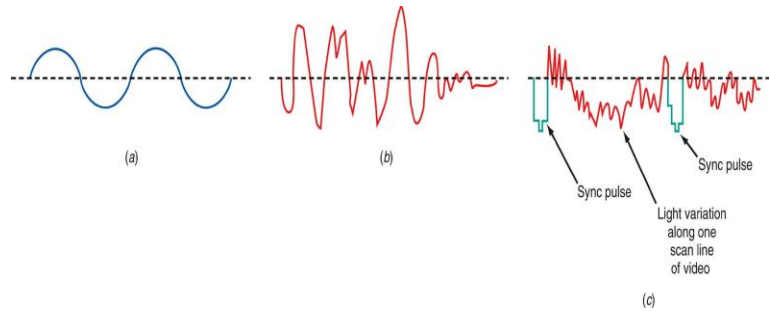
- The form of two-way communication in which only one party transmits at a time is known as **half duplex**. Examples are:
 - Police, military, etc. radio transmissions
 - Citizen band (CB)
 - Family radio
 - Amateur radio

Analog Signals

- An **analog signal** is a smoothly and continuously varying voltage or current.

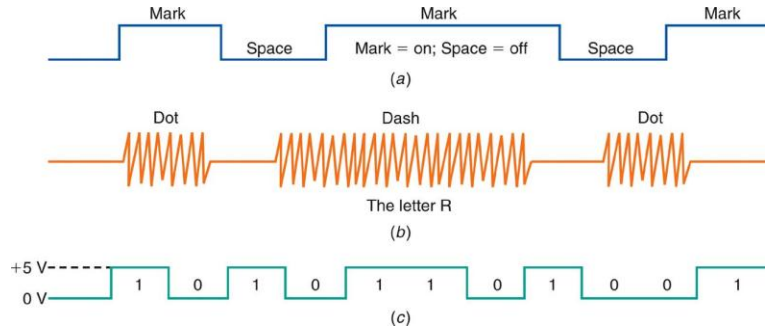
Examples are:

- Sine wave
- Voice
- Video (TV)



Digital Signals

- Digital signals change in steps or in discrete increments.
- Most digital signals use binary or two-state codes. Examples are:
 - Telegraph (Morse code)
 - Continuous wave (CW) code
 - Serial binary code (used in computers)
- Many transmissions are of signals that originate in digital form but must be converted to analog form to match the transmission medium.
 - Digital data over the telephone network.
 - Analog signals.
 - They are first digitized with an analog-to-digital (A/D) converter.
 - The data can then be transmitted and processed by computers and other digital circuits.



Modulation and **multiplexing** are electronic techniques for transmitting information efficiently from one place to another.

- Modulation** makes the information signal more compatible with the medium.
- Multiplexing** allows more than one signal to be transmitted concurrently over a single medium.

Baseband Transmission

- Baseband** information can be sent directly and unmodified over the medium or can be used to modulate a carrier for transmission over the medium.
 - In telephone or intercom systems, the voice is placed on the wires and transmitted.
 - In some computer networks, the digital signals are applied directly to coaxial or twisted-pair cables for transmission.

Broadband Transmission

- 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.
- A broadband transmission takes place when a carrier signal is modulated, amplified, and sent to the antenna for transmission.
- The two most common methods of modulation are:
 - Amplitude Modulation (AM)
 - Frequency Modulation (FM)
- Another method is called **phase modulation (PM)**, in which the phase angle of the sine wave is varied.

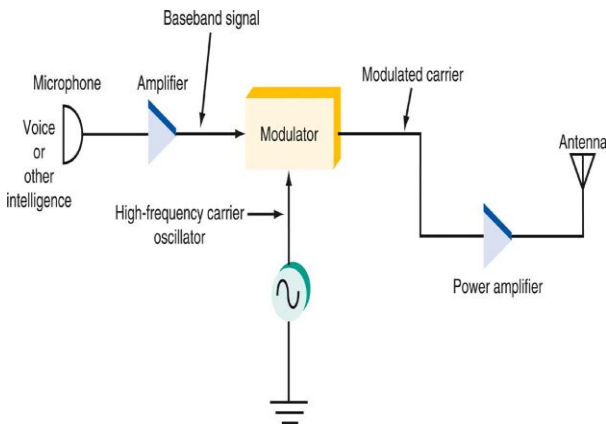


Figure 1-7: Modulation at the transmitter

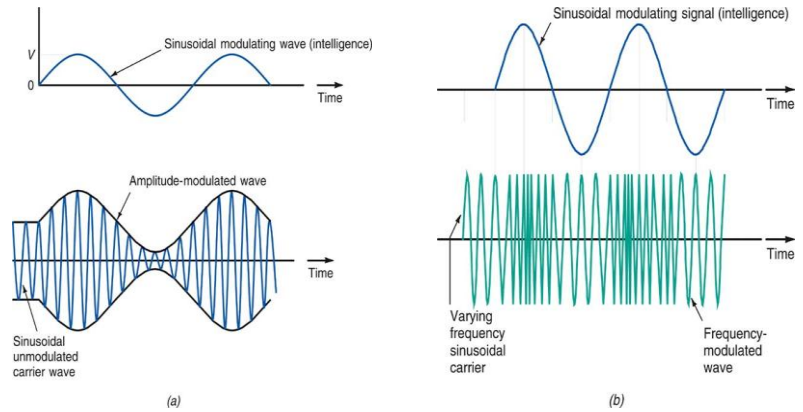


Figure : (a) Amplitude modulation. (b) Frequency modulation.

- **Frequency-shift keying (FSK)** takes place when data is converted to frequency-varying tones.
- Devices called **modems (modulator-demodulator)** translate the data from digital to analog and back again.
- **Demodulation** or detection takes place in the receiver when the original baseband (e.g. audio) signal is extracted.

Multiplexing

- Multiplexing is the process of allowing two or more signals to share the same medium or channel.
- The three basic types of multiplexing are:

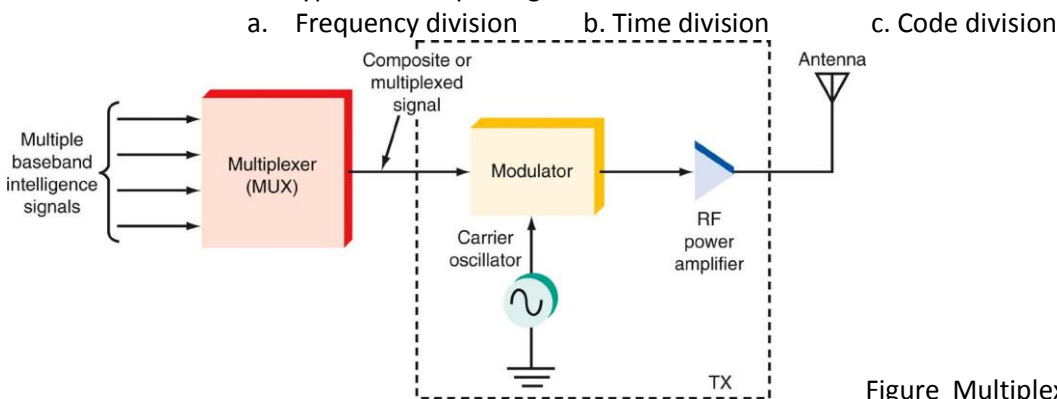


Figure Multiplexing at the transmitter

The Electromagnetic Spectrum

- The range of electromagnetic signals encompassing all frequencies is referred to as the **electromagnetic spectrum**.

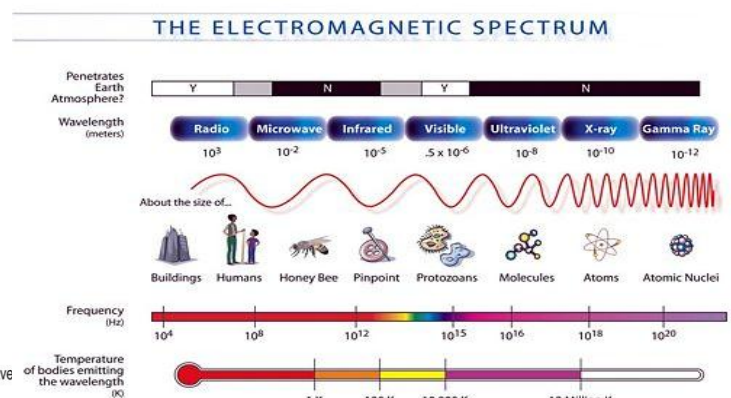
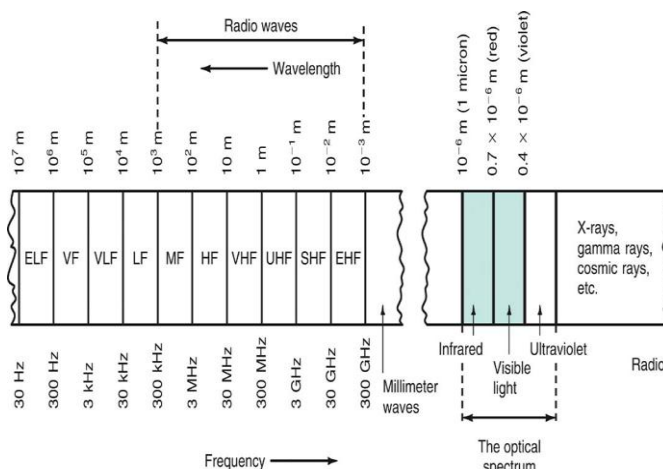


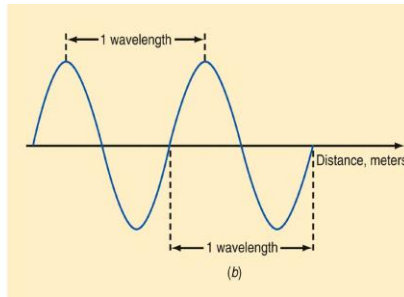
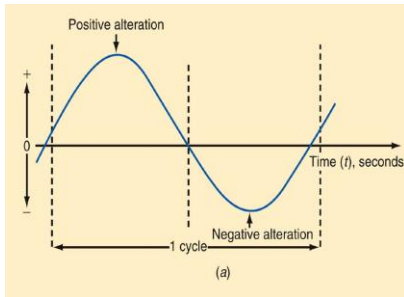
Figure: The electromagnetic spectrum

Frequency and Wavelength: Frequency

- A signal is located on the frequency spectrum according to its frequency and wavelength.
- **Frequency** is the number of cycles of a repetitive wave that occur in a given period of time.
- A cycle consists of two voltage polarity reversals, current reversals, or electromagnetic field oscillations.
- Frequency is measured in cycles per second (cps).
- The unit of frequency is the hertz (Hz).

Frequency and Wavelength: Wavelength

- **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).



Frequency and Wavelength: Wavelength
Wavelength (λ) = speed of light \div frequency
Speed of light = 3×10^8 meters/second
Therefore: $\lambda = 3 \times 10^8 / f$

Example:

What is the wavelength if the frequency is 4MHz?

$$\lambda = 3 \times 10^8 / 4 \text{ MHz} \\ = 75 \text{ meters (m)}$$

Figure : Frequency and wavelength. (a) One cycle. (b) One wavelength.

The Electromagnetic Spectrum

Frequency Ranges from 30 Hz to 300 GHz

The electromagnetic spectrum is divided into segments

Extremely Low Frequencies (ELF)	30–300 Hz. These include ac power lines (50 and 60 Hz) ,as well as those frequency in the low end of human audio range.
Voice Frequencies (VF)	300–3000 Hz. This is the normal range of human speech ,although human hearing extend approximately from 20 Hz to 20 Khz , Most intelligible sound occurs in the VF range.
Very Low Frequencies (VLF)	3K-30 K include the higher end of the human hearing range up to about 20 kHz.Many musical instrument make sounds in this . VLF range is use in some government communication such as VLF radio used by navy to communicate with submarines
Low Frequencies (LF)	30–300 kHz.Use in aeronautical and marine navigation.
Medium Frequencies (MF)	300–3000 kHz AM radio 535–1605 kHz.

High Frequencies (HF)	3–30 MHz ,all kinds of simple broadcasting and half duplex broadcasting (short waves; VOA, BBC broadcasts; government and military two-way communication; amateur radio, CB.
Very High Frequencies (VHF) FM radio broadcasting (88–108 MHz), television channels 2–13.	30–300 MHz. This popular frequency range is used by many services including mobile radio, FM Broadcasting , and Television channel 2- 13 ,Radio amateurs have numerous band on this frequency
Ultra High Frequencies (UHF) TV channels 14–67, cellular phones, military communication.	300–3000 MHz , It include the UHF TV channel from 14-67 and its used for land mobile communication and services such as cellular telephones, some radar and navigation occupy this portion .

Microwaves and Super High Frequencies (SHF) Satellite communication, radar, wireless LANs, microwave ovens	1–30 GHz This microwave frequency are used for satellite communication and Radar , Wireless local area network also use this region .
Extremely High Frequencies (EHF) Satellite communication, computer data, radar	30–300 GHz Electromagnetic signals with frequency higher than 30 GHz are referred to millimetre waves .Satellite communication telephony , Specialize radar and computer data.

Optical Spectrum

- The **optical spectrum** exists directly above the millimeter wave region.
- Three types of light waves are:
 - Infrared
 - Visible spectrum
 - Ultraviolet

Optical Spectrum: Infrared

- Infrared radiation is produced by any physical equipment that generates heat, including our bodies.
- Infrared is used:
 - In astronomy, to detect stars and other physical bodies in the universe,
 - For guidance in weapons systems, where the heat radiated from airplanes or missiles can be detected and used to guide missiles to targets.
 - In most new TV remote-control units, where special coded signals are transmitted by an infrared LED to the TV receiver to change channels, set the volume, and perform other functions.
 - In some of the newer wireless LANs and all fiber-optic communication.

Optical Spectrum: The Visible Spectrum

- Just above the infrared region is the **visible spectrum** we refer to as **light**.
- Red is low-frequency or long-wavelength light
- Violet is high-frequency or short-wavelength light.

Light waves' very high frequency enables them to handle a tremendous amount of information (the bandwidth of the baseband signals can be very wide)

Optical Spectrum: Ultraviolet

- Ultraviolet is not used for communication
- Its primary use is medical.

Bandwidth (BW) 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.

$BW = f_2 - f_1$

Ex. A Commonly used frequency range is 902 to 928 Mhz , What is the width of this band ?

Spectrum Management and Standards

- **Spectrum management** is provided by agencies set up by the United States and other countries to control spectrum use.
 - The Federal Communications Commission (FCC) and the National Telecommunications and Information Administration (NTIA) are two agencies that deal in spectrum management.
- **Standards** are specifications and guidelines necessary to ensure compatibility between transmitting and receiving equipment.

A Survey of Communications Applications

- Simplex
 - AM and FM broadcasting
 - Digital radio
 - TV broadcasting
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 - Digital television (DTV)
 - Cable television
 - Facsimile
 - Wireless remote control
 - Paging services
 - Navigation and direction-finding services
 - Telemetry
 - Radio astronomy
 - Surveillance
 - Music services
 - Internet radio and video
- Duplex
 - Telephones
 - Two-way radio
 - Radar
 - Sonar
 - Amateur radio/Citizens radio
 - Family Radio service
 - The Internet
 - Wide-area networks (WANs)
 - Metropolitan-area networks (MANs)
 - Local area networks (LANs)

The electronics industry is roughly divided into four major specializations:

- Communications (largest in terms of people employed and the dollar value of equipment purchased)
- Computers (second largest).
- Industrial controls.
- Instrumentation

Jobs and Careers in the Communication Industry

Types of Jobs

- Engineers design communication equipment and systems.
- Technicians install, troubleshoot, repair, calibrate, and maintain equipment.
- Engineering Technicians assist in equipment design, testing, and assembly.
- Technical sales representatives determine customer needs and related specifications, write proposals and sell equipment.
- Technical writers generate technical documentation for equipment and systems.
- Trainers develop programs, generate training and presentation materials, and conduct classroom training.

Engineering industries that accept electronic engineering graduates

Electronic engineering graduates are typically accepted into the following industries. However, different employers will have different requirements, so do check out companies individually.

- Aerospace industry
- Automotive industry
- Construction industry
- Defence industry
- Electronics industry
- Fast moving consumer goods industry
- Marine industry
- Oil and gas industry
- Pharmaceuticals industry
- Power generation industry
- Rail industry
- Telecoms
- Utilities industry

Functions

1. To fabricate and test electronic circuits Manufacturing, testing and maintenance of electronic devices and systems.
2. To understand the construction, identification, characteristics, specifications, merits, limitations and applications of electronic components and materials
3. To understand lines communication, audio and video communication, and microwave communication

Employment Opportunities

Electronic Exchanges, Department of Telecommunications, BSNL, Railways, Electricity Board are major employers of Electronics Engineers.

Industries manufacturing Electronics & Communication systems, PCB components, Computers and other electronic equipments.

Commercial organisation providing services, in repair & maintenance of Electronics & Computers.

Marketing and Sales Executives

Teaching / Research

Telecommunications

Broadcasting Networks

Semiconductor Companies