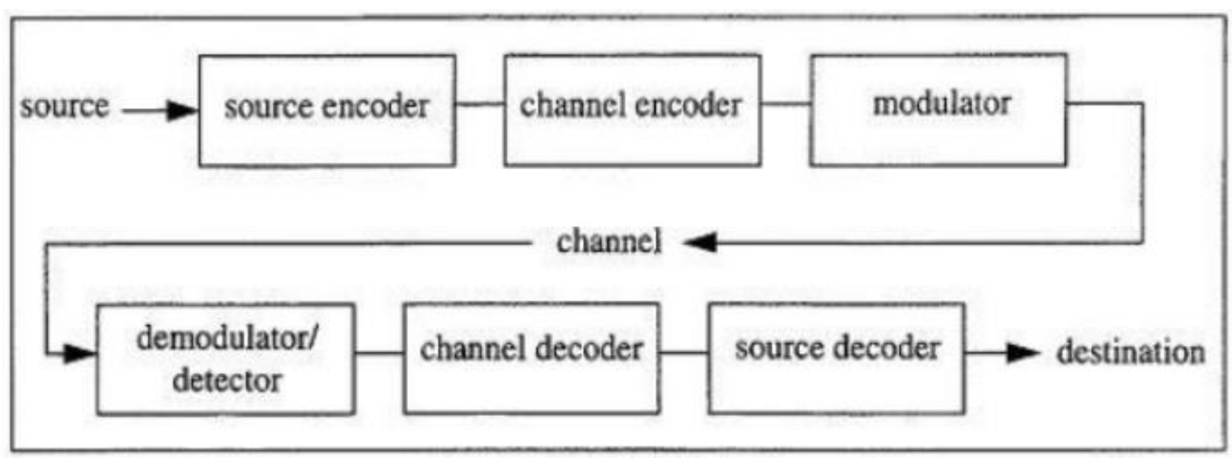
4.2 Analog - Digital Transmission System

1. Analog vs. Digital Transmission:

Compare at two levels:

1. Data—continuous (audio) vs. discrete (text)

2. Signaling—continuously varying electromagnetic wave vs. sequence of voltage pulses.



Basic communication systems

• Improving digital technology

• Data integrity. Repeaters take out cumulative problems in transmission.

• Can thus transmit longer distances.

• Easier to multiplex large channel capacities with digital

• Easy to apply encryption to digital data

• Better integration if all signals are in one form. It is difficult to integrate voice, video and digital data.

Analog Transmission

- An analog wave form (or signal) is characterized by being continuously variable along amplitude and frequency.
- Analog facilities have limited bandwidth, which means they cannot support high-speed data.
- Another characteristic of analog transmission is that noise is accumulated as the signal traverses the network. As the signal moves across the distance, it loses power and becomes impaired by factors such as moisture.
- By the time the signal arrives at the amplifier, it is not only attenuated, it is also impaired and noisy ending up with very high error rates.

Digital Transmission

- Digital transmission is quite different from analog transmission.
- For one thing, the signal is much simpler.
- Rather than being a continuously variable wave form, it is a series of discrete pulses, representing one bits and zero bits.
- Digital networks use regenerative repeaters.
- The repeater regenerates the weak and impaired signal to pass on to the next point in the network, in the essence eliminating noise and thus vastly improving the error rate.

Digital Transmission of Analog Signals

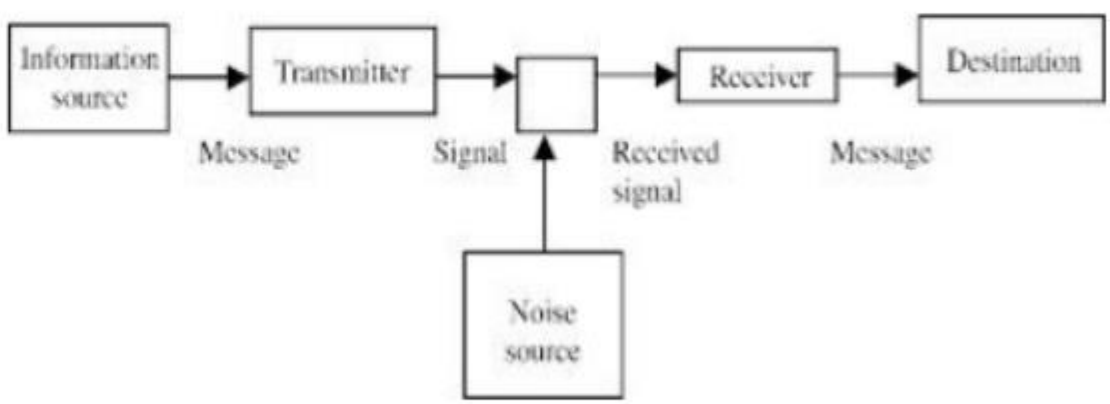
- To transmit analog message signals, such as voice and video signals, by digital means, the signal has to be converted to a digital signal.

- This process is known as the analog-to-digital conversion, or sometimes referred as digital pulse modulation.
- Two important techniques of analog-to-digital conversion are Pulse Code Modulation (PCM) and Delta Modulation (DM).

2. Digital Data/Analog Signals:

Must convert digital data to analog signal such device is a modem to translate between bit-serial and modulated carrier signals?

To send digital data using analog technology, the sender generates a carrier signal at some continuous tone (e.g. 1-2 kHz in phone circuits) that looks like a sine wave. The following techniques are used to encode digital data into analog signals.



Digital /Analog Transmitter & receiver

Resulting bandwidth is centered on the carrier frequency.

• **Amplitude-shift modulation (keying):** vary the amplitude (e.g. voltage) of the signal. Used to transmit digital data over optical fiber.

• **Frequency-shift modulation:** two (or more tones) are used, which are near the carrier frequency. Used in a full-duplex modem (signals in both directions).

- **Phase-shift modulation:** systematically shift the carrier wave at uniformly spaced intervals. For instance, the wave could be shifted by 45, 135, 225, 315 degree at each timing mark. In this case, each timing interval carries 2 bits of information. Why not shift by 0, 90, 180, 270? Shifting zero degrees means no shift, and an extended set of no shifts leads to clock synchronization difficulties.

Frequency division multiplexing (FDM): Divide the frequency spectrum into smaller subchannels, giving each user exclusive use of a subchannel (e.g., radio and TV). One problem with FDM is that a user is given all of the frequency to use, and if the user has no data to send, bandwidth is wasted — it cannot be used by another user.

Time division multiplexing (TDM): Use time slicing to give each user the full bandwidth, but for only a fraction of a second at a time (analogous to time sharing in operating systems). Again, if the user doesn't have data to sent during his time slice, the bandwidth is not used (e.g., wasted).

Statistical multiplexing: Allocate bandwidth to arriving packets on demand. This leads to the most efficient use of channel bandwidth because it only carries useful data. That is, channel bandwidth is allocated to packets that are waiting for transmission, and a user generating no packets doesn't use any of the channel resources.