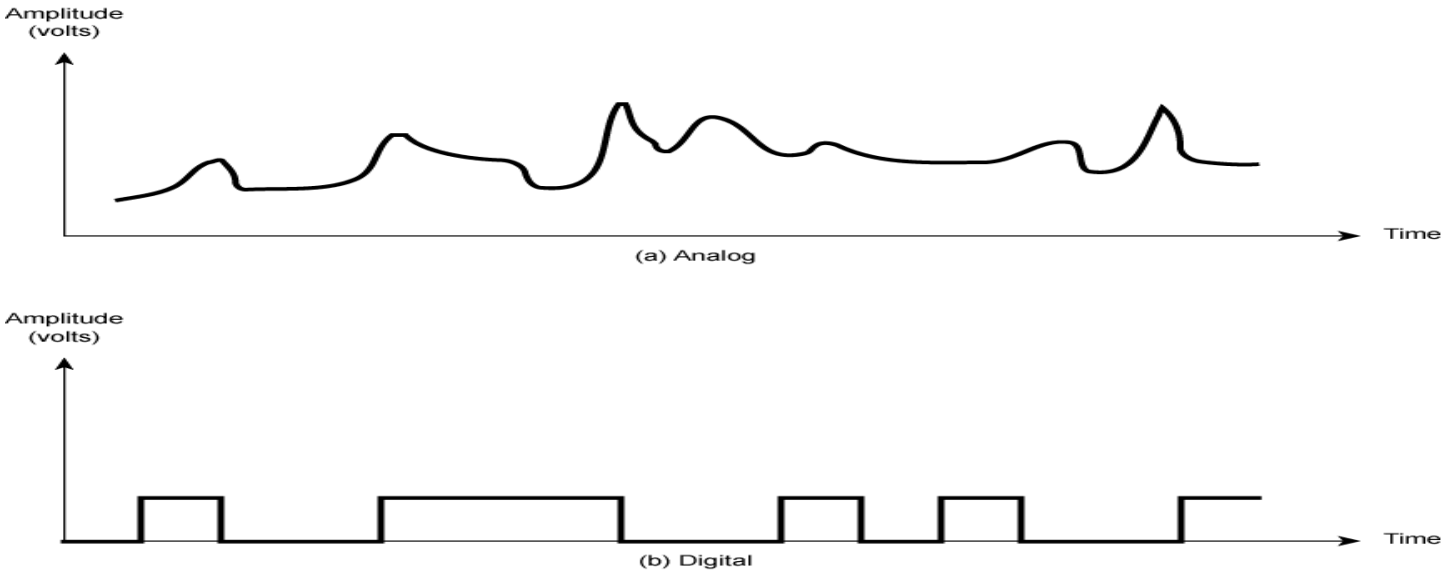
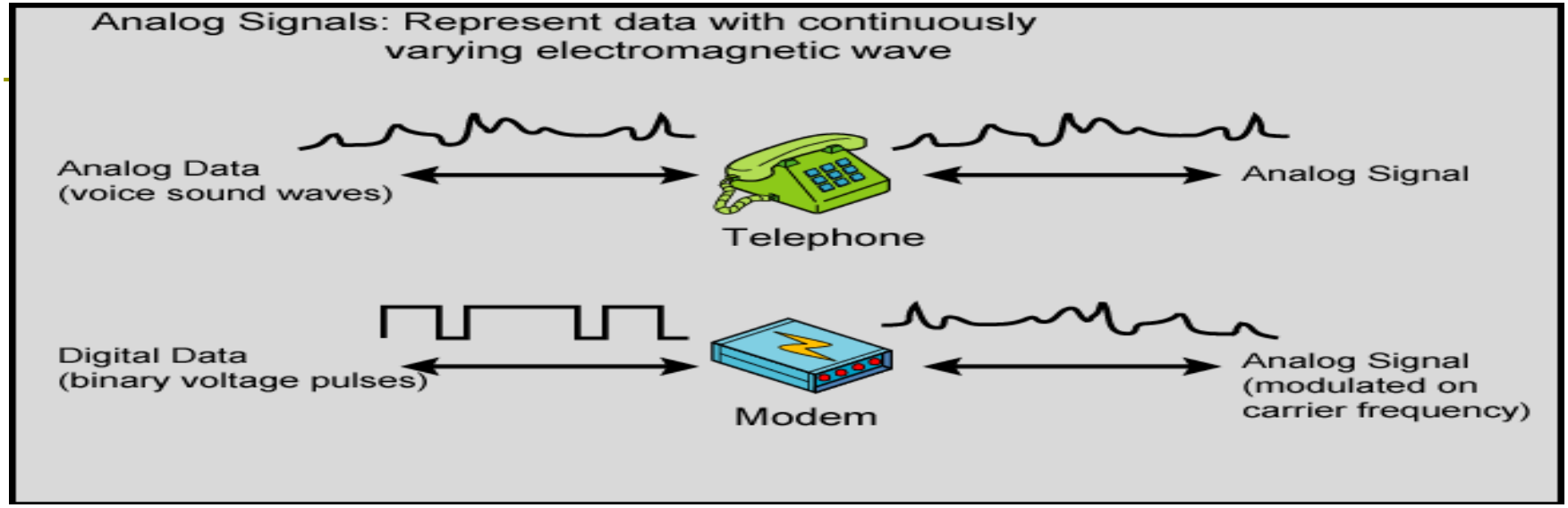
Analog and Digital Data Transmission

- Data - entities that convey meaning or information
- Signals & Signalling
  - **Signals** are electric or electromagnetic representations of data, physically propagates along medium
  - **Signaling** is the physical propagation of the signal along a suitable medium.
- Transmission
  - communication of data by propagation and processing of signals

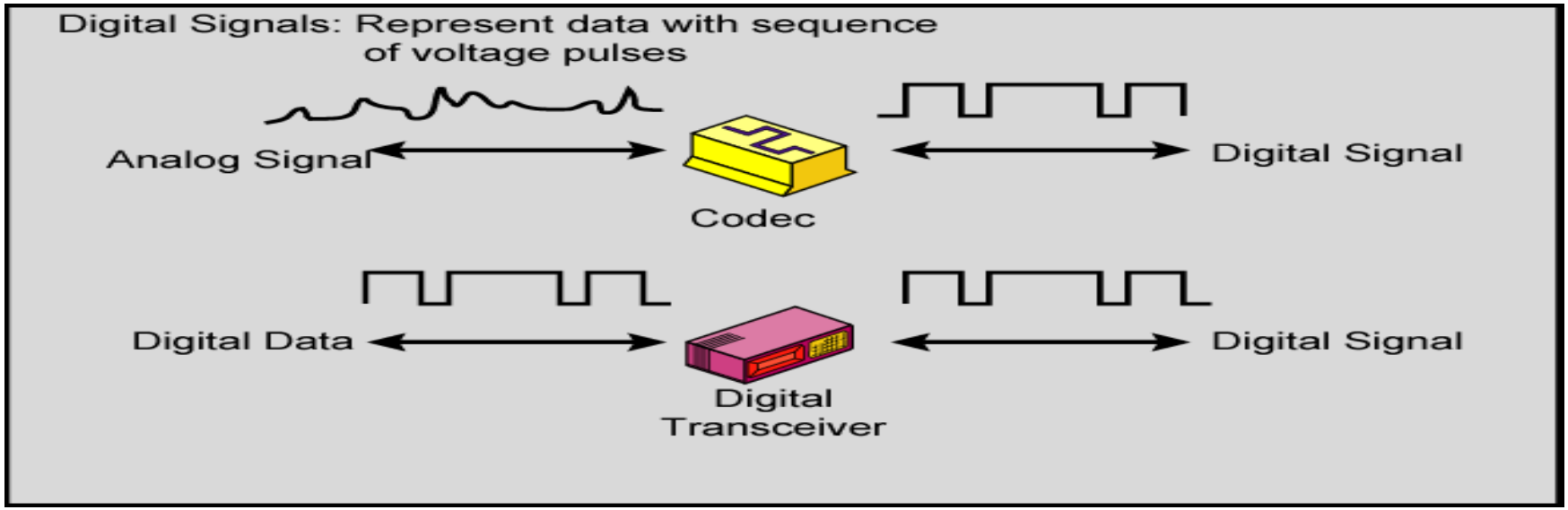
Analogue & Digital Signals



Analog Signals



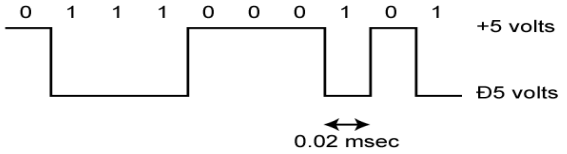
Digital Signals



Analog Signals

- In a communications system, data are propagated from one point to another by means of electromagnetic signals. Both analog and digital signals may be transmitted on suitable transmission media.
- An **analog signal** is a continuously varying electromagnetic wave that may be propagated over a variety of media, depending on spectrum; examples are wire media, such as twisted pair and coaxial cable; fiber optic cable; and unguided media, such as atmosphere or space propagation.
- In the figure, analog signals can be used to transmit both analog data represented by an electromagnetic signal occupying the same spectrum, and digital data using a modem (modulator/demodulator) to modulate the digital data on some carrier frequency.
- However, analog signal will become weaker (attenuate) after a certain distance. To achieve longer distances, the analog transmission system includes amplifiers that boost the energy in the signal. Unfortunately, the amplifier also boosts the noise components. With amplifiers cascaded to achieve long distances, the signal becomes more and more distorted. For analog data, such as voice, quite a bit of distortion can be tolerated and the data remain intelligible. However, for digital data, cascaded amplifiers will introduce errors.

Digital Signals



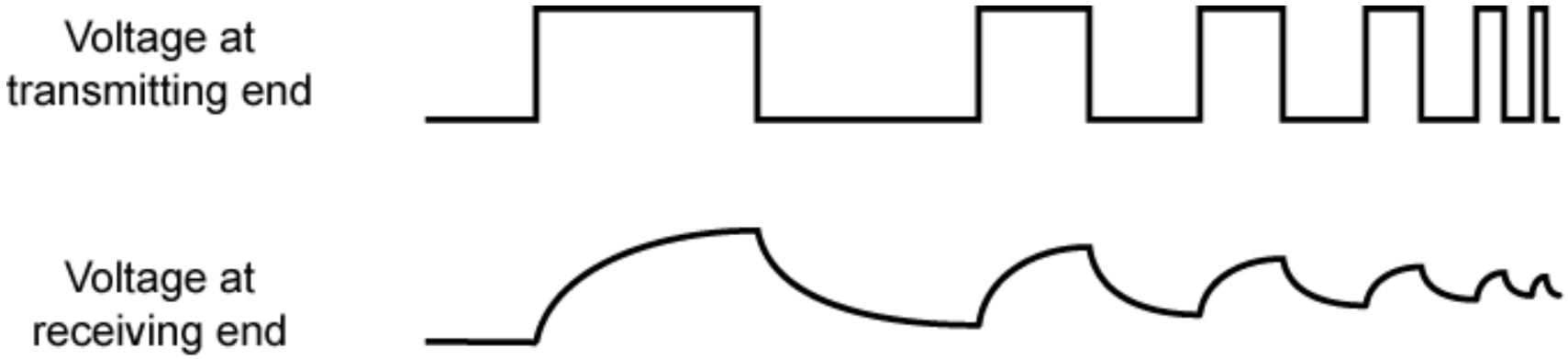
User input at a PC is converted into a stream of binary digits (1s and 0s). In this graph of a typical digital signal, binary one is represented by Ð5 volts and binary zero is represented by +5 volts. The signal for each bit has a duration of 0.02 msec, giving a data rate of 50,000 bits per second (50 kbps).

- A **digital signal** is a sequence of voltage pulses that may be transmitted over a wire medium; eg. a constant positive voltage level may represent binary 0 and a constant negative voltage level may represent binary 1.
- In the figure, digital signals can be used to transmit both analog signals and digital data. Analog data can converted to digital using a codec (coder-decoder), which takes an analog signal that directly represents the voice data and approximates that signal by a bit stream. At the receiving end, the bit stream is used to reconstruct the analog data. Digital data can be directly represented by digital signals.
- A digital signal can be transmitted only a limited distance before attenuation, noise, and other impairments endanger the integrity of the data. To achieve greater distances, repeaters are used. A repeater receives the digital signal, recovers the pattern of 1s and 0s, and retransmits a new signal. Thus the attenuation is overcome.

Advantages and disadvantages of Digital Signals

- cheaper
- less susceptible to noise
- but greater attenuation than analog signals
- digital now preferred choice

  Both long-haul telecommunications facilities and intra-building services have moved to digital transmission and, where possible, digital signaling techniques, for a range of reasons.



Digital Bandwidth

- Digital bandwidth is typically expressed in bits per second (bps)
- Digital bandwidth is determined using the bit interval and the bit rate
- Assuming we have a digital signal with a bit interval of 60 microseconds, what is its bandwidth?
  - The formula is expressed as: bps = $1 / (60 * 10^{-6})$, or approximately 16.6 Kbps (thousands of bits per second)

Guided and unguided media

- guided - wire / optical fibre
- unguided – wireless

- Guided – Makes use of cables
  - Twisted wire pair, coaxial cable, fiber optic

- Unguided – is “In the Air”
  - Terrestrial microwave, satellite, radio, infrared

- characteristics and quality determined by medium and signal
  - in unguided media - bandwidth produced by the antenna is more important
  - in guided media - medium is more important
- key concerns are data rate and distance
- the greater the data rate and distance the better.