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Assignment 3

Assignment: Please describe the digital communication process.

Answer:

Digital Communication - Analog to Digital

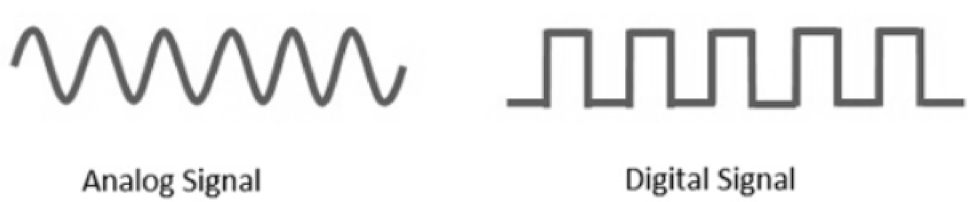
The communication that occurs in our day-to-day life is in the form of signals. These signals, such as sound signals, generally, are analog in nature. When the communication needs to be established over a distance, then the analog signals are sent through wire, using different techniques for effective transmission.

The Necessity of Digitization

The conventional methods of communication used analog signals for long distance communications, which suffer from many losses such as distortion, interference, and other losses including security breach.

In order to overcome these problems, the signals are digitized using different techniques. The digitized signals allow the communication to be more clear and accurate without losses.

The following figure indicates the difference between analog and digital signals. The digital signals consist of **1s** and **0s** which indicate High and Low values respectively.



Representation of Signals

Advantages of Digital Communication

As the signals are digitized, there are many advantages of digital communication over analog communication, such as −

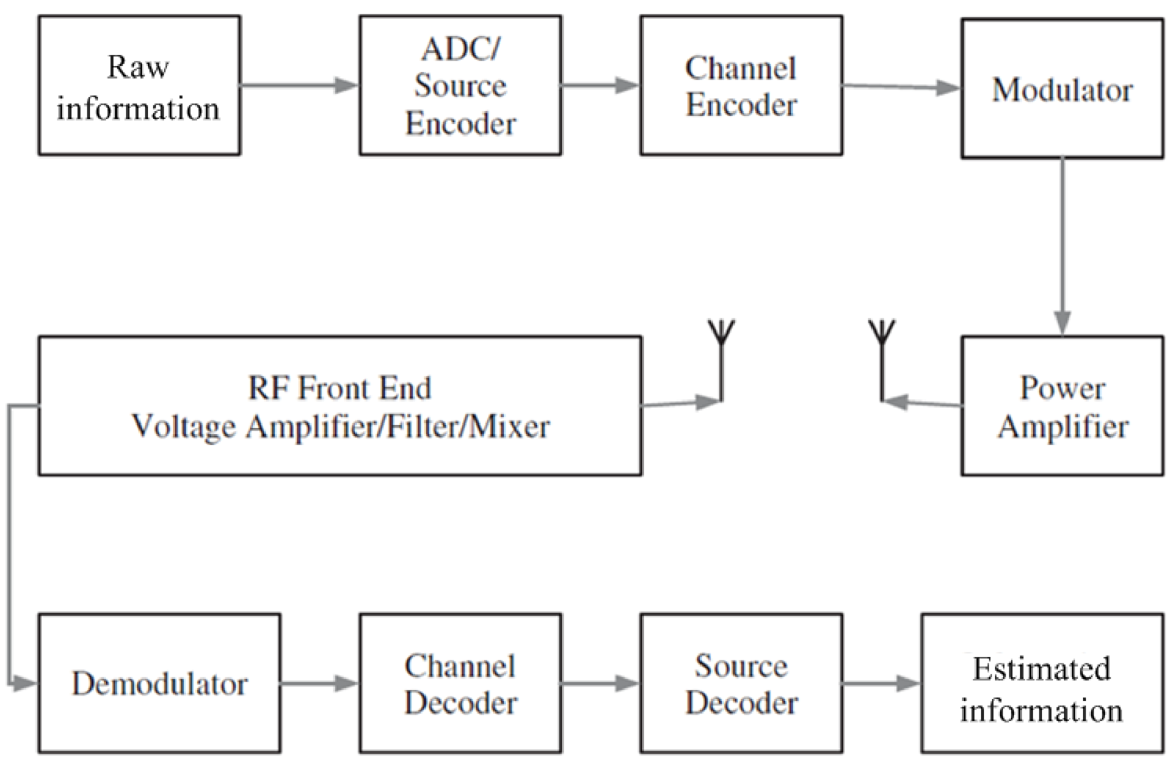
- The effect of distortion, noise, and interference is much less in digital signals as they are less affected.
- Digital circuits are more reliable.
- Digital circuits are easy to design and cheaper than analog circuits.
- The hardware implementation in digital circuits, is more flexible than analog.
- The occurrence of cross-talk is very rare in digital communication.
- The signal is un-altered as the pulse needs a high disturbance to alter its properties, which is very difficult.
- Signal processing functions such as encryption and compression are employed in digital circuits to maintain the secrecy of the information.
- The probability of error occurrence is reduced by employing error detecting and error correcting codes.
- Spread spectrum technique is used to avoid signal jamming.

Digital communication process

–Source encoding

–Modulation/Demodulation

Digital communication process(conversion between information and signal)



•Source encoding

–Transform an analog signal into a digital sequence

–Sampling: convert the continuous-time analog waveform to discrete-time sequence (but still continuous-valued).

–Quantization: convert each continuous-valued symbol to discrete-valued representatives

–Encoding: remove the redundancy in the data and generate roughly i.i.d.uniformly distributed bits

•Channel encoding

–Add some redundancy to facilitate the detection and correctness of bit errors through a wireless channel

•Modulation

–Change one or more parameters of a periodic waveform according to the bit sequences (the wave carries the information of bit sequences, i.e., ***carrier signal***)

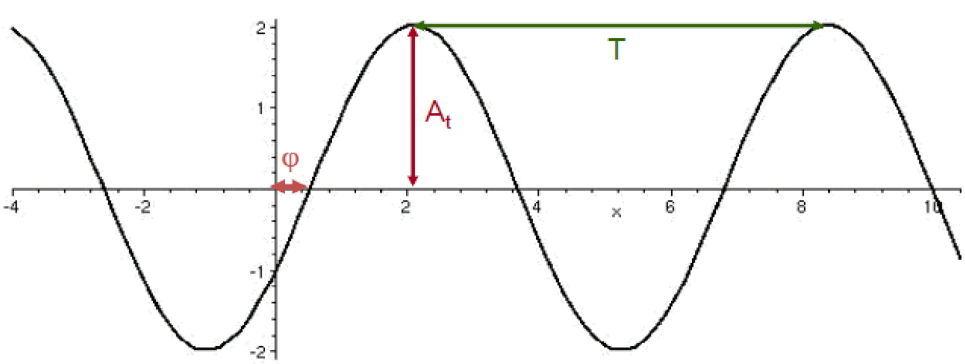
–Changed parameter becomes a function of time

–Sine/Cosine wave is used as the periodic waveform (carrier signal), a starting point for modulating the signal onto it

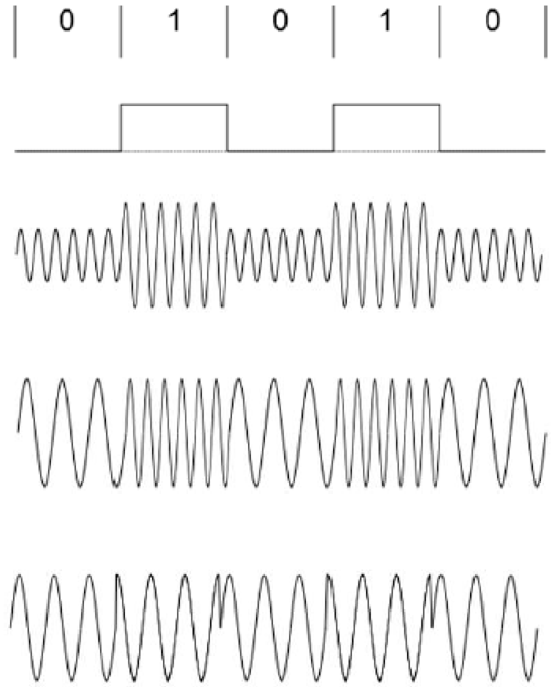
–This periodic waveform has a ***center frequency fc***

–The resulting signal requires a certain ***bandwidth*** to be transmitted (centered around center frequency)

- Parameters of a sine wave
  - $s(t) = A\sin(2\pi f t + \varphi)$
  - A: amplitude   φ: phase shift
  - f: frequency = 1/T   T: period



- Typical modulation types



  - ***Amplitude Shift Keying :*** Use data to modify the amplitude of a carrier signal
  - ***Frequency Shift Keying :*** Use data to modify the frequency of a carrier signal
  - ***Phase Shift Keying :*** Use data to modify the phase of a carrier signal

- Amplitude Shift Keying (ASK)
  - Let $E_i(t)$ be the symbol energy at time t, constant over [0, T]

$$s_i(t) = \sqrt{\frac{2E_i(t)}{T}} \cdot \sin(\omega_0 t + \phi)$$

  - Ei(t) is one of m different levels; Example: E0(t) = 1and E1(t)=2 represent logical zeros and ones, respectively. For data string 110100101, signal is modulated

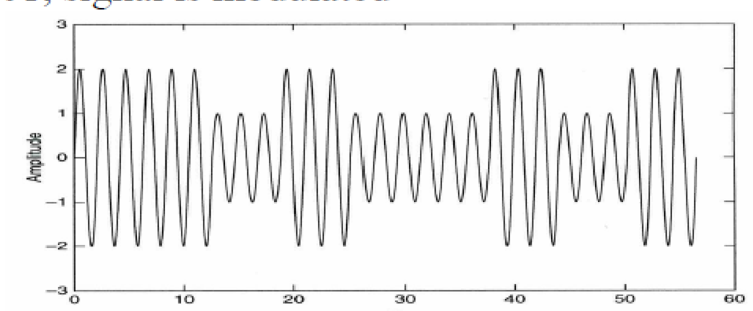


Figure 4.2 Amplitude shift keying (ASK) example

- Frequency Shift Keying (FSK)
  - For frequency signals $\omega_i(t)$

$$s_i(t) = \sqrt{\frac{2E}{T}} \cdot \sin(\omega_i(t) \cdot t + \phi)$$

  - For data string 110100101, signal is modulated

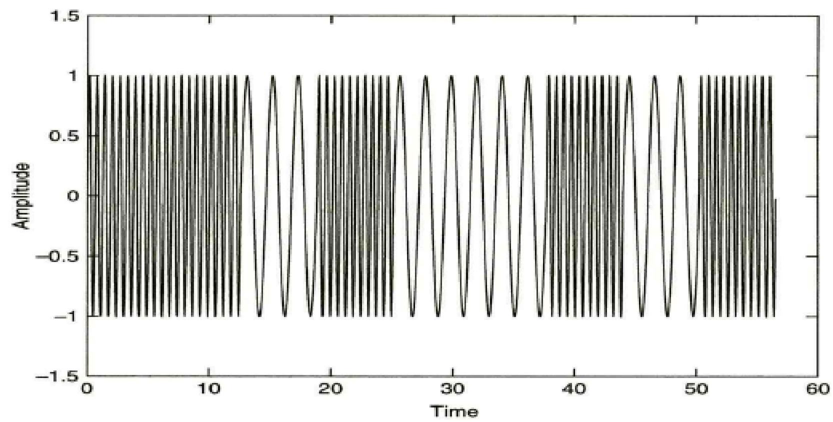


Figure 4.4 Frequency shift keying (FSK) example

- Phase Shift Keying (PSK)
  - For phase signals $\phi_i(t)$

$$s_i(t) = \sqrt{\frac{2E}{T}} \cdot \cos\left[\omega_0 t + \phi_i(t)\right]$$

  - For data string 110100101, signal is modulated

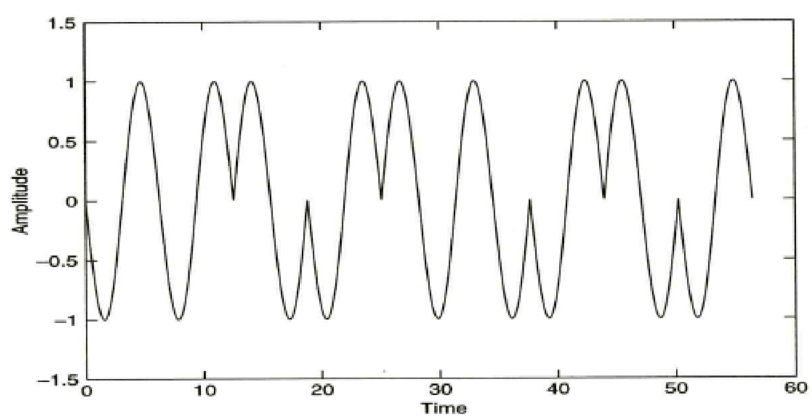


Figure 4.3 Phase shift keying (PSK) example