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Principles of Communications System

Chapter 1 (part 1): Introduction To Communication System

By the end of this chapter you should be able to:

- Explain the basic concept of communication system
- Explain noise and effect of noise to a communication system
- Differentiate between time and frequency domain

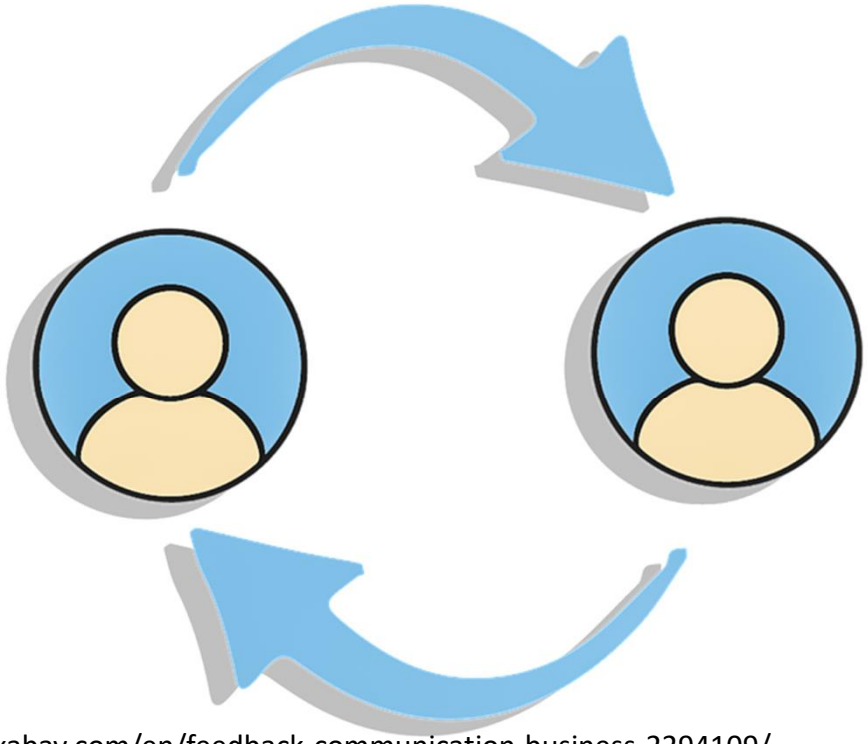


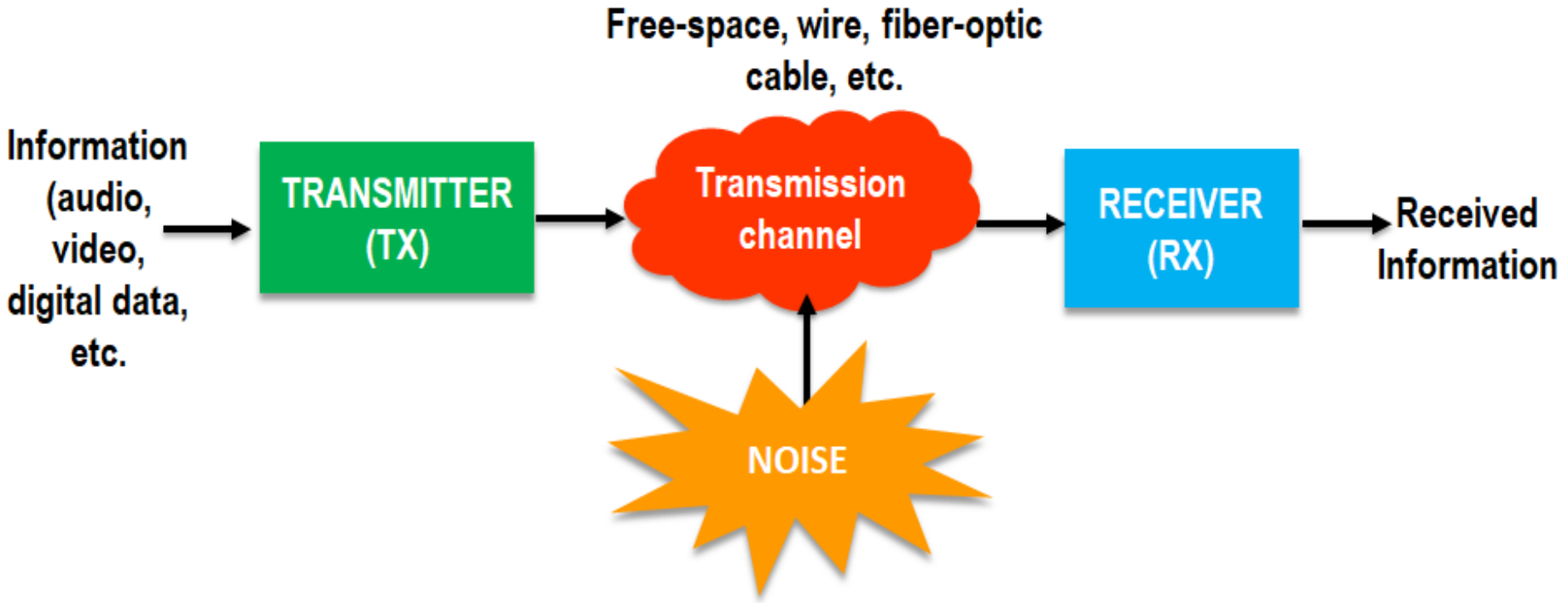
Image source: https://pixabay.com/en/feedback-communication-business-2294109/

1. What is communication?
2. What is electronic communication system?

Definition Of Communications

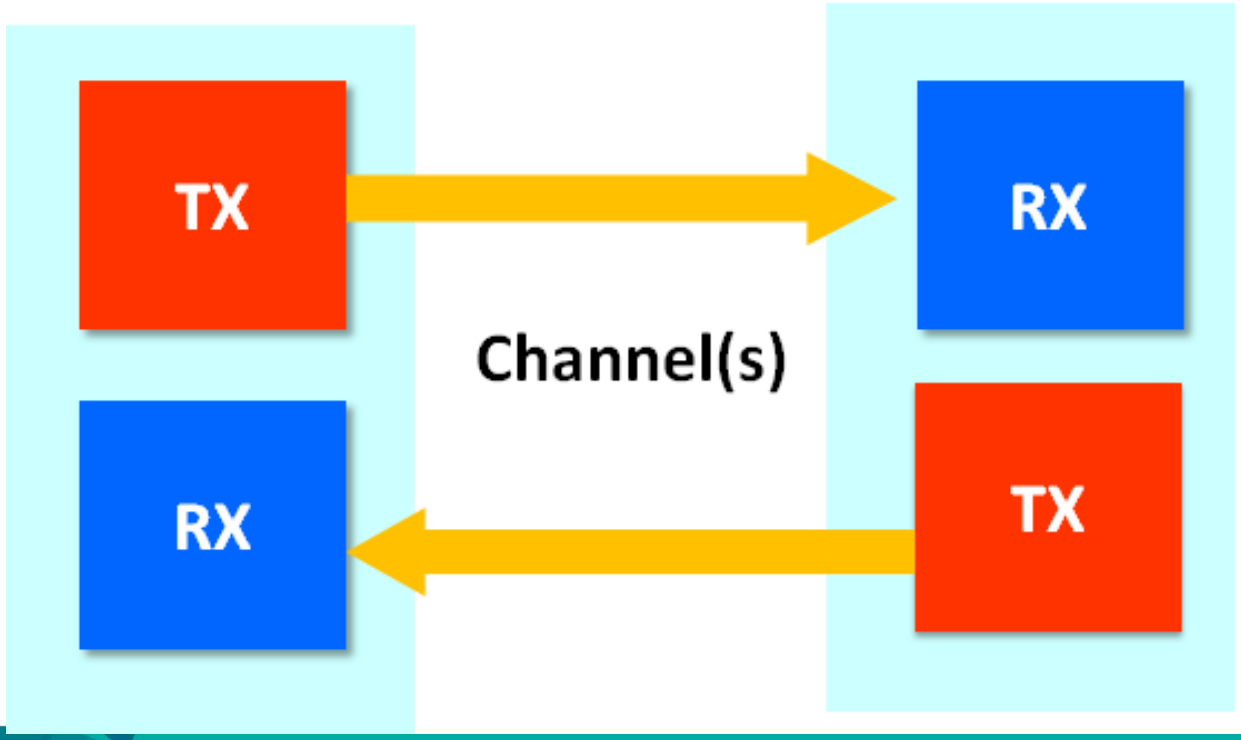
- Humans exchanging information
- Machines exchanging information
- Conveying thoughts, feelings, ideas, and facts
- Sending and receiving information by electronic means

Electronic Communication systems



Types Of Communication Systems

Simplex:
One-way



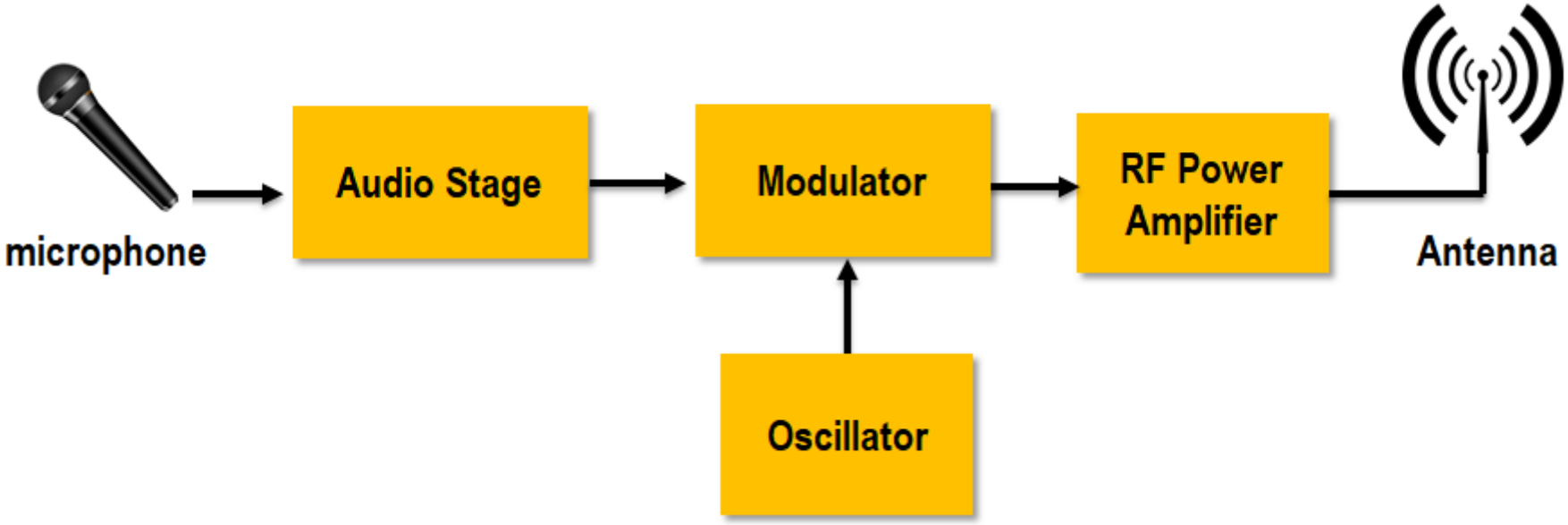
Duplex:
Two-way

Half duplex:
Alternate TX/RX

Full duplex:
Simultaneous
TX/RX

Transmitter

Transmitter is a device that convert input signal by modulating it with carrier signal so that it become a signal that suitable for transmission over a given medium. A typical transmitter components is shown in below:

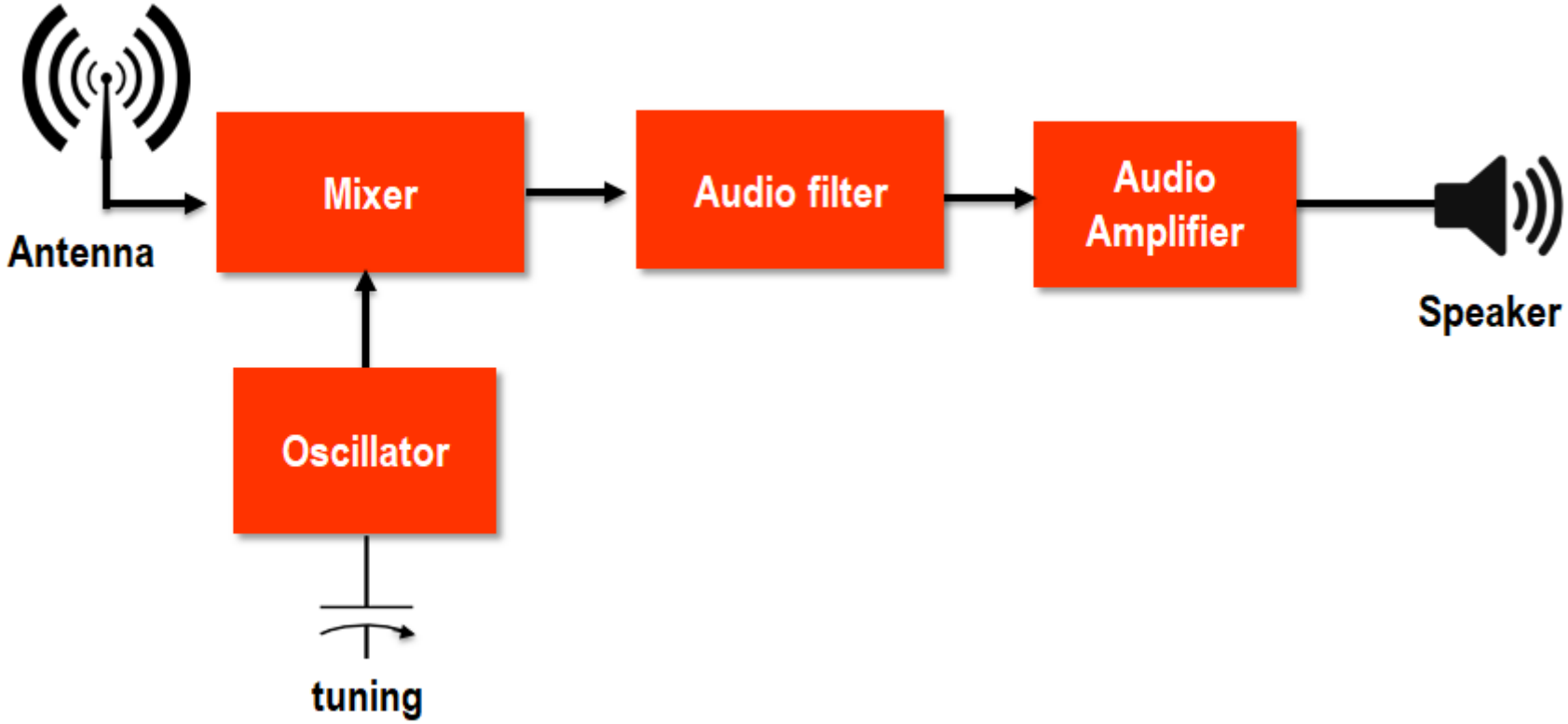


Communication Channel

- Communication channel is the medium where electronic signal is transmitted from one place to another.
- Types of media include
  - Electrical conductors
  - Optical media
  - Free space
  - System-specific media (e.g., water is the medium for sonar).

Receivers

A **receiver** is a device that converts received signals back into original signal.

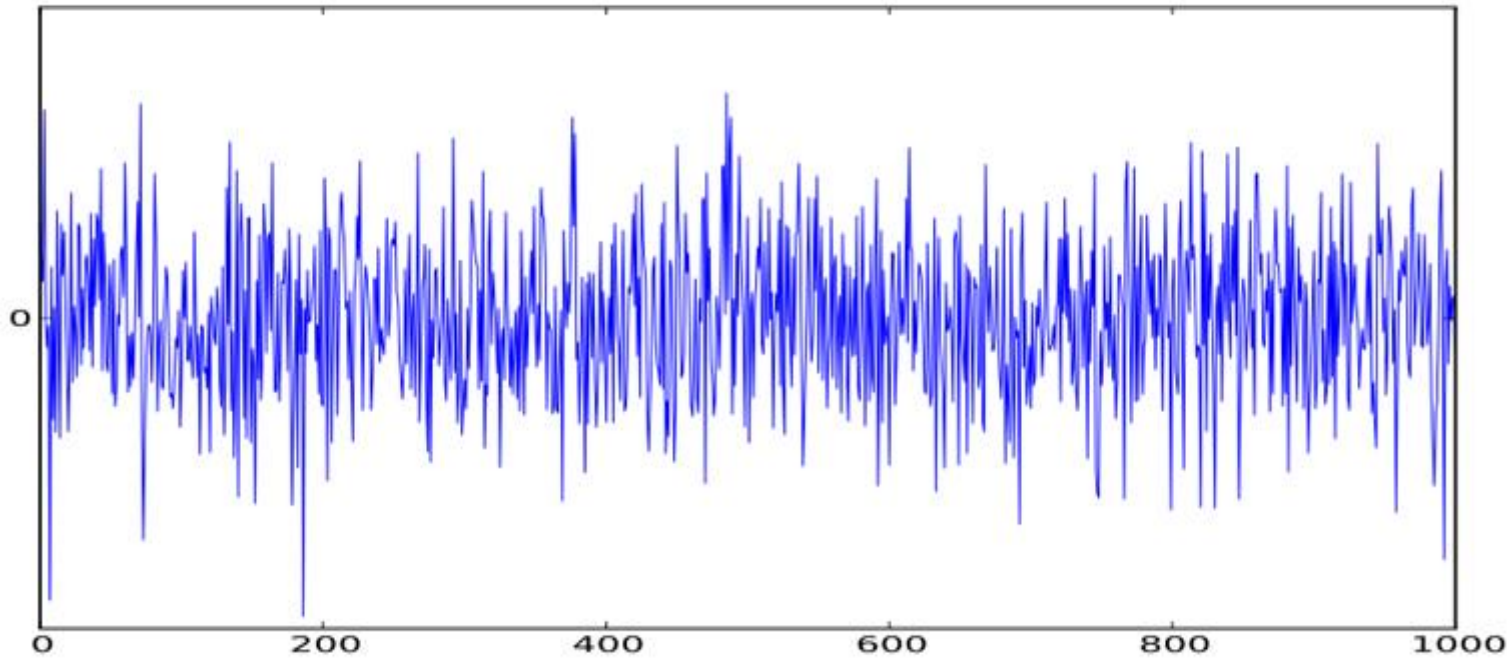


Transceivers

- A **transceiver** is a device that can act as both transmitter and receiver
- Examples are:
  - Telephones
  - Fax machines
  - Handheld CB radios
  - Cell phones
  - Computer modems

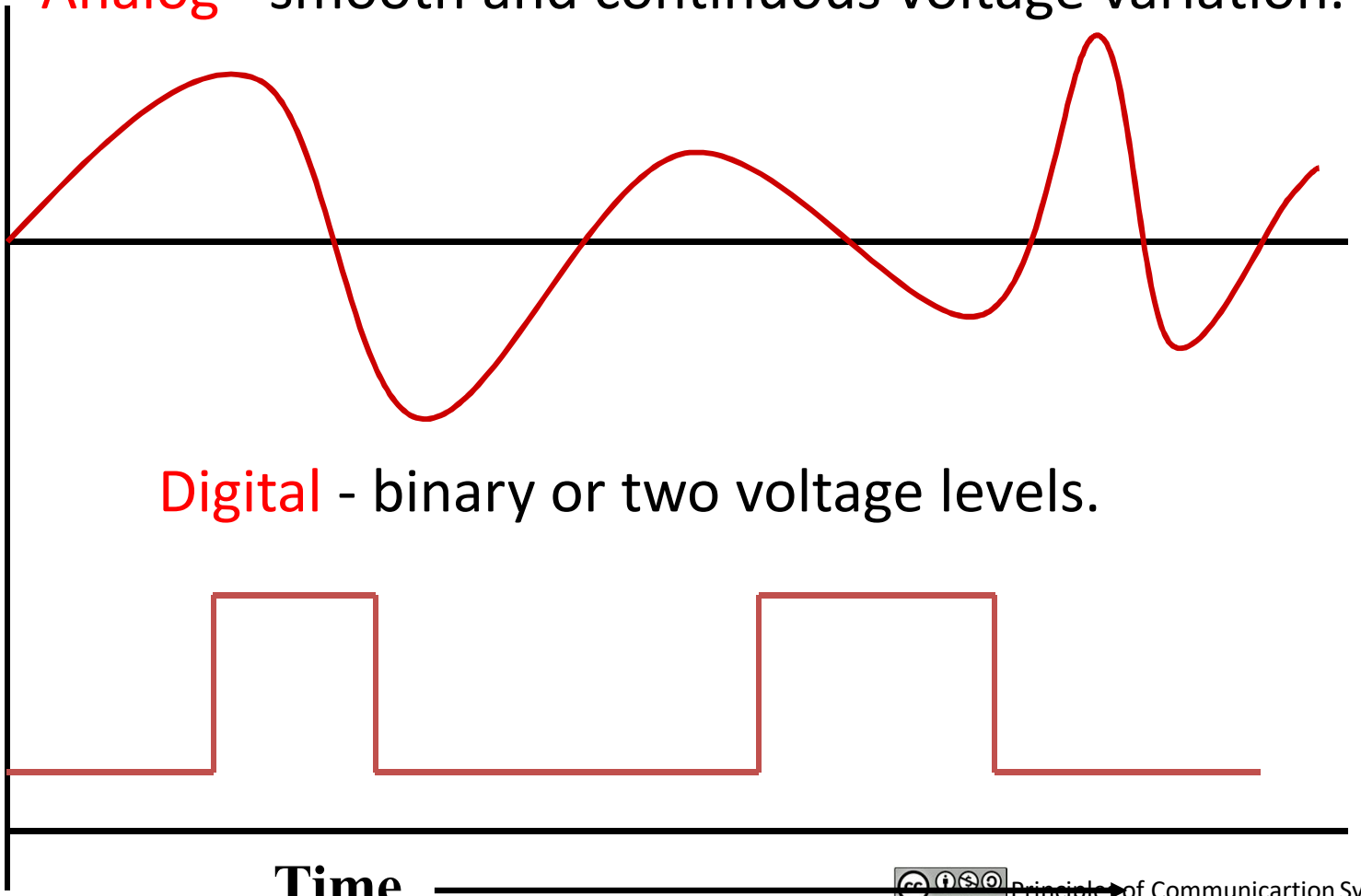
Noise

- **Noise** is random, undesirable electronic energy that enters the communication system via the communicating medium and interferes with the transmitted message.



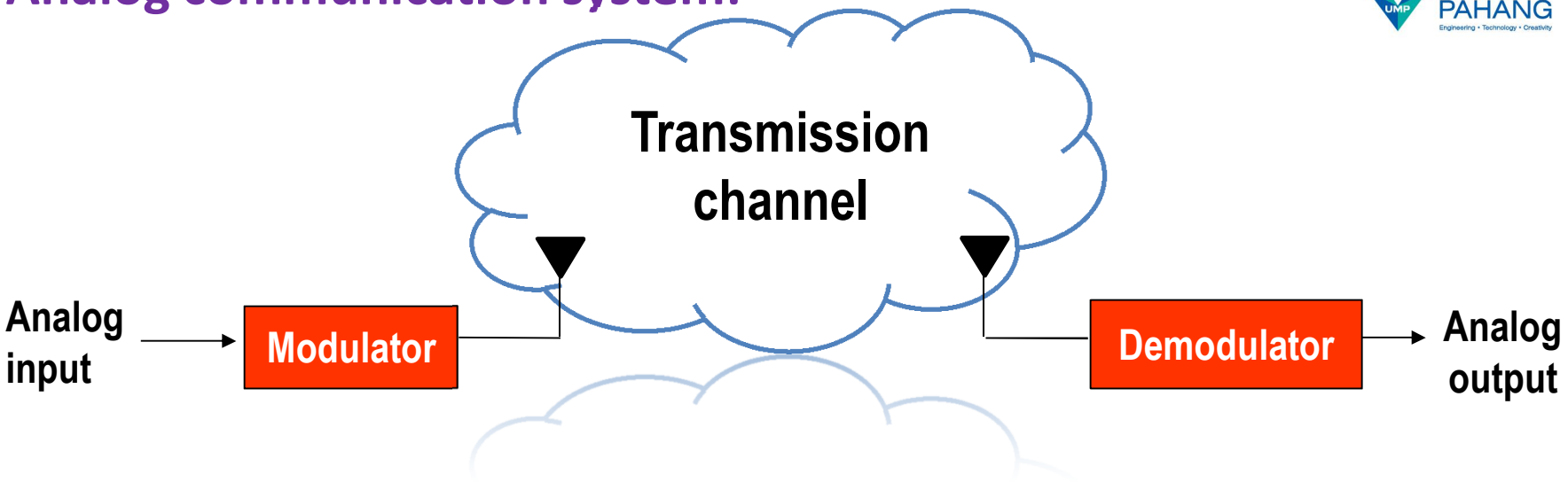
Types Of Communications Signals

Analog - smooth and continuous voltage variation.

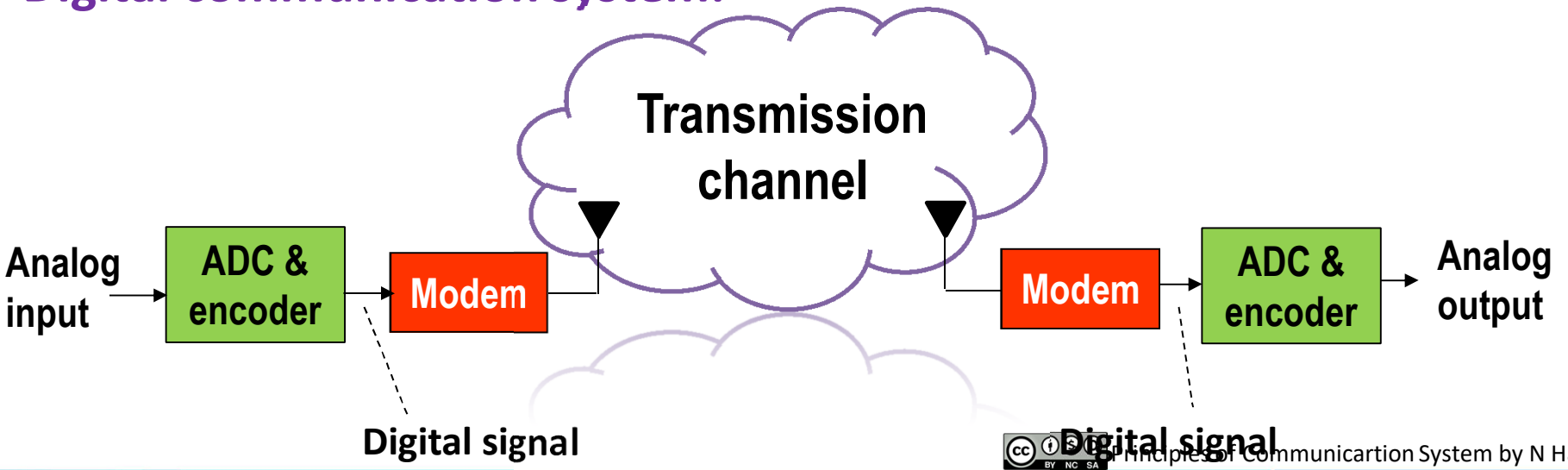


Digital - binary or two voltage levels.

Analog communication system:



Digital communication system:



Modulation

- A process where information signal (low frequency) modifies a carrier signal (usually a high frequency sine wave) so that the signal can be transmitted via radio wave.
- Common types of modulation are amplitude, frequency and phase.

Why modulation is needed?

To generate a modulated signal suited and compatible to the characteristics of the transmission channel.

For ease radiation and reduction of antenna size

Reduction of noise and interference

Channel assignment

Increase transmission speed

Demodulation

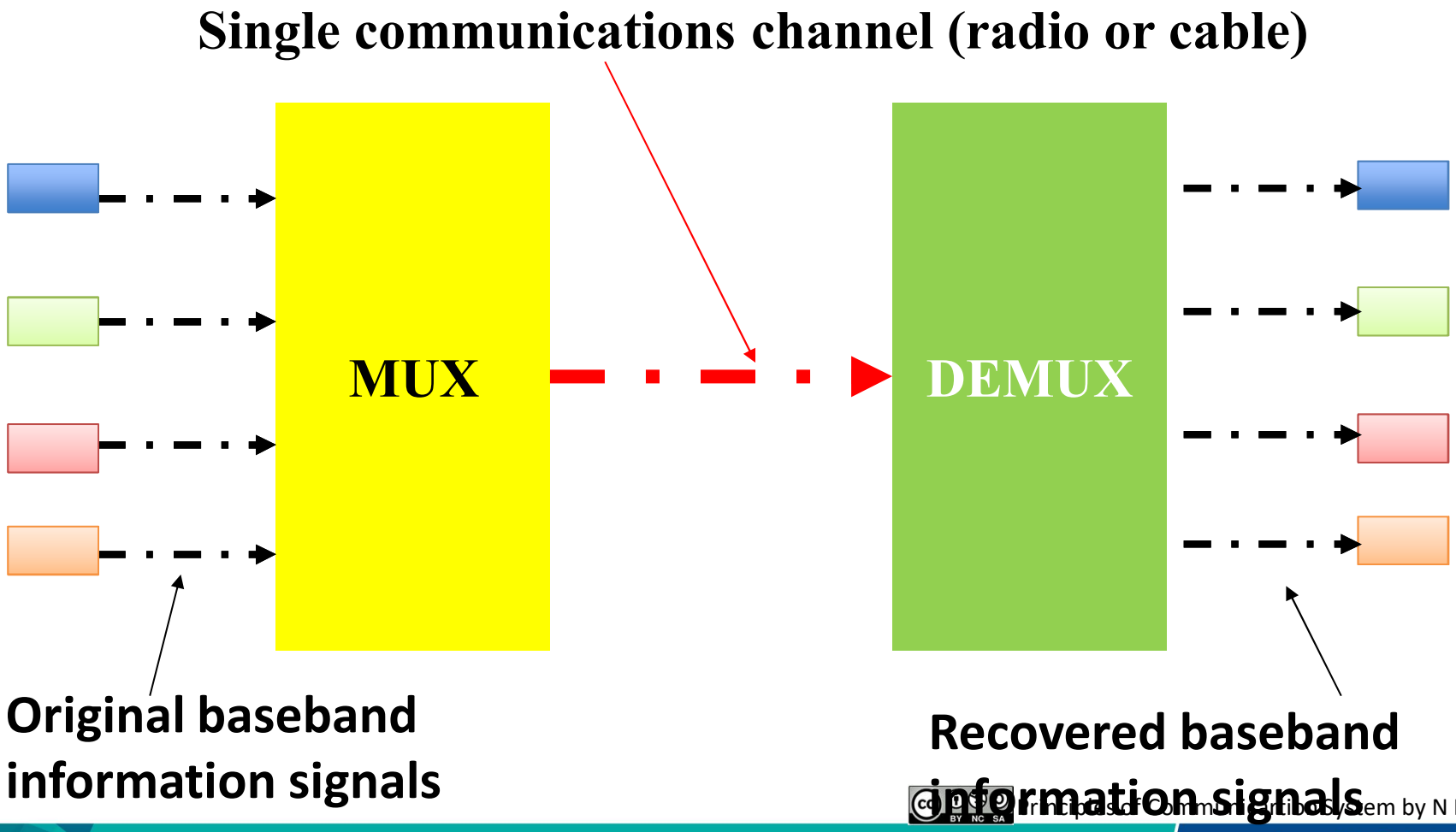
- The reverse process of modulation
- The modulated signal is converted back to its original information at receiver's end

Multiplexing

Multiplexing (MUX or MPX) - Process of transmitting two or more baseband information signals simultaneously over a single communications channel.

Demultiplexing (DEMUX or DMPX) - Process of recovering individual information signals from multiplexed signal.

Multiplexing And Demultiplexing



Frequency And Wavelength

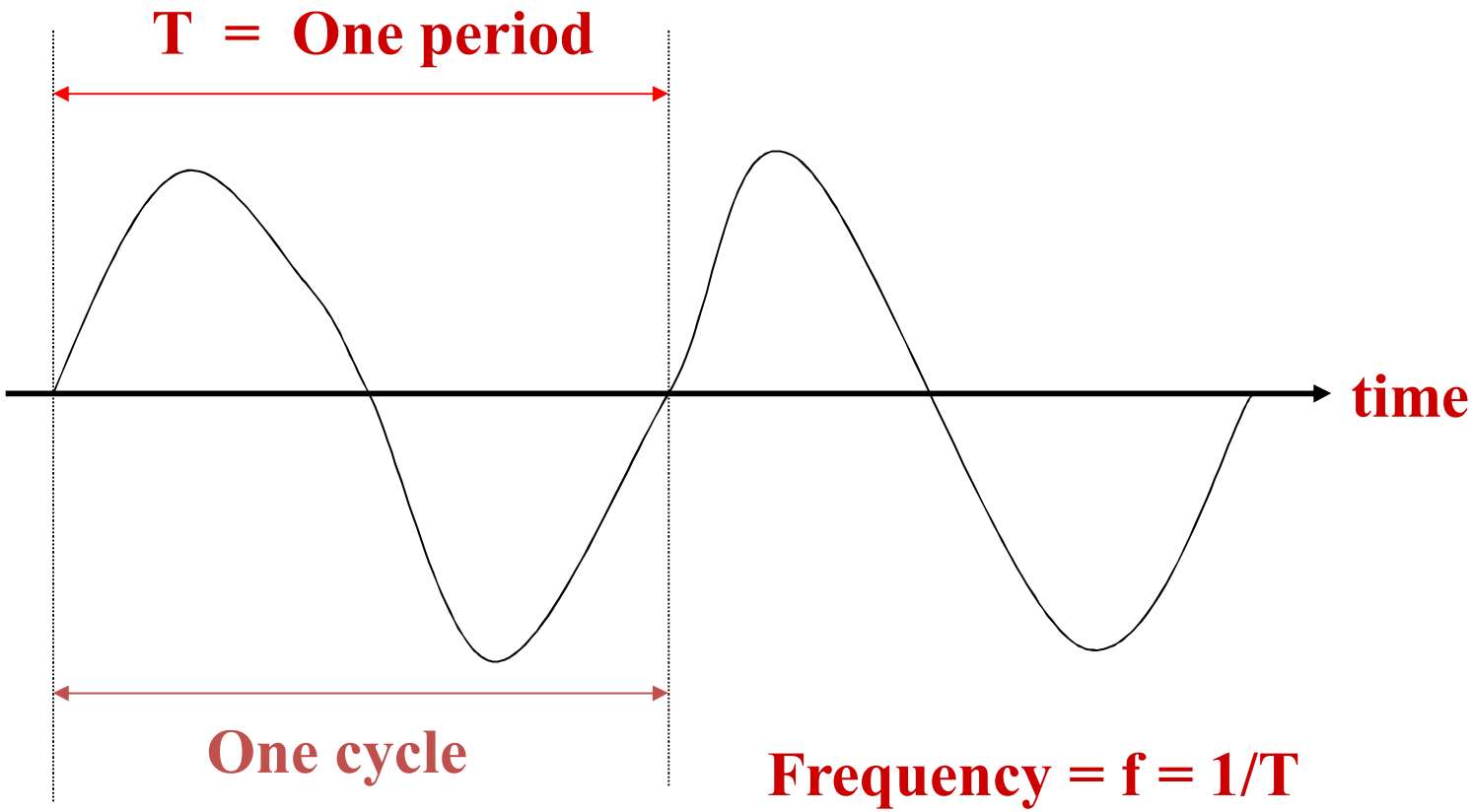
Cycle - One complete occurrence of a repeating wave (periodic signal) such as one positive and one negative alternation of a sine wave.

Frequency - the number of cycles of a signal that occur in one second.

Period - the time distance between two similar points on a periodic wave.

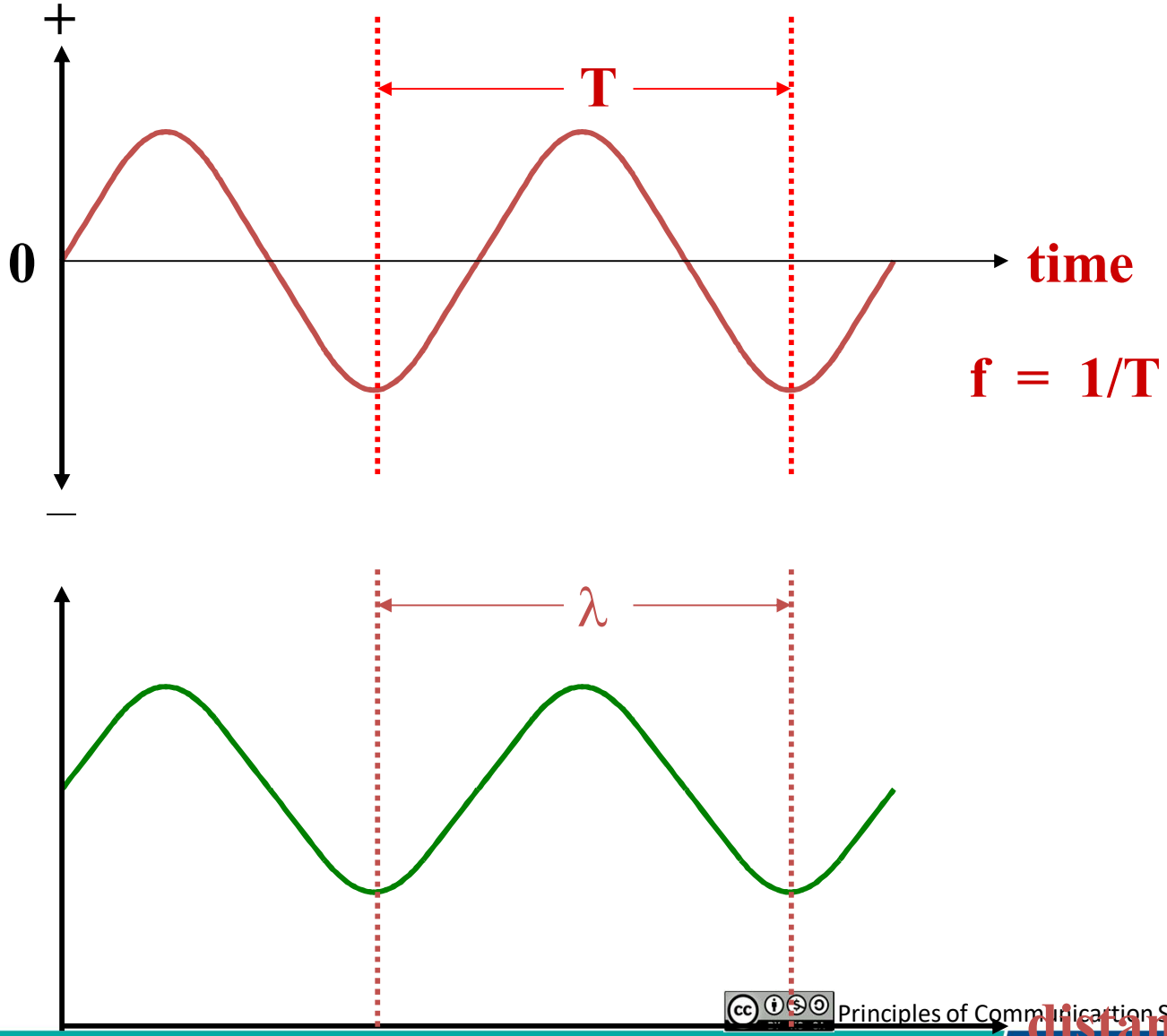
Wavelength - the distance traveled by an electromagnetic (radio) wave during one period.

PERIOD AND FREQUENCY COMPARED



Frequency = f = 1/T

Frequency and wavelength compared



Calculating Wavelength And Frequency

$$\lambda = c/f$$

$$f = c/\lambda$$

λ = wavelength in meters

f = frequency in Hz

C = speed of light = 3×10^8 m/s

Example 1

Find the wavelength of 100-MHz signal

Solution:

$$\lambda = \frac{v}{f} = \frac{3 \times 10^8}{100 \times 10^6} = 3\text{m}$$

Exercise

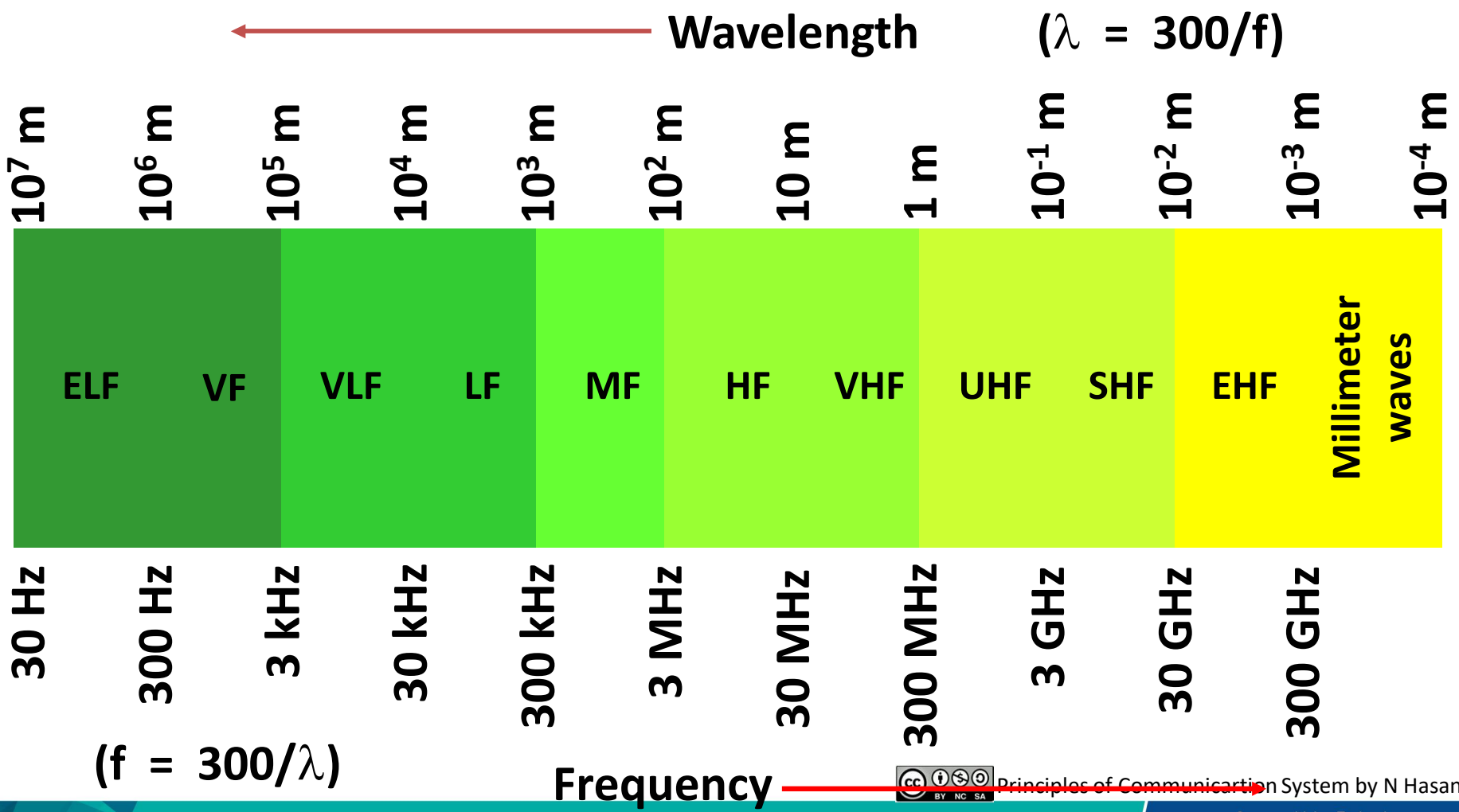
Calculate the frequency of signals with wavelengths of

(a) 40 m,

(b) 5 m, and

(c) 8 cm

The Electromagnetic Spectrum From 30 Hz To 300 Ghz



The Electromagnetic Spectrum Above 300 Ghz

Limitations in communication system

Å Physical constraint

-Delay, attenuation, bandwidth limitation, etc

Å Technological constraint

- hardware.
- Expertise
- economy, law

Frequency Spectrum & Bandwidth

- The frequency spectrum of a waveform consists of all frequencies contained in the waveform and their amplitudes plotted in the frequency domain.

- The bandwidth of a frequency spectrum is the range of of frequencies contained in the spectrum.It is calculated by subtracting the lowest frequency from the highest.

$$(BW = f_H - f_L).$$

Frequency Spectrum & Bandwidth (contôd)

- Bandwidth of the information signal equals to the difference between the highest and lowest frequency contained in the signal.

  ($BW = 2f_m$).

- Similarly, bandwidth of communication channel is the difference between the highest and lowest frequency that the channel allow to pass through it

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