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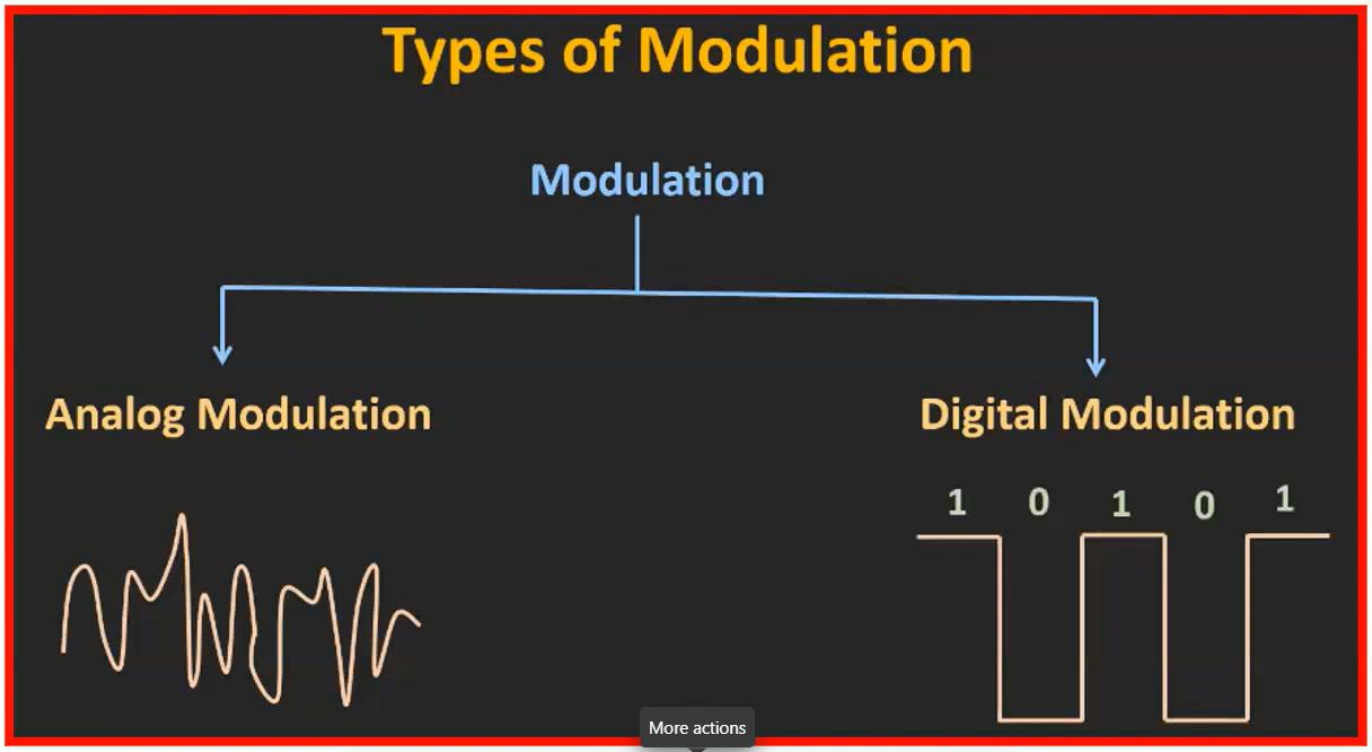
DIGITAL COMMUNICATION

- Prof. N. B. Kanirkar

- Digital Modulation


Types of Modulation
Modulation
Analog Modulation
Digital Modulation
1 0 1 0 1

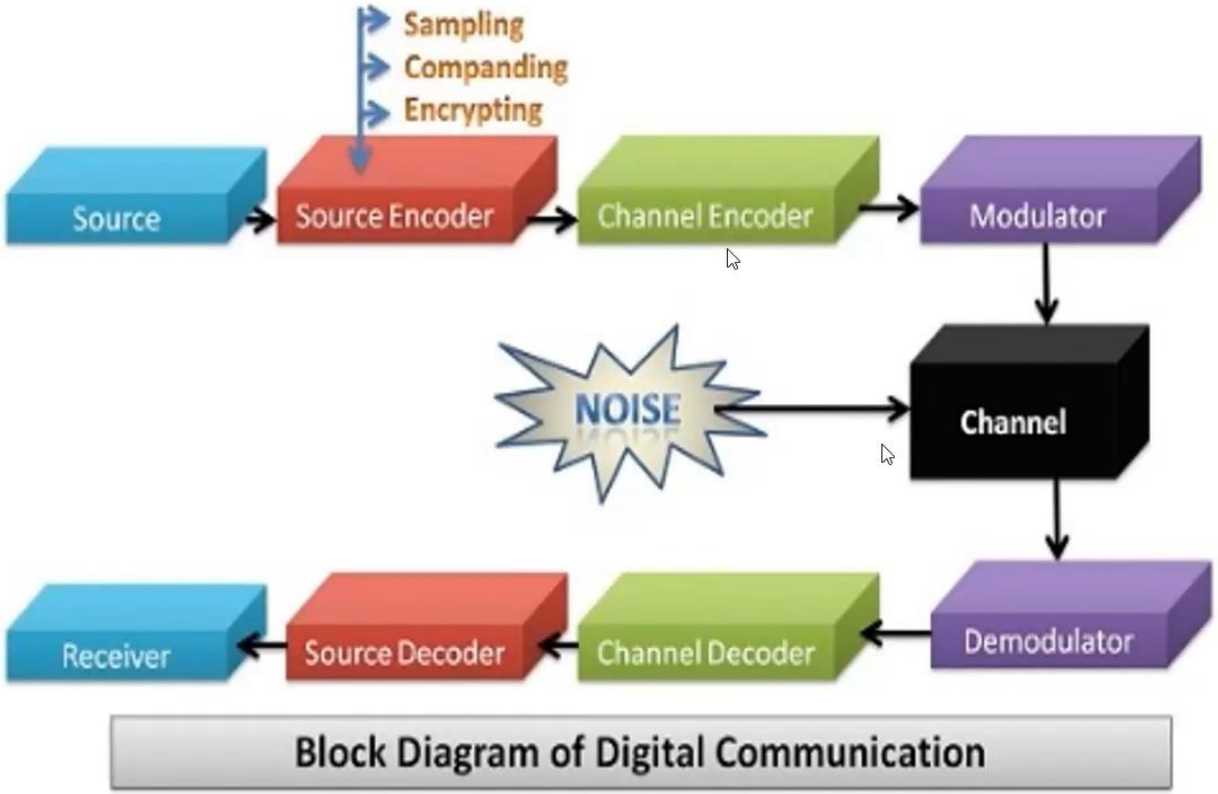
Definition of Digital Communication

Digital Communication is the one which uses digital signals for transmitting information between source and destination. Digital signals are represented by a square wave. This signal consists of discrete values rather than continuous values.

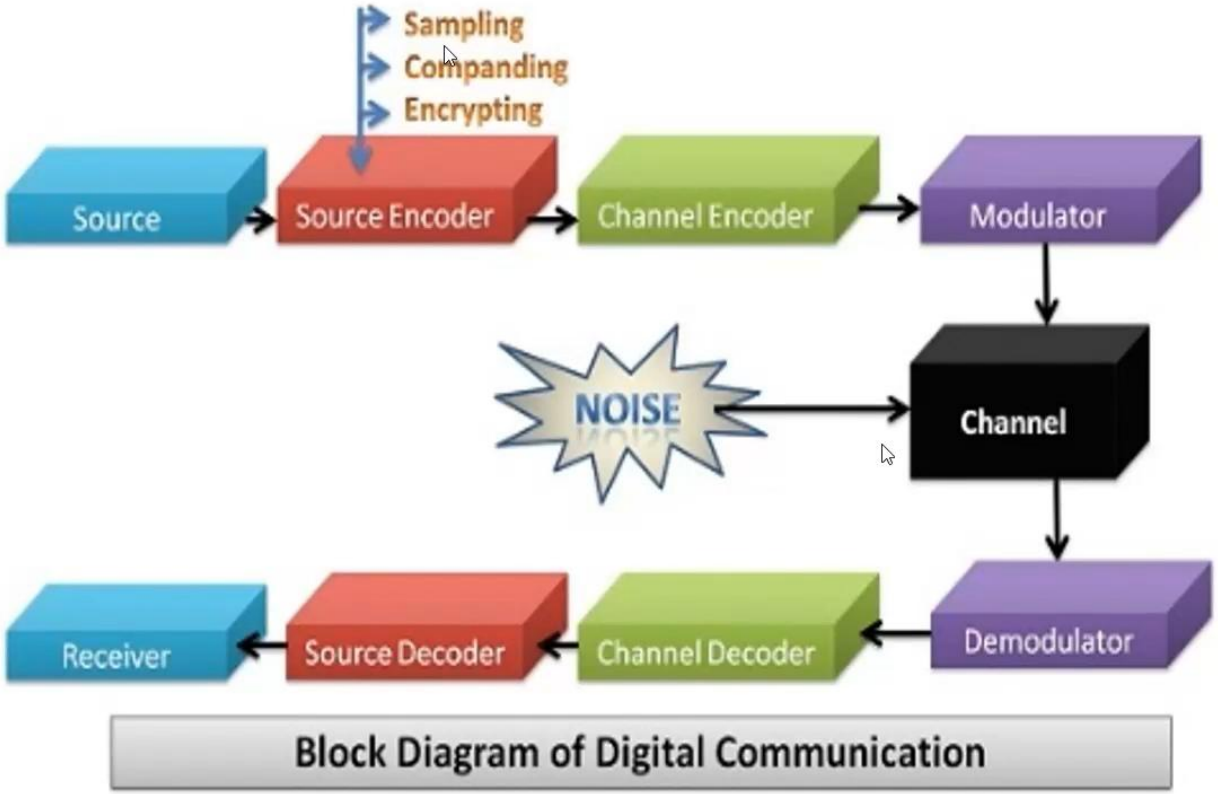
The digital signal is formed by the sampling of the analog signal. The samples of Analog signal are taken, and they are quantized. Digital signals usually consist of signals with two states **ON or OFF,** i.e. **1 & 0.** After the sampling and quantization, the digital signal so obtained is modulated by digital modulation techniques.

The significant advantage of using **Digital Communication** is that it is not deteriorated by channel noise. This is because the digital signal is not a continuously varying signal.

Thus, if noise affects mix with the digital signal, the original signal can be retrieved from the distorted signal. This is because if noise effects one of the points of the signal amplitude, we know the range in which that point lies because digital signal consists of discrete values.



Block Diagram of Digital Communication



Block Diagram of Digital Communication

Digital communication supports **higher noise immunity** than analog communication. But at the same time, digital data requires **more bandwidth** as compared to an analog signal.

In Digital communication, error detection and correction can be implemented easily. Digital modulation provides much more **efficient** results when compared to analog communication.

Digital Communication Types :

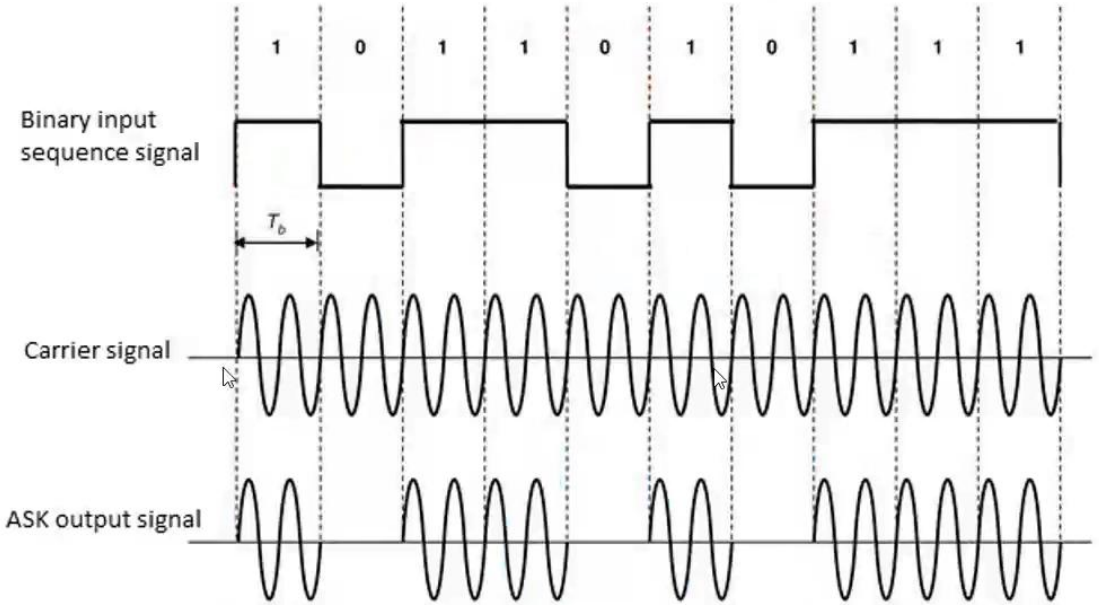
- ASK – Amplitude Shift Keying
- FSK – Frequency Shift Keying
- PSK – Phase Shift Keying

  BPSK, QPSK, 8PSK, 16PSK
- QAM – Quadrature Amplitude Modulation

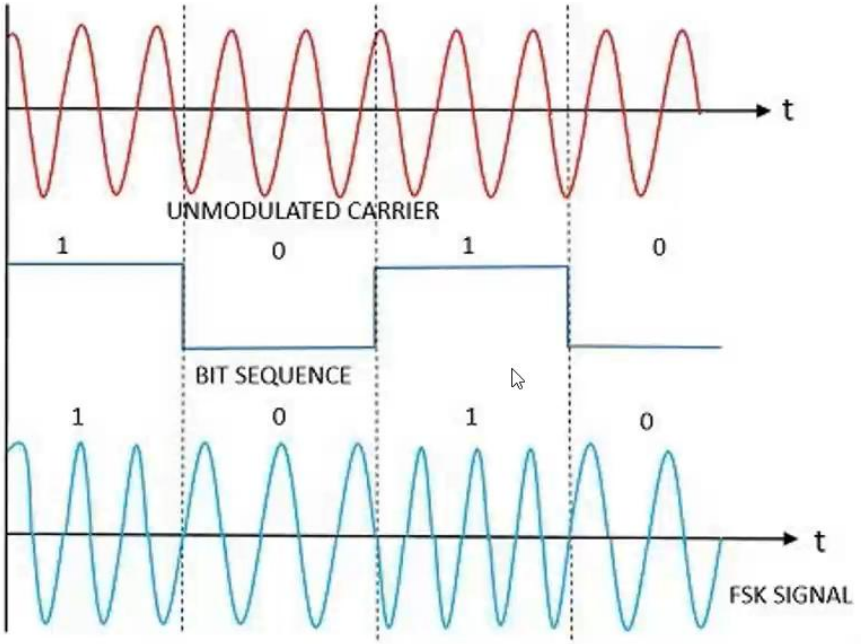
  Formats : *8QAM, 16QAM, 64QAM, 128QAM, 256QAM*

- ASK

Amplitude shift keying or ASK: The signal carrying digital bit stream is modulated with the amplitude of carrier signal.

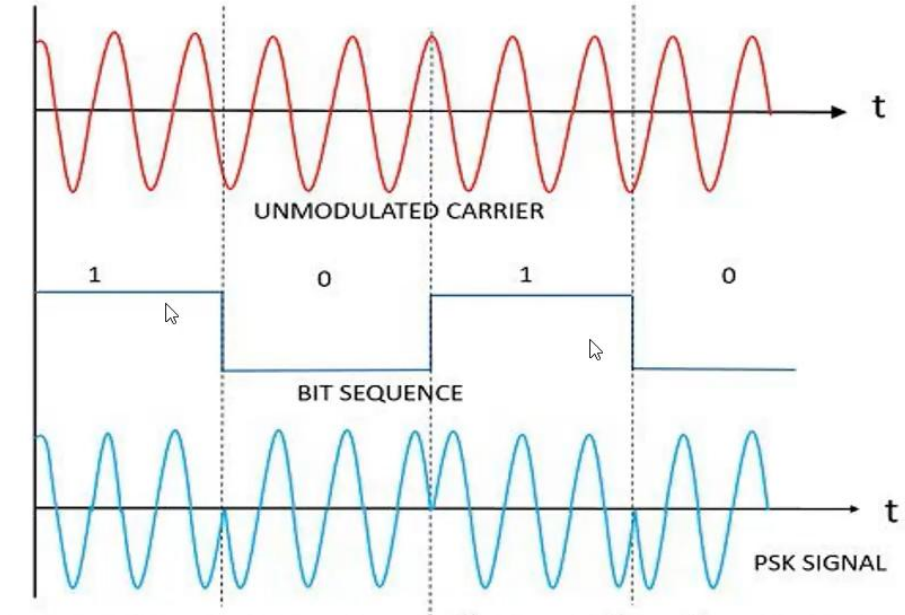


Frequency shift keying or FSK: In this, the frequency of carrier signal is varied according to the digital bit stream of information bearing signal.



FREQUENCY SHIFT KEYING WAVEFORM

Phase shift keying or PSK: This technique ensures the data to be transmitted in a more efficient manner as compared to FSK. In this, the phase of the carrier is varied with respect to the digital bit stream of the information signal.



PHASE SHIFT KEYING WAVEFORM

Mobile Phones / Cellular Telecommunications

- Cellular / mobile communication basics
- 3GPP
- 2G GSM
  - 2G GPRS
  - 2G GSM EDGE
- IS95 / cdmaOne
- 3G UMTS
  - 3G HSPA
- 4G LTE
  - LTE Advanced
- 5G technology
- 6G - next generation concepts

https://www.electronics-notes.com/articles/connectivity/6g-mobile-wireless-cellular/technology-basics.php

Wireless Connectivity

- WiFi - IEEE 802.11
- Bluetooth
- RFID: radio frequency identification
- NFC: near field communication
- IEEE 802.15.4
- WiMAX
- DECT
- SIGFOX
- LoRa
- Zigbee
- Z-Wave
- Wireless M bus
- WHDI

Wired Connectivity

- Erlang
- E carrier
- Optical fibre communications
- VoIP
- Networking fundamentals
- Cloud
- Network, functions virtualization, NFV
- Software defined networking, SDN
- SD-WAN
- ISDN
- Ethernet IEEE 802.3
- USB, Universal Serial Bus
- Serial data standards
  - RS232
  - RS422
  - RS449
  - RS485

Radio systems

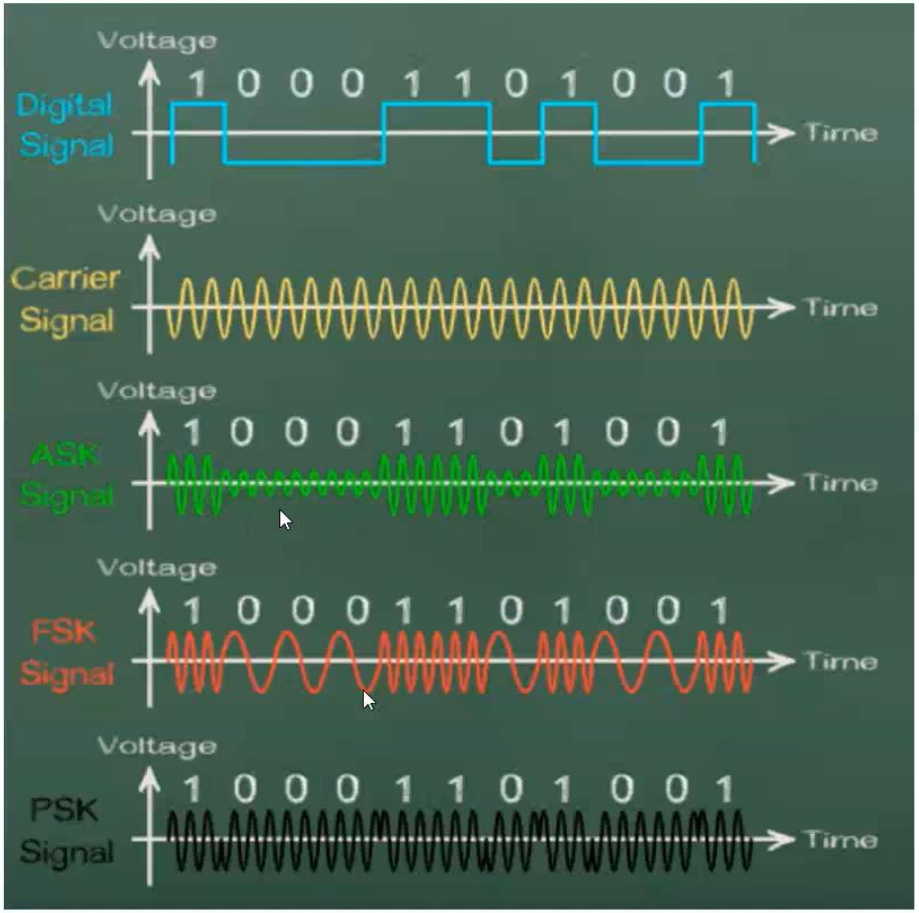
- Licence-free radio systems
- Land / private mobile radio summary
- TETRA
- DMR
- dPMR
- APCO P25
- NXDN

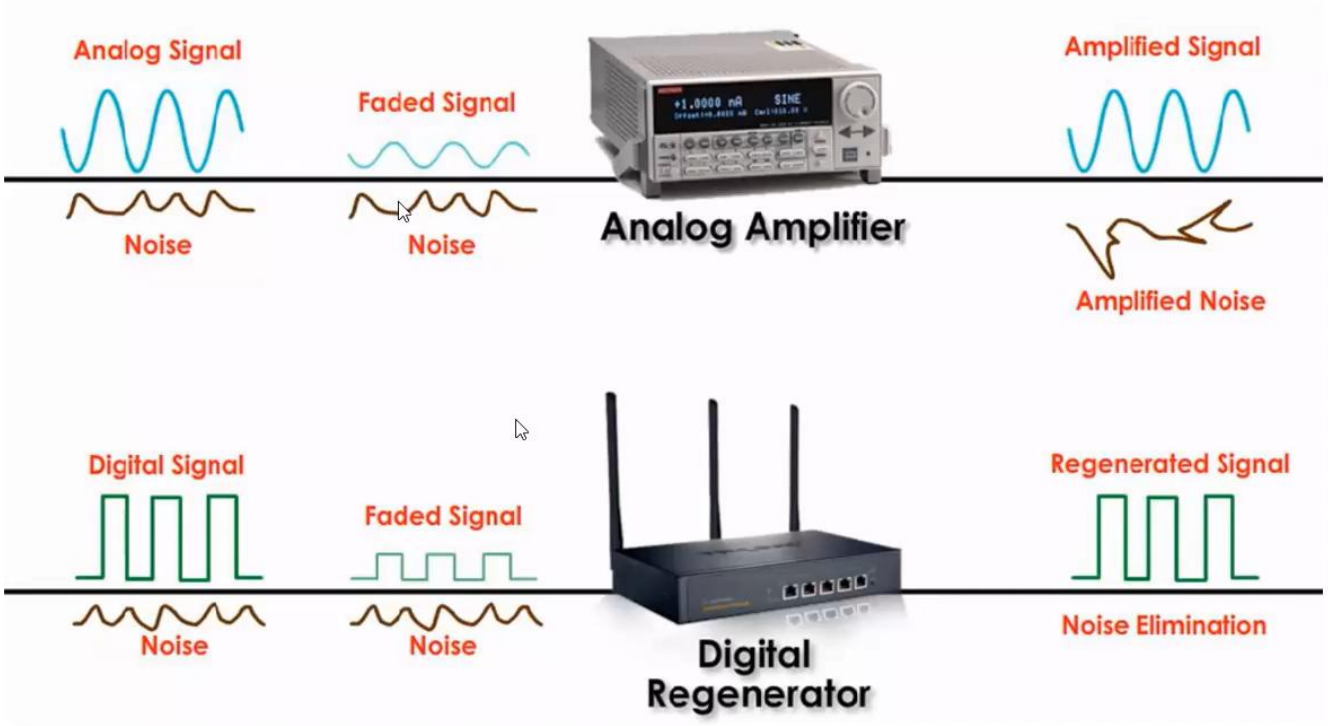
- Key Differences between Analog & Digital Communication

1. **Bandwidth:** This factor creates the key difference between Analog and Digital communication. Analog signal requires less bandwidth for the transmission while Digital signal requires more bandwidth for the transmission.
2. **Power Requirement:** Power requirement in case of Digital communication is less a compared to Analog communication. Since the bandwidth requirement in digital systems is more thus, they consume less power. And Analog communication system requires less bandwidth thus more power.
3. **Fidelity:** Fidelity is a factor which creates a crucial difference between Analog and digital communication. Fidelity is the ability of the receiver which receives the output exactly in coherence with that of transmitted input. Digital communication offers more fidelity as compared to Analog Communication.
4. **Hardware Flexibility:** The hardware of Analog communication system is not as flexible as Digital communication. The equipment used in digital technology are compact in size and consumes less power.
5. **Error Rate:** Error rate is another significant difference which separates Analog and Digital Communication. In Analog instruments, there is an error due to parallax or other kinds of observational method.
6. **Synchronization:** Digital communication system offers to synchronize which is not effective in Analog communication. Thus, synchronization also creates a key difference between Analog and Digital Communication.
7. **Cost:** Digital communication equipments are costly and Digital signal require more bandwidth for transmission.

- Comparison Chart

PARAMETERS	ANALOG COMMUNICATION	DIGITAL COMMUNICATION
Definition	Analog Communication is the technology which uses Analog signal for the transmission of information.	Digital Communication is the technology which uses digital signal for the transmission of information.
Noise and Distortion	Get affected by Noise	Immune from Noise and Distortion
Error Probability	Error Probability is high due to parallax.	Error Probability is low
Hardware	Hardware is complicated and less flexible than digital system.	Hardware is flexible and less complicated than Analog system.
Cost	Low Cost	High Cost
Bandwidth Requirement	Low bandwidth requirement	High bandwidth Requirement
Power Requirement	High power is required	Low Power Requirement
Portability	Less Portable as the components are heavy	More portable due to compact equipment.
Modulation Used	Amplitude and Angle Modulation	Pulse coded Modulation or PCM, DPCM etc.
Representation of Signal	Analog signal can be represented by sine wave.	Digital signal is represented by square wave.
Signal Values	Consists of continuous values	Consists of discrete values
Example of Signal	Analog signal comprises of voice, sound etc.	Digital signals are used in computers


Voltage
1 0 0 0 1 1 0 1 0 0 1
Digital Signal
Time
Voltage
Carrier Signal
Time
Voltage
1 0 0 0 1 1 0 1 0 0 1
ASK Signal
Time
Voltage
1 0 0 0 1 1 0 1 0 0 1
FSK Signal
Time
Voltage
1 0 0 0 1 1 0 1 0 0 1
PSK Signal
Time


Analog Signal
Noise
Faded Signal
Noise
Analog Amplifier
Amplified Signal
Amplified Noise
Digital Signal
Noise
Faded Signal
Noise
Digital Regenerator
Regenerated Signal
Noise Elimination