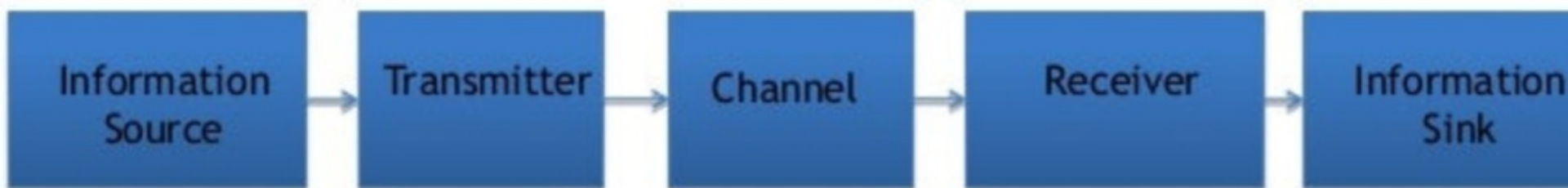# What is Communication?

- <u>Communication</u> is transferring data **reliably** from one point to another
  - Data could be: voice, video, codes etc...

- It is important to receive the same information that was sent from the transmitter.

- <u>Communication system</u>
  - A system that allows transfer of information realiably

Information Source	→	Transmitter	→	Channel	→	Receiver	→	Information Sink

Block Diagram of a typical communication system

- **Information Source**
  - The source of data
    - Data could be: human voice, data storage device CD, video etc..
  - Data types:
    - Discrete: Finite set of outcomes "Digital"
    - Continuous : Infinite set of outcomes "Analog"
- **Transmitter**
  - Converts the source data into a suitable form for transmission through signal processing
  - Data form depends on the channel

- Channel:
  - The physical medium used to send the signal
  - The medium where the signal propagates till arriving to the receiver
  - Physical Mediums (Channels):
    - Wired : twisted pairs, coaxial cable, fiber optics
    - Wireless: Air, vacuum and water
  - Each physical channel has a certain limited range of frequencies ,($f_{min} \rightarrow f_{max}$), that is called the channel bandwidth
  - Physical channels have another important limitation which is the **NOISE**

- Channel:
  - Noise is **<u>undesired random</u>** signal that corrupts the original signal and degrades it
  - Noise sources:
    - » Electronic equipments in the communication system
    - » Thermal noise
    - » Atmospheric electromagnetic noise (Interference with another signals that are being transmitted at the same channel)
- Another Limitation of noise is the attenuation
  - Weakens the signal strength as it travels over the transmission medium
  - Attenuation increases as frequency increases
- One Last important limitation is the delay distortion
  - Mainly in the wired transmission
  - Delays the transmitted signals → Violates the reliability of the communication system

- Receiver
  - Extracting the message/code in the received signal
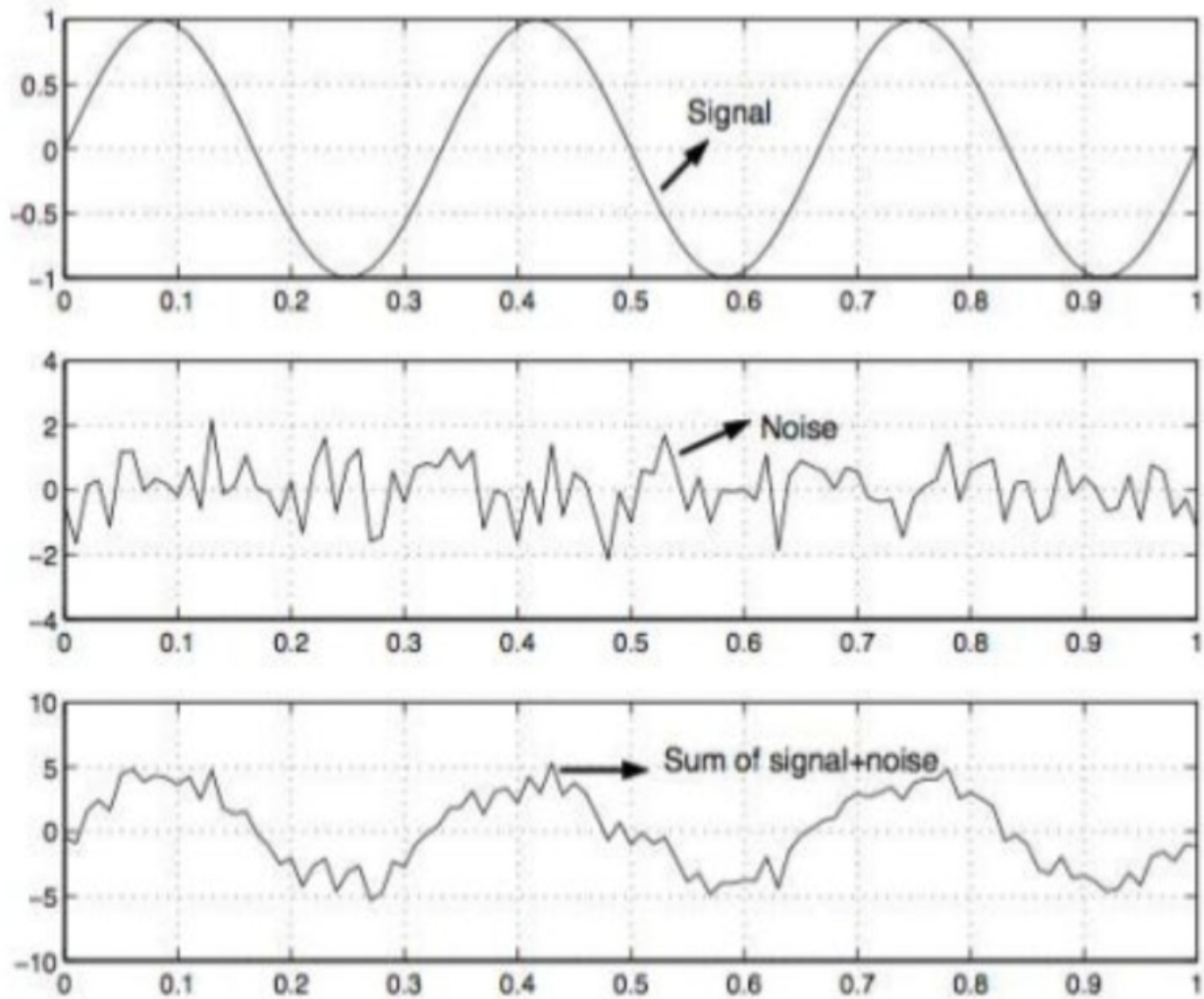   - Example
      - Speech signal at transmitter is converted into electromagnetic waves to travel over the channel
      - Once the electromagnetic waves are received properly, the receiver converts it back to a speech form
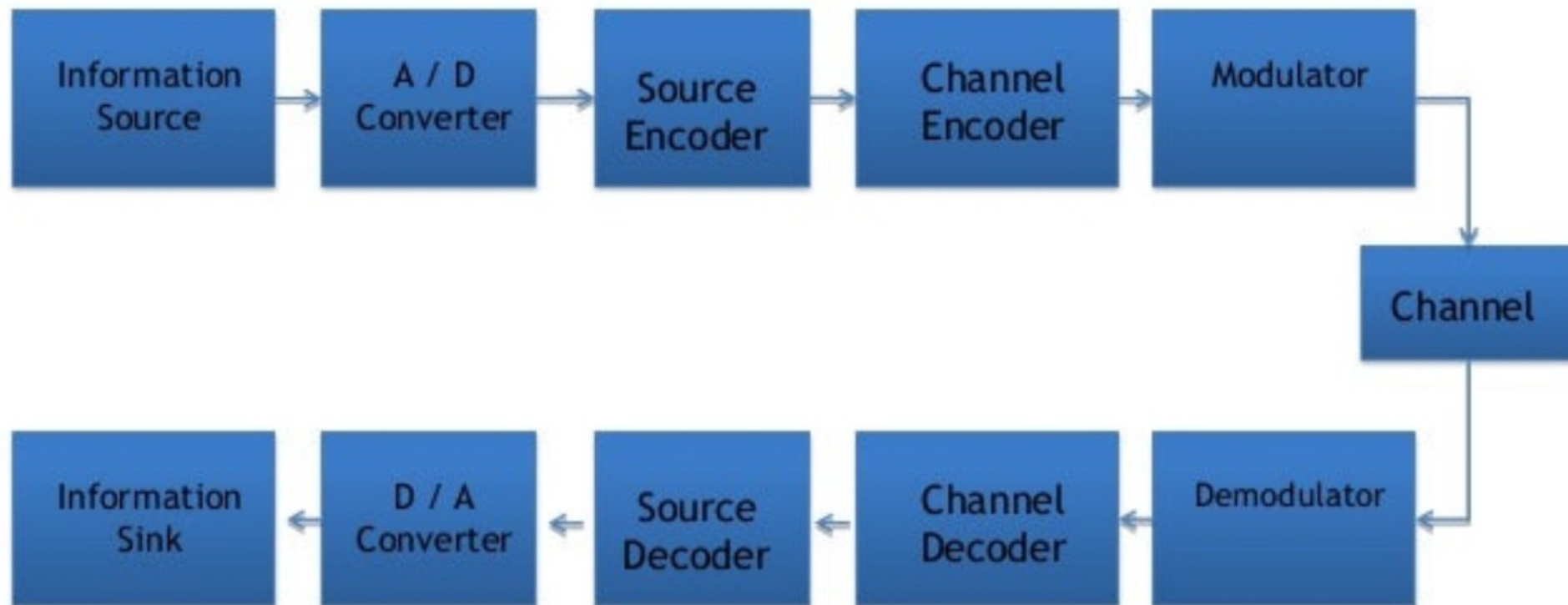 - Information Sink
    - The final stage
    - The user

Effect of Noise On a transmitted signal

Digital Communication System

- Data of a digital format "i.e binary numbers"

- Information source
  - Analog Data: Microphone, speech signal, image, video etc...
  - Discrete (Digital) Data: keyboard, binary numbers, hex numbers, etc...
- Analog to Digital Converter (A/D)
  - Sampling:
    - Converting continuous time signal to a digital signal
  - Quantization:
    - Converting the amplitude of the analog signal to a digital value
  - Coding:
    - Assigning a binary code to each finite amplitude in the

- Source encoder
  - Represent the transmitted data more efficiently and remove redundant information
    - How? "write Vs. rite"
    - Speech signals frequency and human ear "20 kHz"
  - Two types of encoding:
  - Lossless data compression (encoding)
    - Data can be recovered without any missing information
  - Lossy data compression (encoding)
    - Smaller size of data
    - Data removed in encoding can not be recovered again

- Channel encoder:
  - To control the noise and to detect and correct the errors that can occur in the transmitted data due the noise.

- Modulator:
  - Represent the data in a form to make it compatible with the channel
    - Carrier signal "high frequency signal"

- Demodulator:
  - Removes the carrier signal and reverse the process of the Modulator

- Channel decoder:
  - Detects and corrects the errors in the signal gained from the channel
- Source decoder:
  - Decompresses the data into it's original format.
- Digital to Analog Converter:
  - Reverses the operation of the A/D
  - Needs techniques and knowledge about sampling, quantization, and coding methods.
- Information Sink
  - The User

Why should we use digital communication?

- Ease of regeneration
  - Pulses " 0 , 1"
  - Easy to use repeaters
- Noise immunity
  - Better noise handling when using repeaters that repeats the original signal
  - Easy to differentiate between the values "either 0 or 1"
- Ease of Transmission
  - Less errors
  - Faster !
  - Better productivity

Why should we use digital communication?

- Ease of multiplexing
  - Transmitting several signals simultaneously
- Use of modern technology
  - Less cost !
- Ease of encryption
  - Security and privacy guarantee
  - Handles most of the encryption techniques

Disadvantage !

- The major disadvantage of digital transmission is that it requires a greater transmission bandwidth or channel bandwidth to communicate the same information in digital format as compared to analog format.

- Another disadvantage of digital transmission is that digital detection requires system synchronization, whereas analog signals generally have no such requirement.