Data Communication

Introductory Discussions

DATA COMMUNICATIONS

- The term telecommunication means communication at a distance.
- The word data refers to information presented in whatever form is agreed upon by the parties creating and using the data.
- Data communications are the exchange of data between two devices via some form of transmission medium such as a wire cable.

Topics discussed in this section

- ✔ Components
- ✔ Data Representation
- ✔ Data Flow

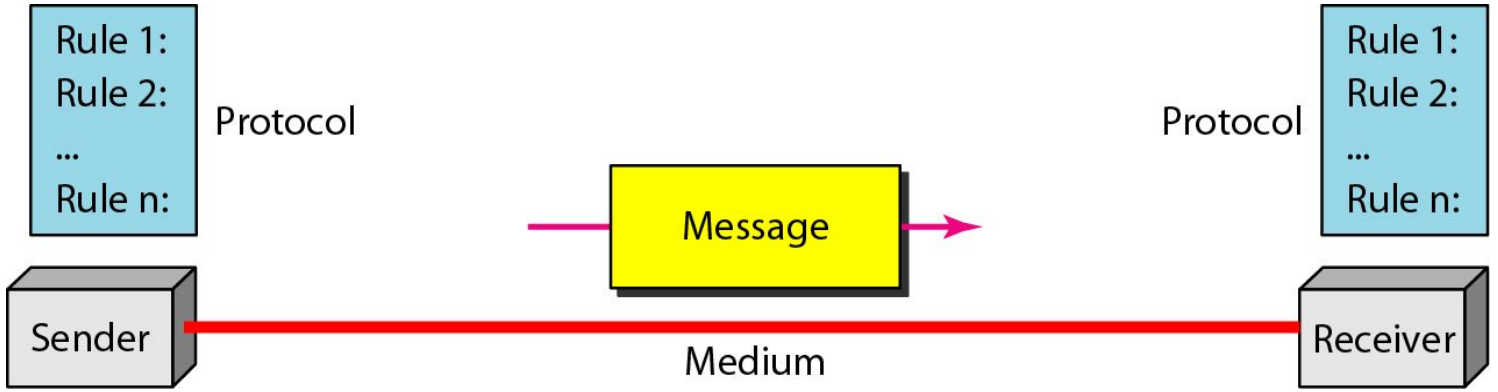


Figure 1.1 ***Five components of data communication***

Components

Message:

The message is the information (data) to be communicated. Popular forms of information include text, numbers, pictures, audio, and video.

Sender:

The sender is the device that sends the data message. It can be a computer, workstation, telephone handset, video camera, and so on.

Components

Receiver:

The receiver is the device that receives the message. It can be a computer, workstation, telephone handset, television, and so on.

Transmission medium:

The transmission medium is the physical path by which a message travels from sender to receiver. Some examples of transmission media include twisted-pair wire, coaxial cable, fiber-optic cable, and radio waves.

Components

Protocol:

A protocol is a set of rules that govern data communications. It represents an agreement between the communicating devices.

Without a protocol, two devices may be connected but not communicating, just as a person speaking French cannot be understood by a person who speaks only Japanese.

Data Representation

Information today comes in different forms such as text, numbers, images, audio, and video.

In data communications, text is represented as a bit pattern, a sequence of bits (0s or 1s). Different sets of bit patterns have been designed to represent text symbols. Each set is called a code, and the process of representing symbols is called coding.

Data Representation

Numbers

Numbers are also represented by bit patterns. However, a code such as ASCII is not used to represent numbers; the number is directly converted to a binary number to simplify mathematical operations.

Data Representation

Images

Images are also represented by bit patterns. In its simplest form, an image is composed of a matrix of pixels (picture elements), where each pixel is a small dot. The size of the pixel depends on the *resolution.*

After an image is divided into pixels, each pixel is assigned a bit pattern. The size and the value of the pattern depend on the image.

Data Representation

Audio

Audio refers to the recording or broadcasting of sound or music. Audio is by nature different from text, numbers, or images. It is continuous, not discrete. Even when we use a microphone to change voice or music to an electric signal, we create a continuous signal.

Data Representation

Video

Video refers to the recording or broadcasting of a picture or movie. Video can either be produced as a continuous entity (e.g., by a TV camera), or it can be a combination of images, each a discrete entity, arranged to convey the idea of motion.

Direction of data flow

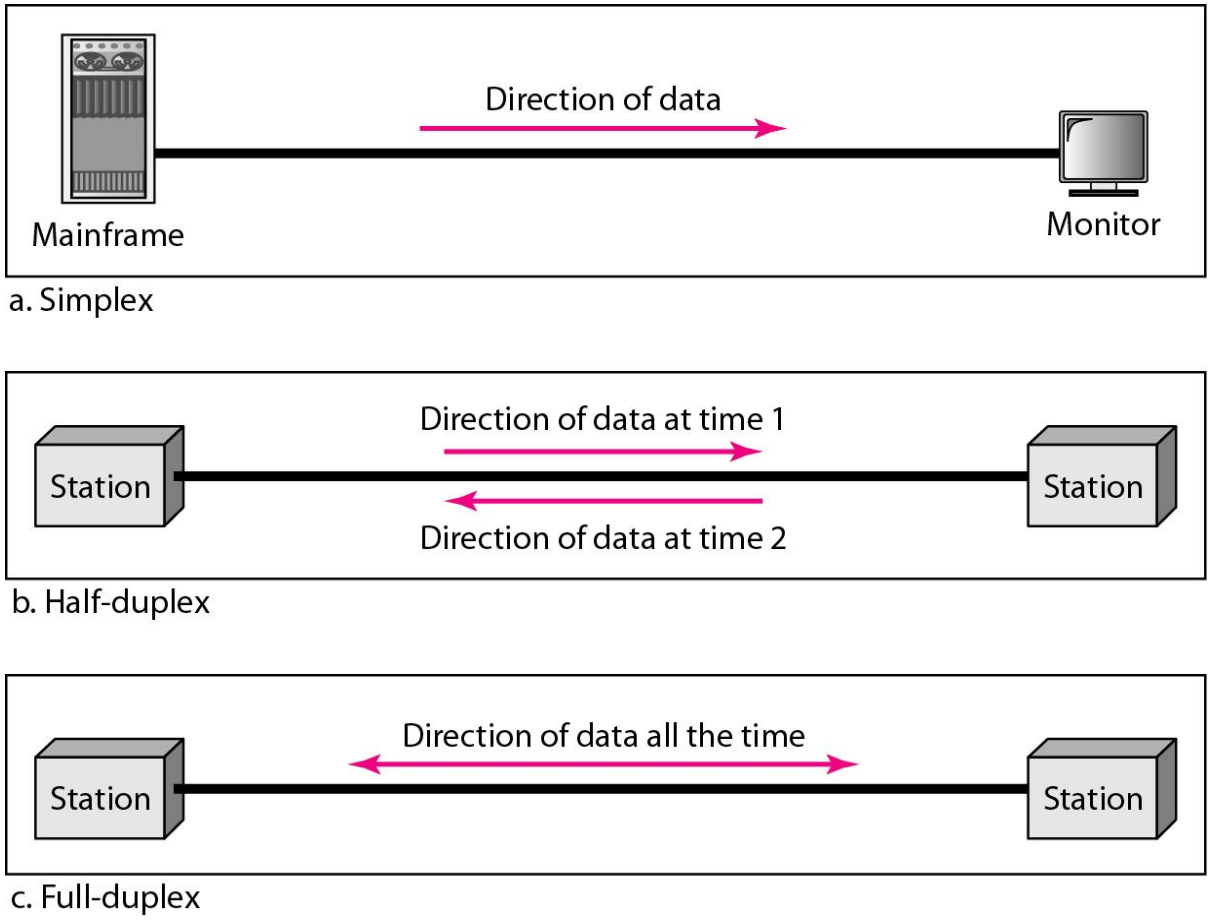


Figure 1.2 ***Data flow (simplex, half-duplex, and full-duplex)***

ANALOG AND DIGITAL

Data can be analog or digital.

The term analog data refers to information that is continuous; digital data refers to information that has discrete states.

Signals can be analog or digital.

Analog signals can have an infinite number of values in a range; digital signals can have only a limited number of values.

ANALOG AND DIGITAL

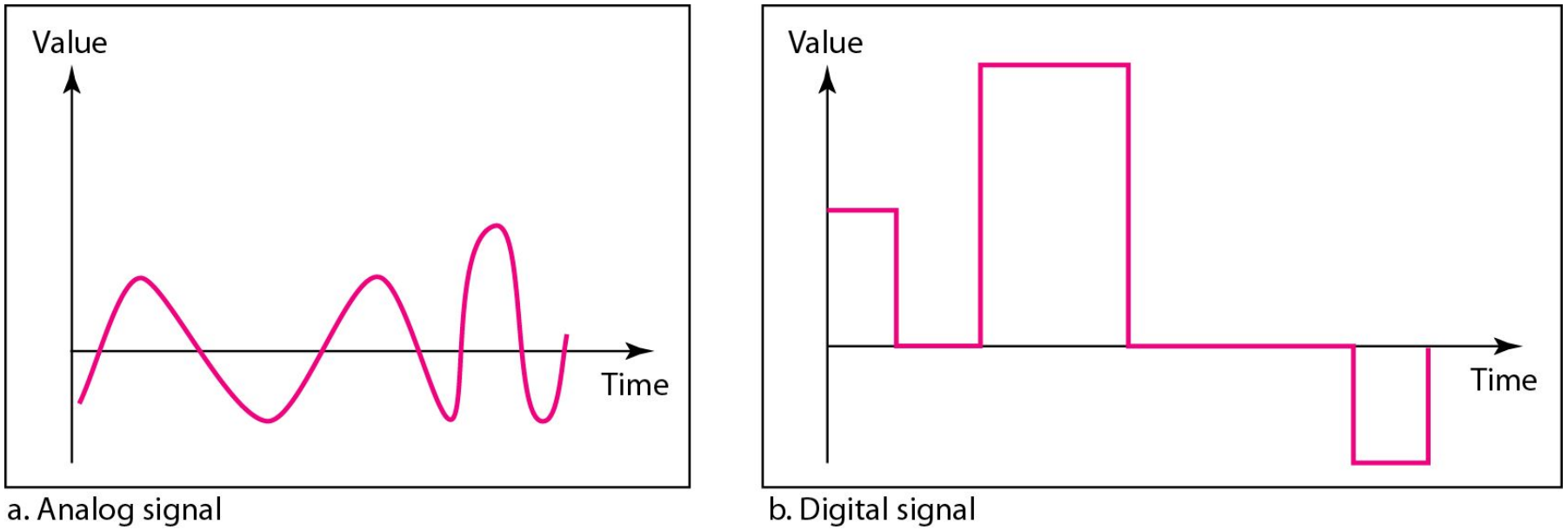


Figure 3.1 ***Comparison of analog and digital signals***

In data communications, we commonly use periodic analog signals and non-periodic 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

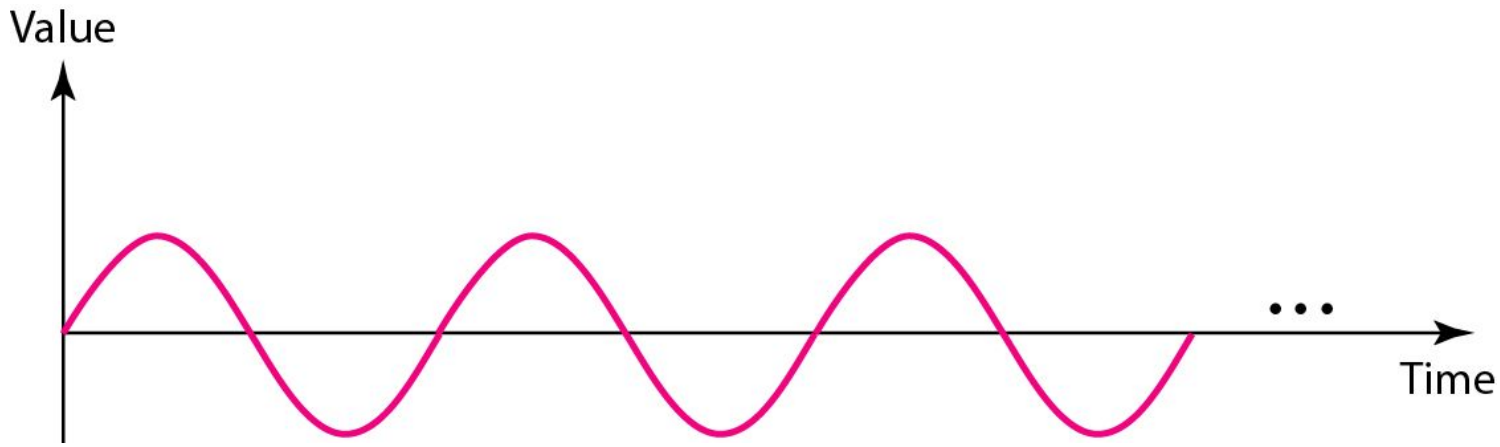
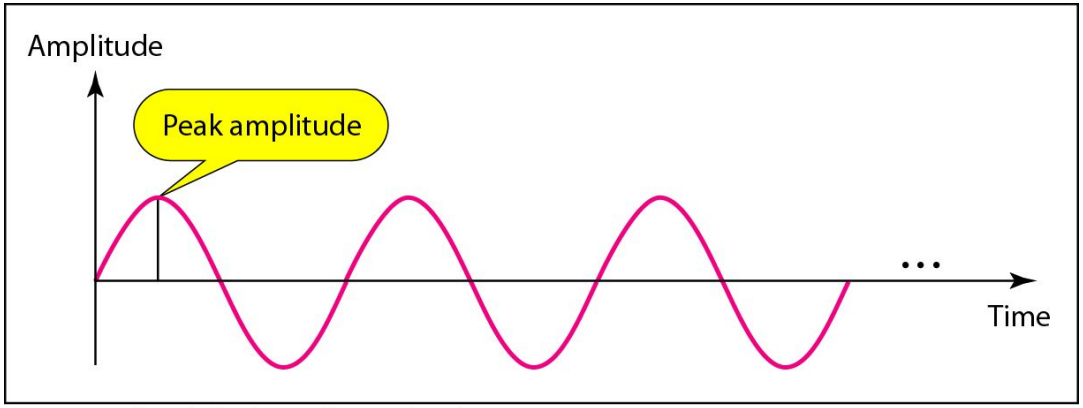
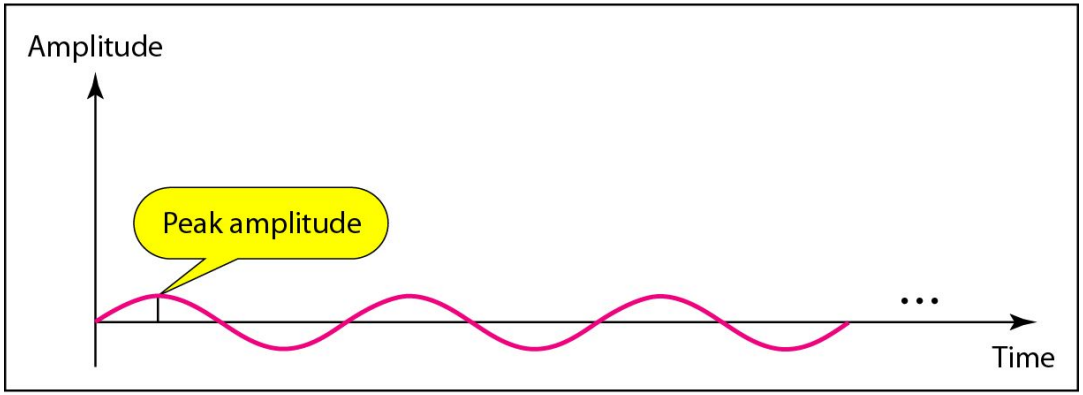


Figure 3.2 ***A sine wave***

SINE WAVE



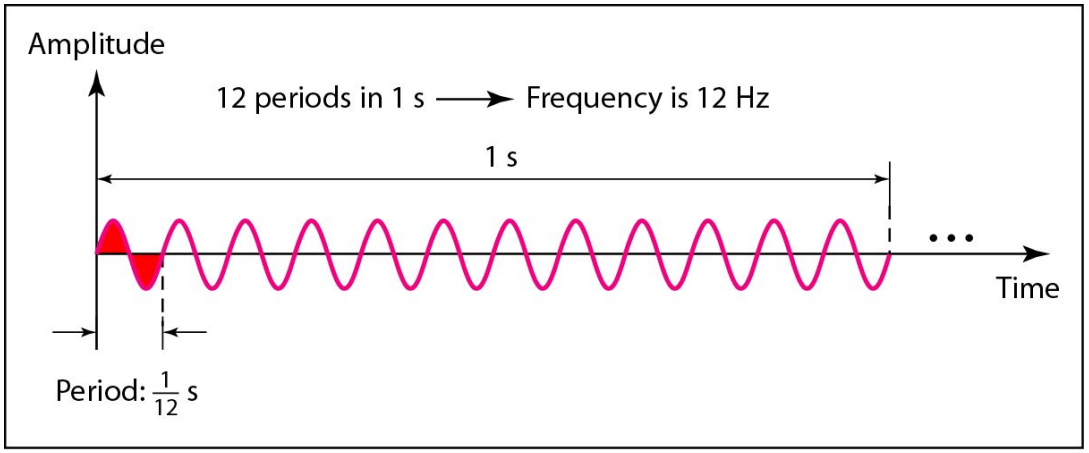
a. A signal with high peak amplitude



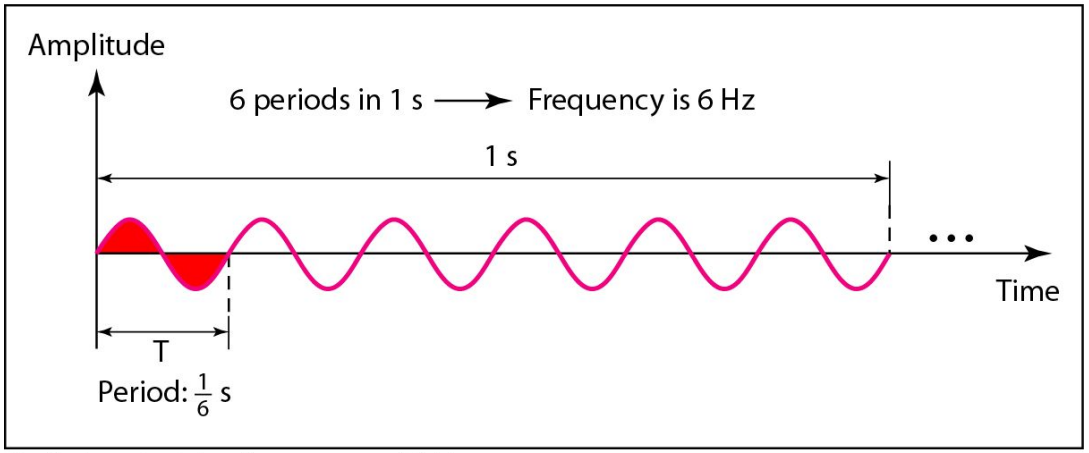
b. A signal with low peak amplitude

Figure 3.3 ***Two signals with the same phase and frequency, but different amplitudes***

SINE WAVE



a. A signal with a frequency of 12 Hz



b. A signal with a frequency of 6 Hz

Figure 3.4 ***Two signals with the same amplitude and phase, but different frequencies***

Frequency and period are the inverse of each other.

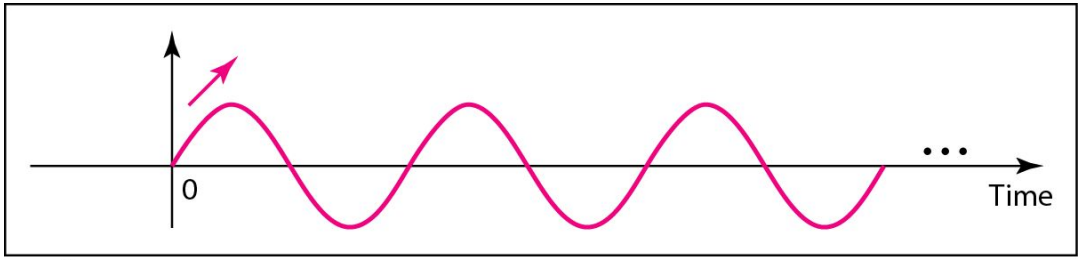
$$f = \frac{1}{T} \quad \text{and} \quad T = \frac{1}{f}$$

SINE WAVE

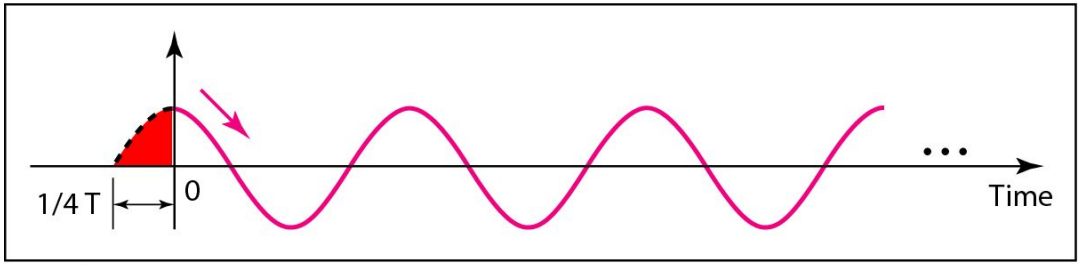
Frequency concerns:

- ✔ Frequency is the rate of change with respect to time.
- ✔ Change in a short span of time means high frequency.
- ✔ Change over a long span of time means low frequency.
- ✔ If a signal does not change at all, its frequency is zero.
- ✔ If a signal changes instantaneously, its frequency is infinite.

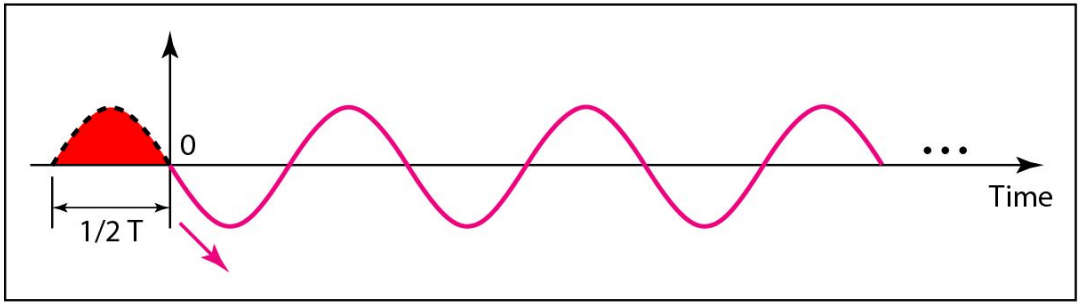
SINE WAVE



a. 0 degrees



b. 90 degrees



c. 180 degrees

Figure 3.5 ***Three sine waves with the same amplitude and frequency, but different phases.***

Phase describes the position of the waveform relative to time 0.

SINE WAVE

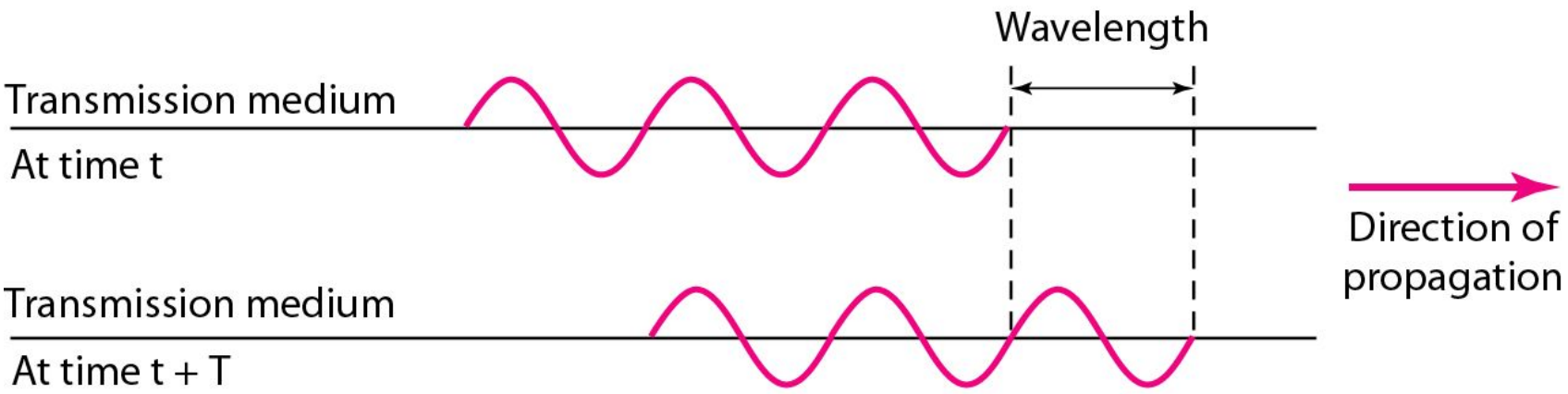


Figure 3.6 ***Wavelength and period***