Introduction to Communication systems

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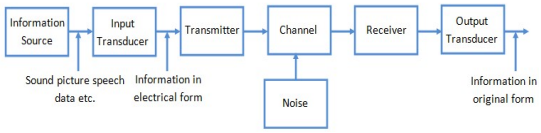
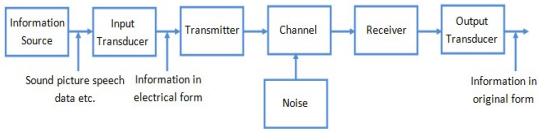
Basic Communication system



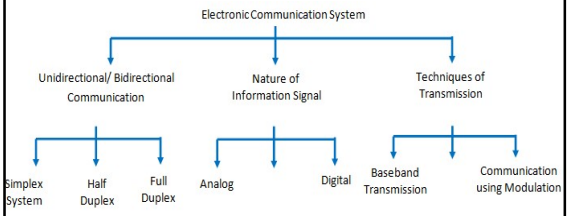
- Information Source or Input Signal (speech or music, or it can be in the form of pictures (TV signals) or it can be in the form of data information coming from the computer)
- Input Transducer (microphones and TV camera)
- Transmitter (amplifier, mixer, oscillator and power amplifier)

Basic Communication system

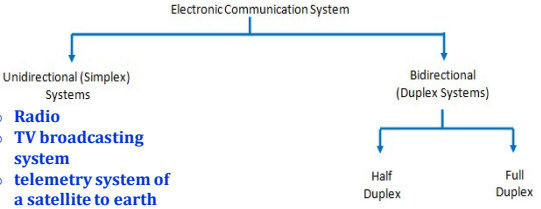


- Communication Channel or Medium
  - Wire Communication or line Communication (conducting wires, cables, optical fibres)
  - Wireless Communication or Radio Communication (free space)
- Noise (natural or manmade)
- Receiver (electronic circuits like mixer, oscillator, detector, amplifier)
- Output Transducer (loudspeakers picture tubes, computer monitor)

Classification of Electronic Communication Systems



Classification Based on Direction of Communication

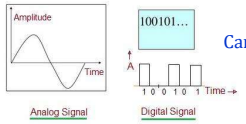


- **Radio**
- **TV broadcasting system**
- **telemetry system of a satellite to earth**

Transreceiver or Walky talky setradio communications such as those in military, firefighting, citizen band (CB) and amateur radio

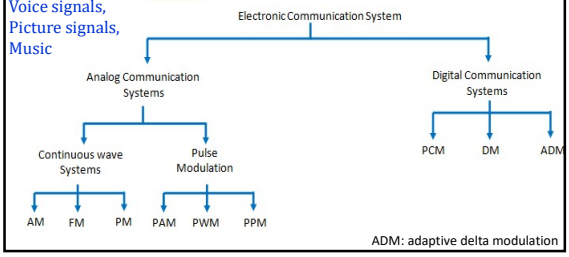
telephone systems

Classification Based on the Nature of Information Signal



Can be obtained from Computer

Voice signals, Picture signals, Music



ADM: adaptive delta modulation

Classification Based on the Nature of Information Signal

Analog signals	Digital data
The amplitude of a Analog signal changes continuously with time	The amplitude of a digital signal changes suddenly from 0 to 1 or from 1 to 0.
Voice signals, picture signals, music are the examples of analog signals.	Computer data is digital in nature.
Analog signal is an exact reproduction of the physical quantity.	Digital data is not the exact representation but it is always an approximation.
The error introduced in representing a physical quantity is very small.	Due to approximation there is a large error introduced in representing a physical quantity.
Bandwidth requirement for analog signal is less.	Large bandwidth is required to transmit digital data.

Classification Based on the Technique of Signal Transmission

- Baseband transmission system
- Communication systems using modulation

Baseband Signals

The information can be analog that is sound, picture or it can be digital e.g. the computer data. The electrical equivalent of this original information signal is known as the **baseband signal**.

Classification Based on the Technique of Signal Transmission

Baseband Transmission

- In baseband transmission systems, the baseband signals (original information signals) are directly transmitted.
- telephone networks
- computer data transmission over the coaxial cables in the computer networks. Thus, the baseband transmission is the transmission of the original information signal as it is.

Limitation of Baseband Transmission

- The baseband transmission cannot be used with certain mediums e.g., it cannot be used for the radio transmission where the medium is free space.
- for the radio communication of baseband signals, a technique called modulation is used.

Communication systems using modulation:

- two signals are used namely the modulating signal and the carrier.
- modulating signal is baseband signal carrier is a high frequency sinusoidal signal.
- In the modulation process, some parameter of the carrier wave (such as amplitude, frequency or phase) is varied in accordance with the modulating signal.
- This modulated signal is then transmitted by the transmitter.
- The receiver demodulates the received modulated signal and gets the original information signal back.
- Thus, demodulation is exactly opposite to modulation. In the process of modulation the carrier wave actually acts as carrier which carries the information signal from the transmitter to receiver.

Communication systems using modulation:

Depending on which parameter of the carrier is changed the modulation techniques are classified as follows:

a) Amplitude Modulation (AM):

Amplitude of carrier is varied, keeping its frequency and phase constant.

b) Frequency Modulation (FM):

Frequency of carrier is varied, keeping its amplitude and phase constant.

c) Phase Modulation (FM):

Phase of carrier is modified, keeping the other parameters amplitude and frequency constant.

Why do we need modulation?

In the process of modulation, the baseband signal is translated i.e., shifted from low frequency to high frequency. This frequency shift is proportional to the frequency of carrier.

Advantages of Modulation

1. Reduction in the height of antenna
2. Avoids mixing of signals
3. Increases the range of communication
4. Multiplexing is possible
5. Improves quality of reception

Reduction in the height of antenna

For the transmission of radio signals, the antenna height must be multiple of λ/4, where λ is the wavelength. λ = c /f; where c: is the velocity of light; f: is the frequency of the signal to be transmitted.

The minimum antenna height required to transmit a baseband signal of f = 10 kHz is calculated as follows :

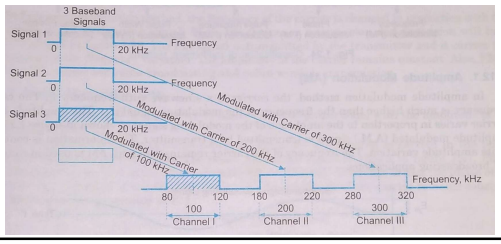
$$Minimum\ antenna\ height = \frac{\lambda}{4} = \frac{c}{4f} = \frac{3 \times 10^8}{4 \times 10 \times 10^3} = 7500\ meters\ i.e.\ 7.5\ km$$

Now, let us consider a modulated signal at f = 1 MHz . The minimum antenna height is given by,

$$Minimum\ antenna\ height = \frac{\lambda}{4} = \frac{c}{4f} = \frac{3 \times 10^8}{4 \times 1 \times 10^6} = 75\ meters$$

Avoids mixing of signals

If the baseband sound signals are transmitted without using the modulation by more than one transmitter, then all the signals will be in the same frequency range i.e. 0 to 20 kHz. Therefore, all the signals get mixed together and a receiver cannot separate them from each other. So, if each baseband sound signal is used to modulate a different carrier then they will occupy different slots in the frequency domain (different channels). Thus, modulation avoids mixing of signals.



3. Increases the range of communication

The frequency of baseband signal is low, and the low frequency signals cannot travel long distance when they are transmitted. They get heavily attenuated (suppressed). The attenuation reduces with increase in frequency of the transmitted signal, and they travel longer distance. The modulation process increases the frequency of the signal to be transmitted. Therefore, it increases the range of communication.

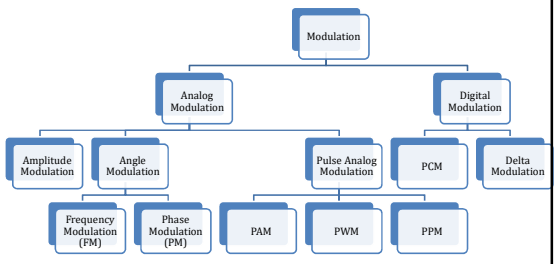
4. Multiplexing is possible

Multiplexing is a process in which two or more signals can be transmitted over the same communication channel simultaneously. This is possible only with modulation. The multiplexing allows the same channel to be used by many signals. Hence, many TV channels can use the same frequency range, without getting mixed with each other or different frequency signals can be transmitted at the same time.

5. Improves quality of reception

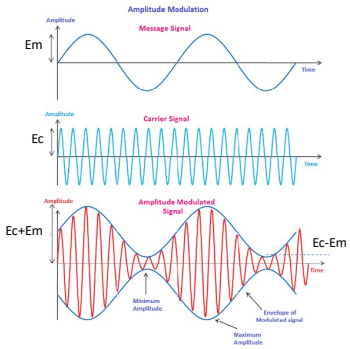
With frequency modulation (FM) and the digital communication techniques such as PCM, the effect of noise is reduced to a great extent. This improves quality of reception.

Different types of Modulation



Classification of Modulation techniques

Amplitude Modulation



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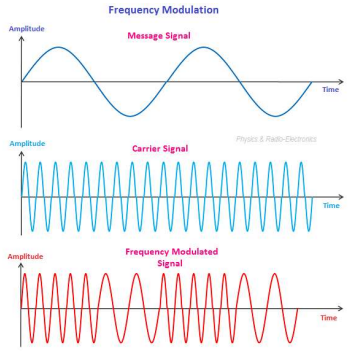
Frequency Modulation



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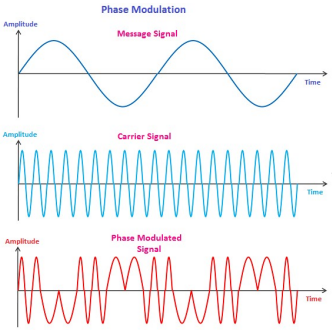
Phase Modulation



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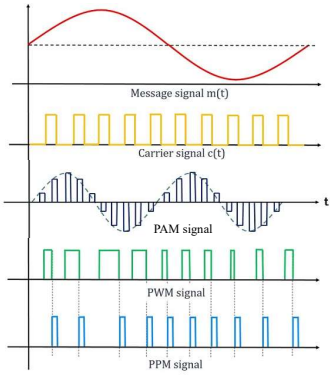
Pulse Analog Modulation: (PAM, PWM and PPM)

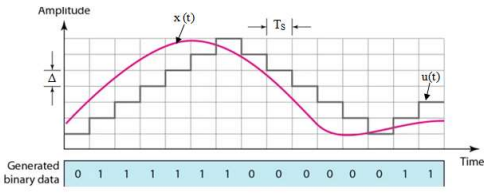


Pulse Code Modulation (PCM) and Delta Modulation (D.M.)

Pulse-code modulation or PCM is known as a digital pulse modulation technique. In fact, the pulse-code modulation is quite complex as compared to the analog pulse modulation techniques i.e. PAM, PWM and PPM, in the sense that the modulating signal is subjected to a great number of operations. In PCM an analog signal or information is converted into a binary sequence, i.e., '1's and '0's. The output of a PCM resembles a binary sequence. The digital communication has higher noise immunity than the analog communications.

Delta Modulation (D.M.)

A delta modulation (DM or Δ-modulation) is an analog-to-digital and digital-to-analog signal conversion technique used for transmission of voice information where quality is not of primary importance.

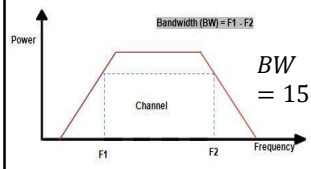


Demodulation or Detection:

The modulated signals are transmitted by the transmitter via air medium or wire medium. These signals reach the receivers by traveling over the communication medium. At the receiver, the original information signal is separated from the carrier. The process is called as demodulation or detection. Detection is exactly the opposite process of Modulation.

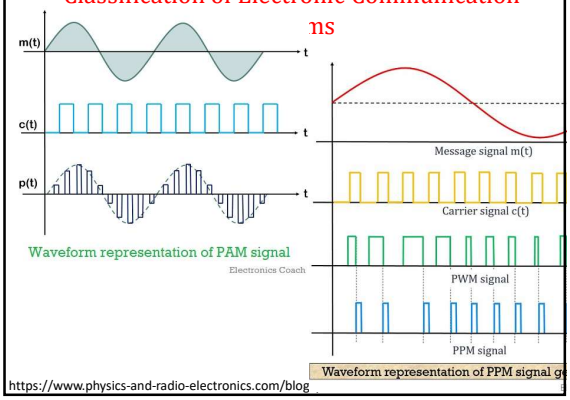
Concept of Bandwidth

The different types of baseband signals such as voice signal, music signal, TV signal etc. Each of these signals has its own frequency. This frequency range of a signal is known as its bandwidth. For example the range of music is 20 Hz to 15 kHz. Therefore as shown in Fig the bandwidth is (f_2-f_1)



$$BW = f_2 - f_1$$
$$= 15000 - 20 = 14980\ Hz$$

Classification of Electronic Communication ns



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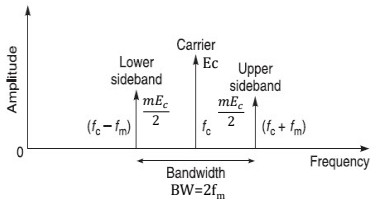

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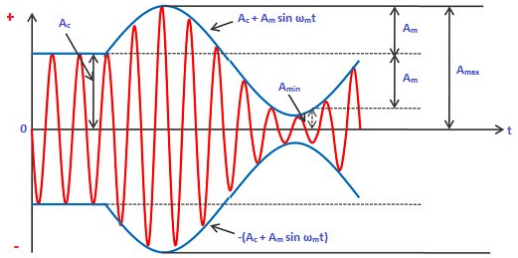

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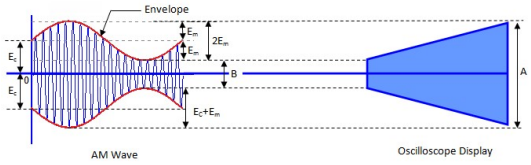
Calculation of modulation index using AM wave and Trapezoidal Display



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