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Wisdom & Virtue

MIRPUR UNIVERSITY OF SCIENCE AND TECHNOLOGY (MUST), MIRPUR

DEPARTMENT OF SOFTWARE ENGINEERING

Computer Networks

Lecture [12]: Introduction to Physical Layer

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(Lecturer)

Topics discussed in Today's Lectures

- Physical Layer
- Data and Signals
- Analog and Digital Data
- Analog and Digital Signals
- Periodic and Nonperiodic Signals
- Sine Wave

Physical Layer

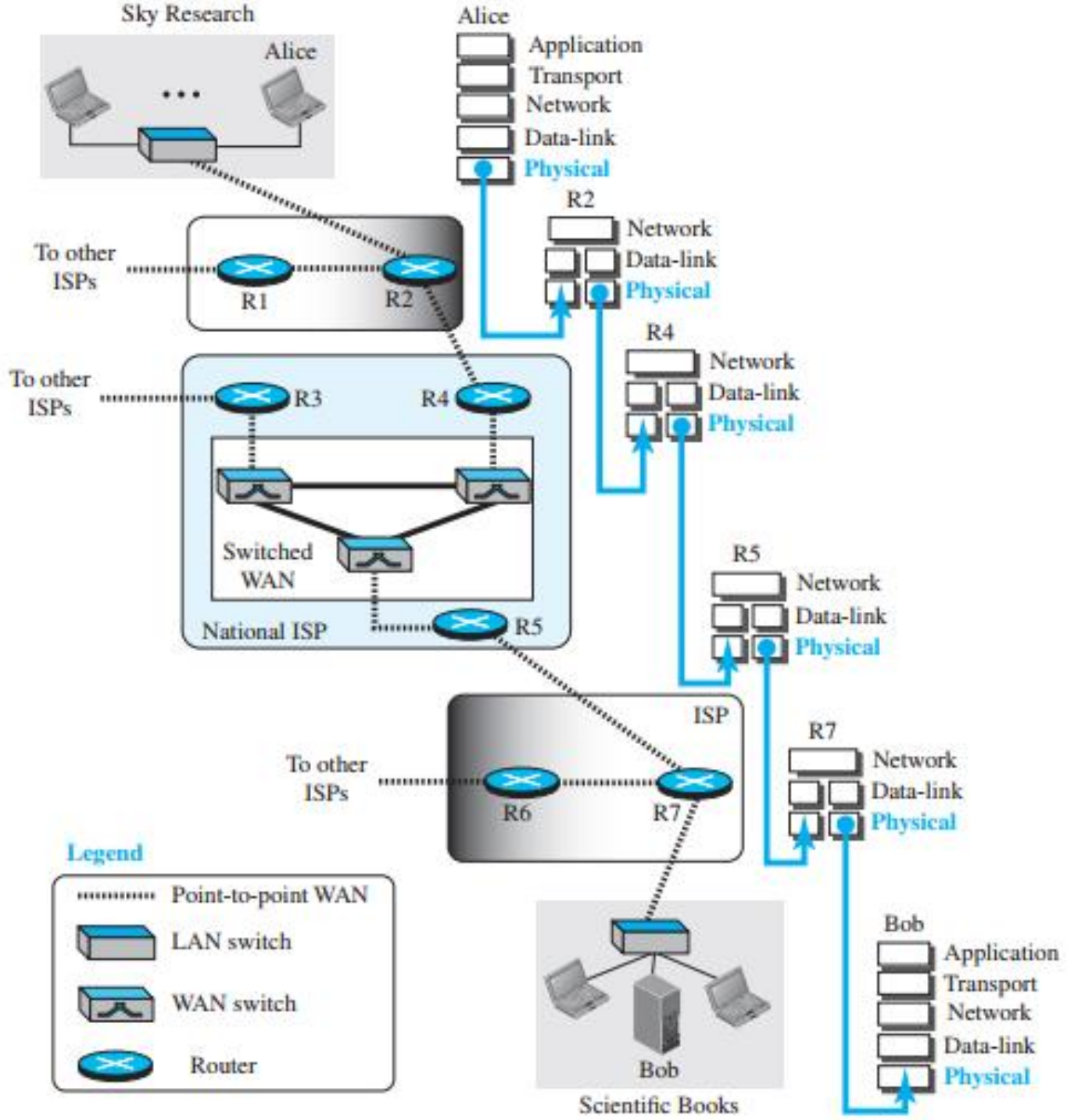
- Physical layer moves data in the form of electromagnetic signals across a transmission medium; whether you are:
  - Collecting numerical statistics from another computer
  - Sending animated pictures from a design workstation
  - Causing a bell to ring at a distant control center
  - Working with the transmission of data across network connections

Physical Layer

- Generally, data usable to a person or application, are not in a form that can be transmitted over a network
- **For example**, a photograph must first be changed to a form that transmission media can accept
- Transmission media work by conducting energy along a physical path
- For transmission, data needs to be changed to signals

Data and Signals

- Figure 3.1 shows a scenario in which a scientist working in a research company, *Sky Research*, needs to order a book related to her research from an online bookseller, *Scientific Books*



Data and Signals

- Comm. at application, transport, network, or data-link is logical;
- Comm. at the physical layer is physical
- For simplicity, we have shown only *host-to-router, router-to-router*, and *router-to-host*, but the switches are also involved in physical comm.
- Although Alice and Bob need to exchange data, communication at the physical layer means exchanging signals
- Data need to be transmitted and received, but the transmission media have to change data to signals
- Both data and the signals that represent them can be either analog or digital

Analog and Digital Data

- **Analog Data** refers to information that is continuous
  - For example, an analog clock that has hour, minute, and second hands gives info. in a continuous form;
    - Movements of the hands are continuous.
- **Digital data** refers to information that has discrete states
  - For example, a digital clock that reports the hours and the minutes will change suddenly from 8:05 to 8:06

Analog and Digital Data

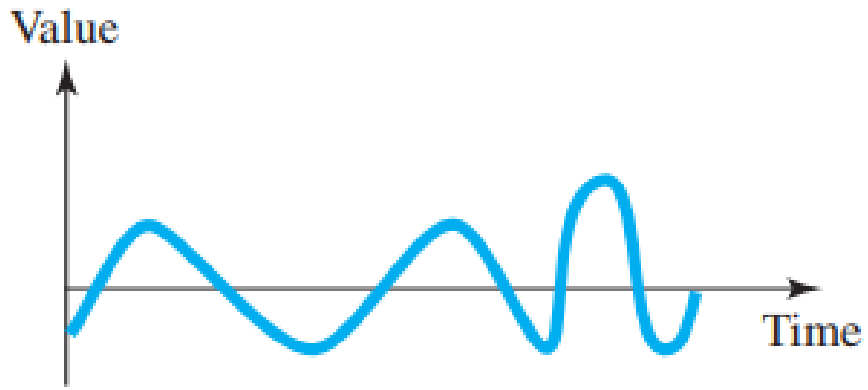
- Analog data, such as the sounds made by a human voice, take on continuous values
  - When someone speaks, an analog wave is created in the air
  - This is captured by a microphone & converted to an analog signal or
  - Sampled and converted to a digital signal
- Digital data take on discrete values
  - For example, data are stored in computer memory in the form of 0s and 1s
  - They can be converted to a digital signal or modulated into an analog signal for transmission across a medium

Analog and Digital Signals

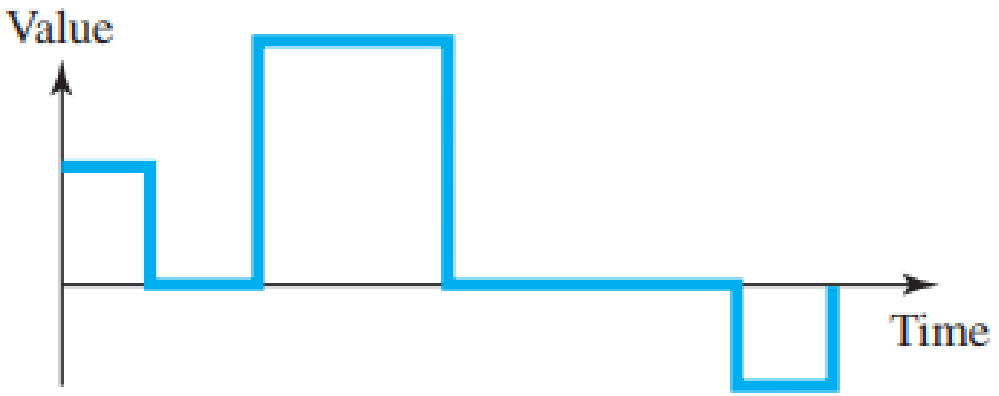
- An **analog signal** has infinitely many levels of intensity over a period of time
  - As the wave moves from value A to value B, it passes through and includes an infinite number of values along its path
- A **digital signal**, can have only a limited number of defined values
  - Although each value can be any number, it is often as simple as 1 and 0

Analog and Digital Signals

- Signals can be shown by plotting them on a pair of perpendicular axes
- Vertical axis represents the value or strength of a signal
- Horizontal axis represents time
- Curve representing the analog signal passes through an infinite number of points
- Vertical lines of the digital signal, demonstrate the sudden jump that the signal makes from value to value



a. Analog signal



b. Digital signal

Periodic and Nonperiodic Signals

- Both analog & digital signals can take one of two forms: periodic or nonperiodic
- **Periodic signal** completes a pattern within a measurable time frame, called a **period**, and repeats that pattern over subsequent identical periods
  - Completion of one full pattern is called a **cycle**
- **Nonperiodic signal** changes without exhibiting a pattern or cycle that repeats over time
- Both analog and digital signals can be periodic or nonperiodic
- In data comm., there are periodic analog signals and nonperiodic digital signals

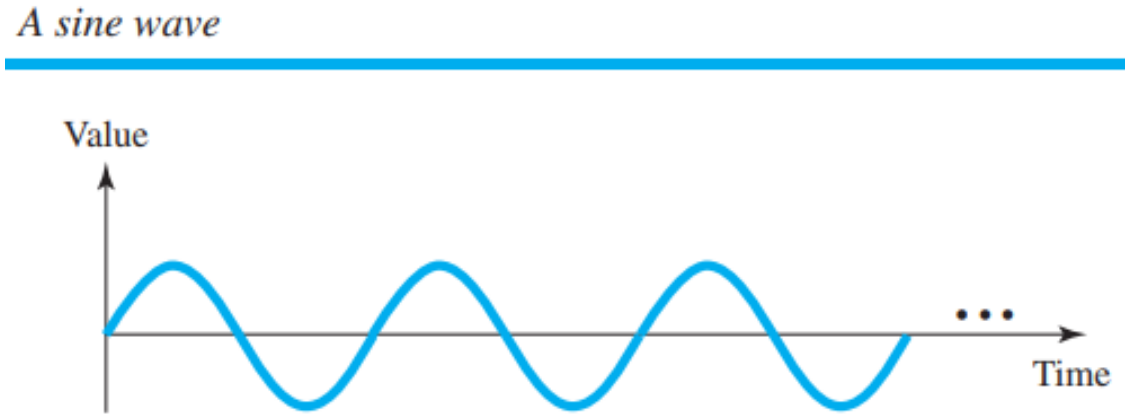
PERIODIC ANALOG SIGNALS

- Periodic analog signals can be classified as simple or composite
- A **simple periodic analog signal**, a sine wave, cannot be decomposed into simpler signals
- A **composite periodic analog signal** is composed of multiple sine waves

Sine Wave

- The sine wave is a periodic analog signal
- It can be visualized it as a simple oscillating curve

Sine Wave (Contd…)

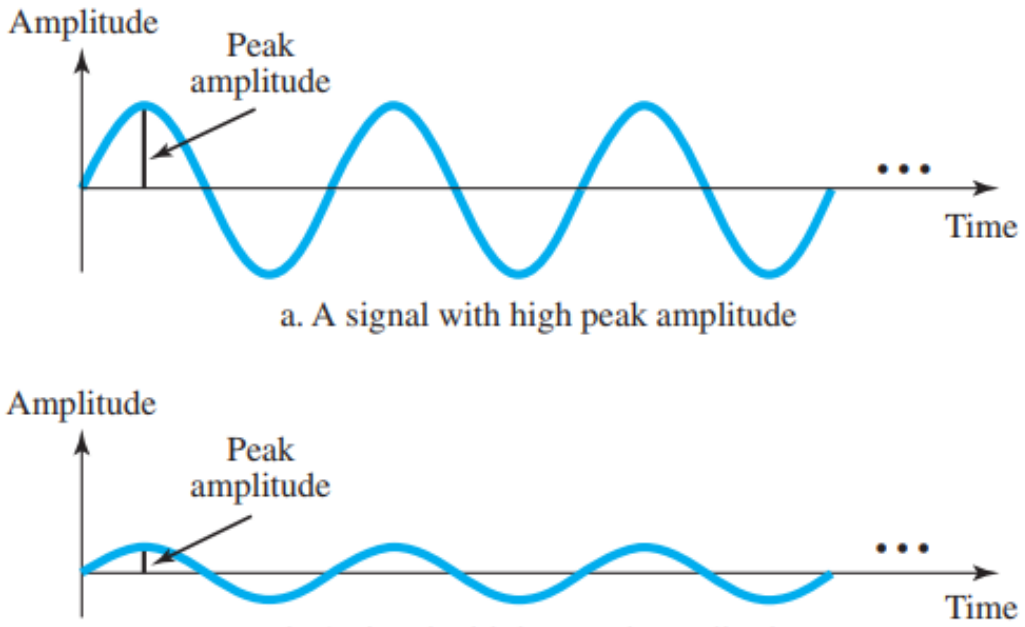


- Each cycle consists of a single arc above and below time axis
- A sine wave can be represented by three parameters, which fully describe a sine wave:
  i. Peak amplitude
  ii. Frequency
  iii. Phase

Peak Amplitude of Sine Wave

- Peak amplitude of a signal is the absolute value of its highest intensity, proportional to the energy it carries
- For electric signals, peak amplitude is normally measured in volts
- Figure 3.4 shows two signals and their peak amplitudes

Figure 3.4 *Two signals with the same phase and frequency, but different amplitudes*



Period and Frequency

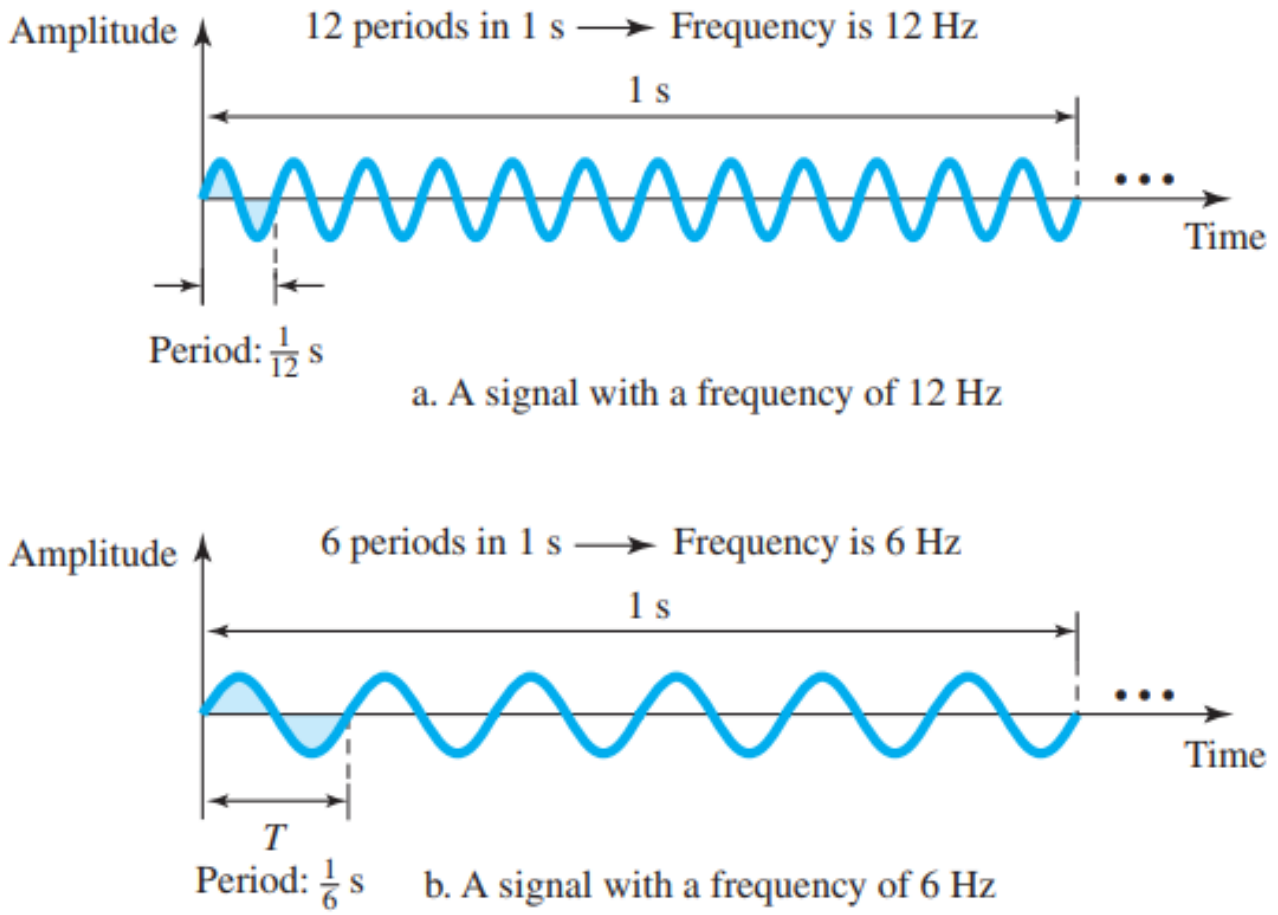
- **Period** refers to the amount of time, in seconds, a signal needs to complete 1 cycle
- **Frequency** refers to the number of periods in 1 s
  - Period and frequency are just one characteristic defined in two ways
  - Period is the inverse of frequency, and frequency is the inverse of period, as the following formulas show

$$f = \frac{1}{T} \quad \text{and} \quad T = \frac{1}{f}$$

  - Period is formally expressed in seconds
  - Frequency is formally expressed in Hertz (Hz), which is cycle per second.

Period and Frequency

Figure 3.5 *Two signals with the same amplitude and phase, but different frequencies*

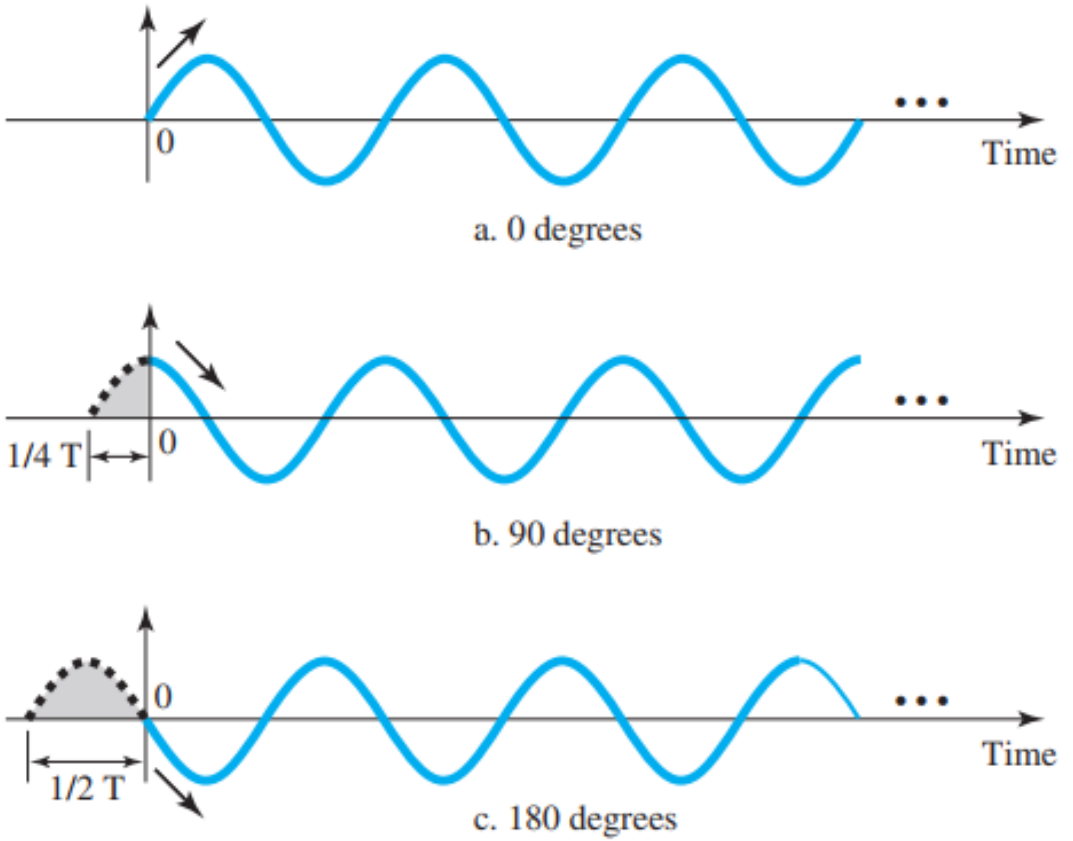


Phase of Sine Wave

- The term **phase**, or **phase shift,** describes the position of the waveform relative to time 0
- If we think of the wave as something that can be shifted backward or forward along the time axis, phase describes the amount of that shift
- It indicates the status of the first cycle
- Phase is measured in degrees or radians [360º is 2π rad; 1º is 2π/360 rad, and 1 rad is 360/(2π)]
- A phase shift of 360º corresponds to a shift of a complete period
- A phase shift of 180° corresponds to a shift of one-half of a period
- A phase shift of 90º corresponds to a shift of one-quarter of a period

Phase of Sine Wave

Figure 3.6 *Three sine waves with the same amplitude and frequency, but different phases*



References

Chapter 3

Data Communication and Networking (5th Edition)
By Behrouz A. Forouzan

THANKS