LECTURE #11

Signals

❖ Need For Signals

- One of the major concerns of Physical layer is moving information in the form of electromagnetic signals across a TX medium
- Information can be voice, image, numeric data, characters or any message that is readable and has meaning to the destination user (human or m/c)
- Generally, the info usable to a person or application is not in a form that can be transmitted over a network
- For Example, you cannot roll up a photograph, insert it into the wire and transmit it across the city
- You can transmit however an encoded description of the photograph
- The binary digits must be converted into a form that TX. Medium can accept
- TX. Media work by conducting energy along a physical path. So the data stream of 1s and 0s must be turned into energy in the form of EM signals

❖ Analog and Digital

- Both data and signals that represent them can take either analog or digital form

➢ ANALOG

- Analog refers to something that is continuous in time
- *Continuous*– A set of specific points of data and all possible points b/w them

➢ DIGITAL

- Digital refers to something that is discrete
- *Discrete*– A set of specific points of data with no points in between

- Data can be Analog or Digital

  - ✓ Example of ANALOG Data is **Human voice**
  - ✓ When somebody speaks, a continuous wave is created in the air.
  - ✓ This can be captured by a Microphone and converted to an Analog Signal
  - ✓ An example of DIGITAL data is Data stored in the memory of a computer in the form of 1s and 0s. It is usually converted to a digital

signal when it is transferred from one position to the other inside or outside the computer

- Signals can be Analog or Digital

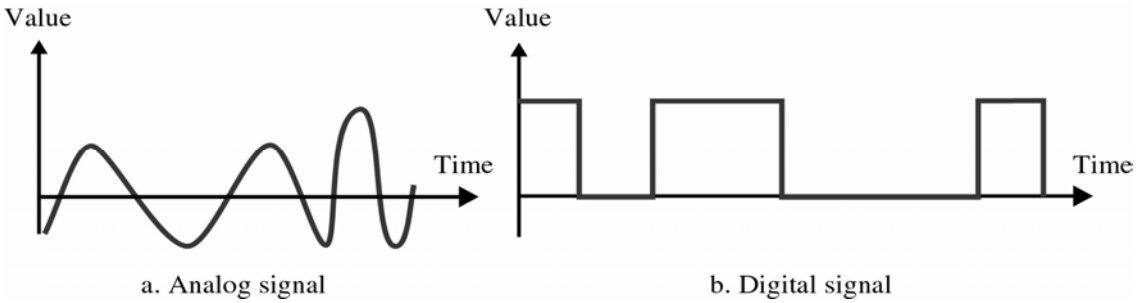
❖ **ANALOG Signal**

- It is a continuous waveform that changes smoothly over time
- As the wave moves from value ' A' to value 'B', it passes through and includes an infinite number of values along its path

❖ **DIGITAL Signal**

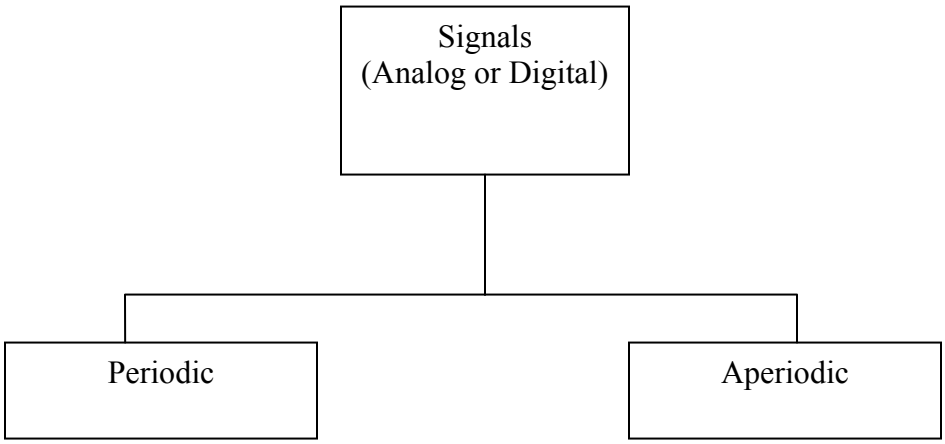
- A digital signal is discrete. It can have only a limited number of defined values, often as simple as 1s and 0s
- The transition of a digital signal from value to value is instantaneous like a light being switched ON and OFF

Analog and Digital Signals



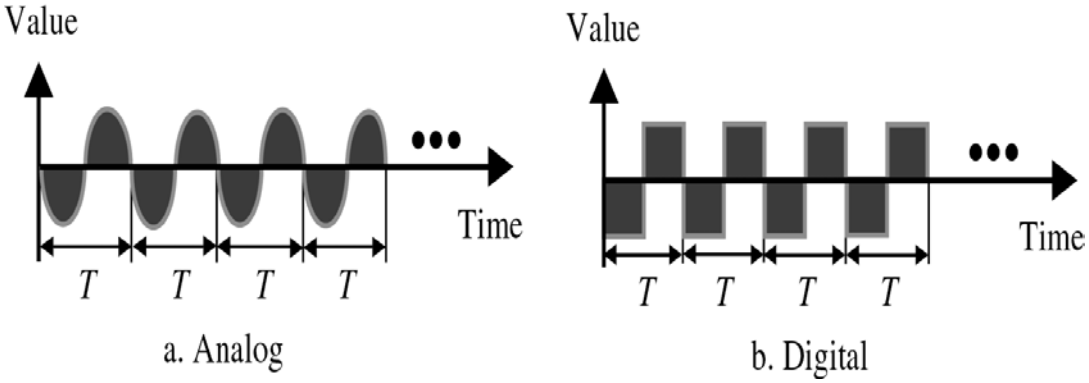
- We illustrate signals usually by plotting them on a pair of perpendicular axis
- Vertical axis represent the value or the strength of the signal
- Horizontal axes represent the passage of time
- The curve representing the Analog signal is smooth and continuous, passing through an infinite number
- The vertical lines of the digital signal shows the sudden jump the signal makes from value to value. The flat highs and the the lows represent that those values are fixed
- In short, Analog signal varies continuously w.r.t Time whereas Digital signal varies instantaneous

Periodic and Aperiodic Signals



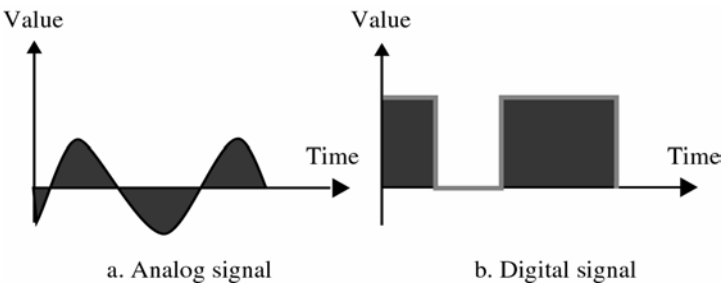
❖ **Periodic Signals**

- A signal is called Periodic if it completes a pattern within a measurable time frame called a Period and then repeats that pattern over identical subsequent Periods
- The completion of one full pattern is called a CYCLE
- Period: Time required (in Seconds) to complete one full cycle, represented by 'T'



❖ **Aperiodic Signals**

- An Aperiodic or Non-Periodic signal is the one that changes constantly without exhibiting a pattern or cycle that repeats over time



- **Fourier Transform**
  It has been proved by a technique called FOURIER TRANSFORM that any Aperiodic signal can be decomposed into an infinite number of Periodic Signals

❖ **ANALOG SIGNALS**
- Analog signals can be classified as Simple or Composite

- Simple Analog Signal(Sine Wave)
  – Cannot be decomposed into simpler signal

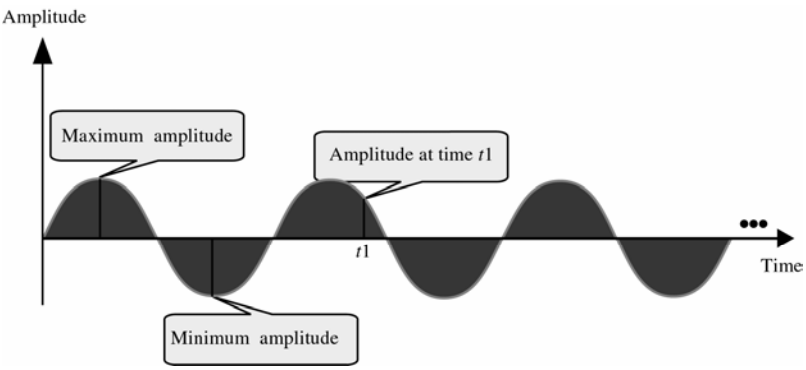
- Composite Analog Signal
  – Composed of multiple sine waves

❖ **Sine Waves**
- Sine Waves are the most fundamental form of Periodic Analog Signals
- The curve oscillates over the course of a cycle smoothly and consistently
- Each cycle consists of a single arc above the time axis followed by a single arc below it
- Sine Waves can be fully described by three characteristics:

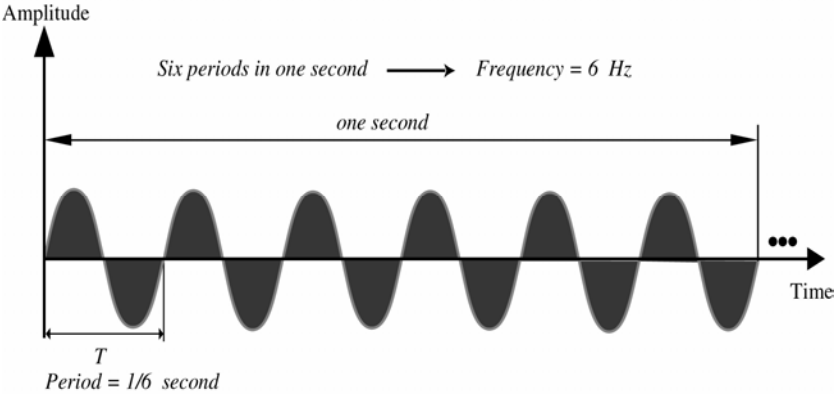
  ➢ Amplitude
  ➢ Period/Frequency
  ➢ Phase

➢ Amplitude

- Amplitude of a signal is the value of the signal at any point on the wave
- It is equal to the vertical distance from a given point on the wave form to the horizontal axis
- The maximum amplitude of the sine wave is equal to the highest value it reaches on the vertical axis
- Amplitude measured in Volts, Amperes or Watts



- **Period & Frequency**
  - Period: Amount of time (in seconds) a signal need to complete one cycle
  - Frequency: Number of cycles completed in one second
  - Unit of Period: Period is expressed in seconds



  - Communication industry uses 5 units to measure period
  - Frequency is measured in hertz, There are 5 units used in Hertz

Seconds____Hertz
Milliseconds____Kilohertz
Microseconds____Megahertz
Nanoseconds____Gigahertz
Picoseconds____Terahertz

Summary

- Signals
- Analog and Digital
- Analog and Digital Data & Signals
- Periodic & Aperiodic Signals
- Sine Waves and its Characteristics

Reading Sections

◆Section 4.1, 4.2, 4.3"Data Communications and Networking" 2nd Edition by Behrouz A. Forouzan