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Keep progressing to attain a higher self.

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CAP275: Data Communication and Networking

Lecture 9

Signals

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Signals

ANALOG AND DIGITAL DATA TRANSMISSION

The terms analog and digital correspond to continuous and discrete respectively.

Data as entities that convey meaning, or information.

Signals are electric or electromagnetic representations of data.

Transmission is the communication of data by the propagation and processing of signals.

Analog and Digital Signaling

An analog signal is a continuously varying electromagnetic wave that may be propagated over a variety of media, depending on frequency;

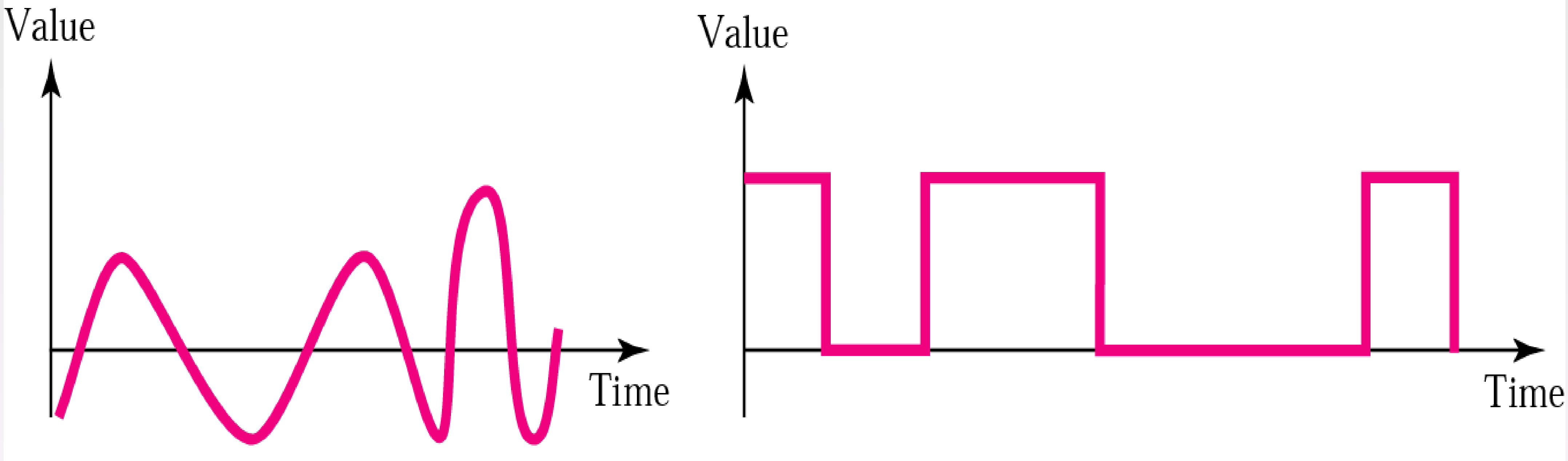
examples are copper wire media, such as twisted pair and coaxial cable; fiber optic cable; and atmosphere or space propagation (wireless).

Note:

To be transmitted, data must be transformed to electromagnetic signals.

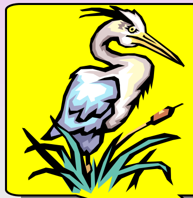
Note:

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.



a. Analog signal

b. Digital signal



Note:

In data communication, we commonly use periodic analog signals and aperiodic digital signals.

Figure 3.2 *A sine wave*

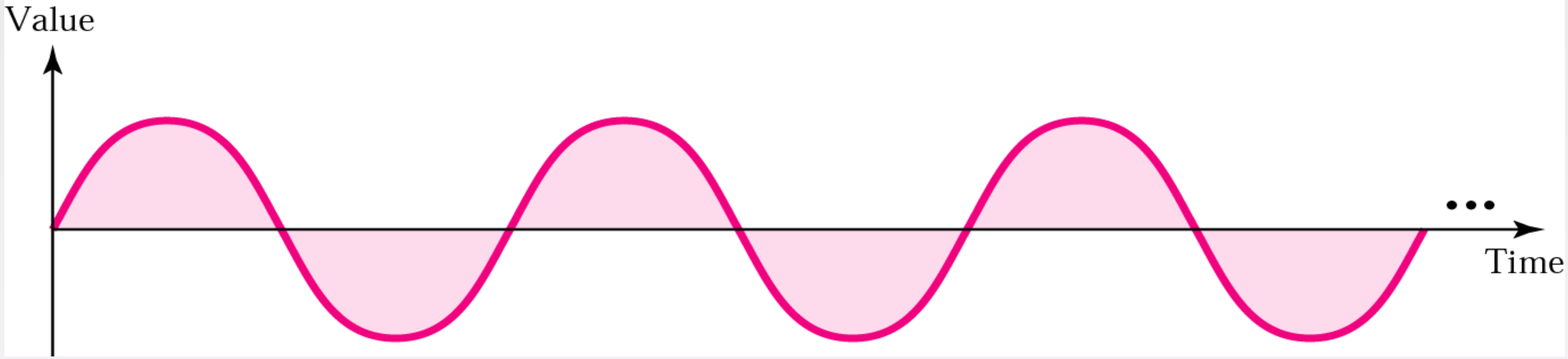
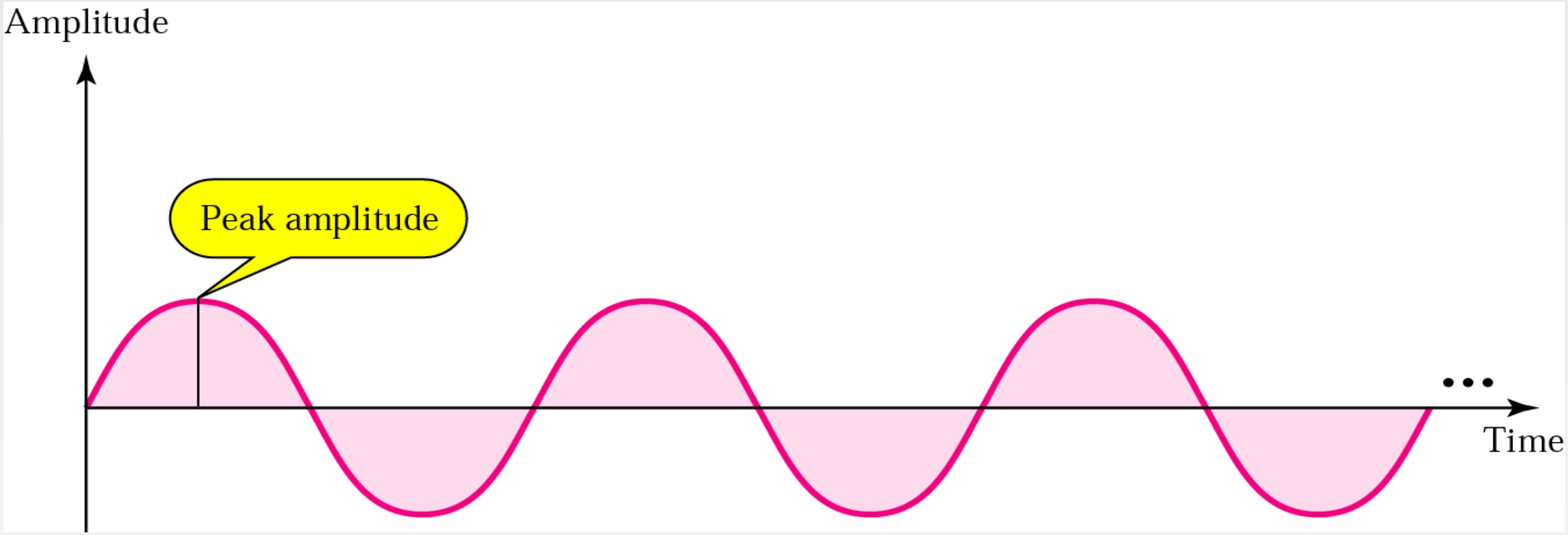
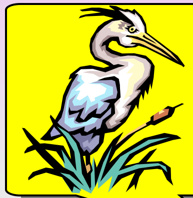


Figure 3.3 *Amplitude*





Note:

Frequency and period are inverses of each other.

Figure 3.4 *Period and frequency*

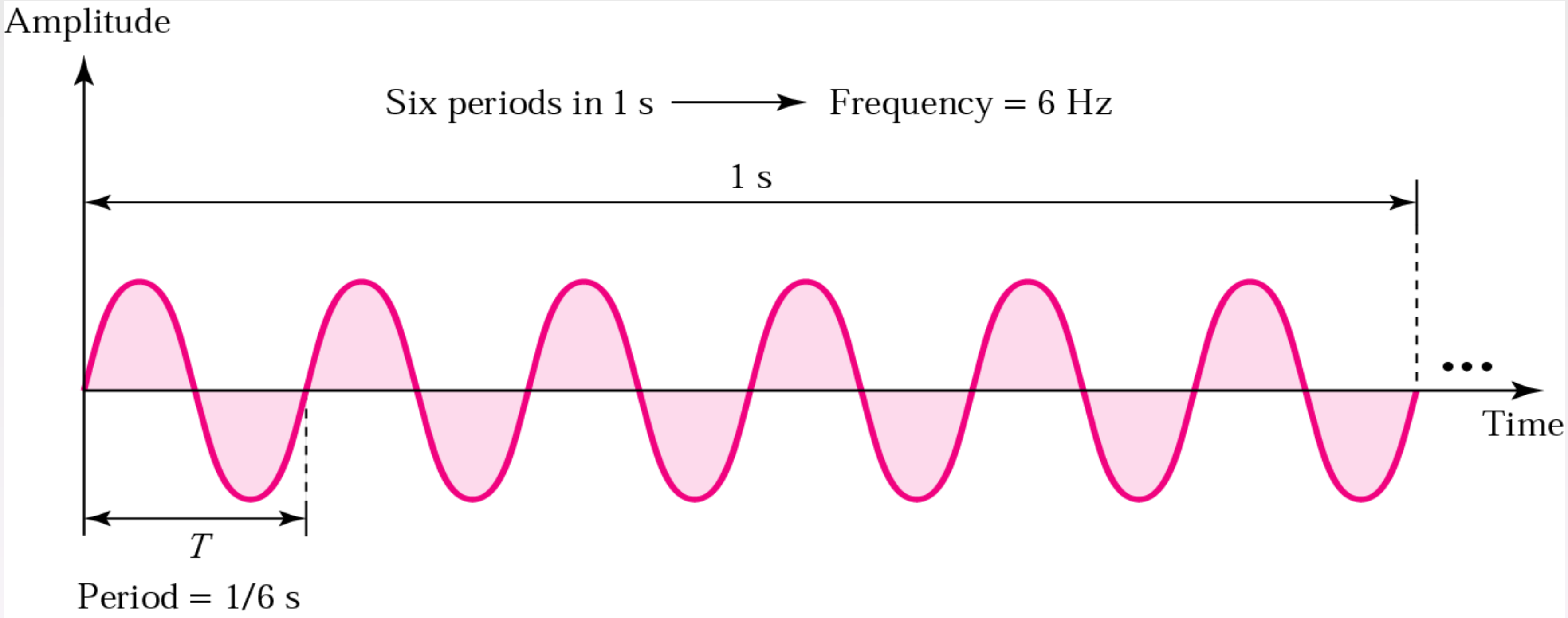


Table 3.1 Units of periods and frequencies

Unit	Equivalent	Unit	Equivalent
Seconds (s)	1 s	hertz (Hz)	1 Hz
Milliseconds (ms)	10^{-3} s	kilohertz (KHz)	10^{3} Hz
Microseconds (ms)	10^{-6} s	megahertz (MHz)	10^{6} Hz
Nanoseconds (ns)	10^{-9} s	gigahertz (GHz)	10^{9} Hz
Picoseconds (ps)	10^{-12} s	terahertz (THz)	10^{12} Hz

Example 1

Express a period of 100 ms in microseconds, and express the corresponding frequency in kilohertz.

Solution

From Table 3.1 we find the equivalent of 1 ms.We make the following substitutions:

$100 \text{ ms} = 100 \times 10^{-3} \text{ s} = 100 \times 10^{-3} \times 10^{6} \ \mu\text{s} = 10^{5} \ \mu\text{s}$

Now we use the inverse relationship to find the frequency, changing hertz to kilohertz

$100 \text{ ms} = 100 \times 10^{-3} \text{ s} = 10^{-1} \text{ s}$

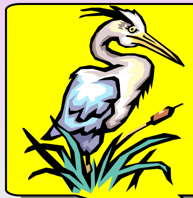
$f = 1/10^{-1} \text{ Hz} = 10 \times 10^{-3} \text{ KHz} = 10^{-2} \text{ KHz}$

Note:

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.

Note:

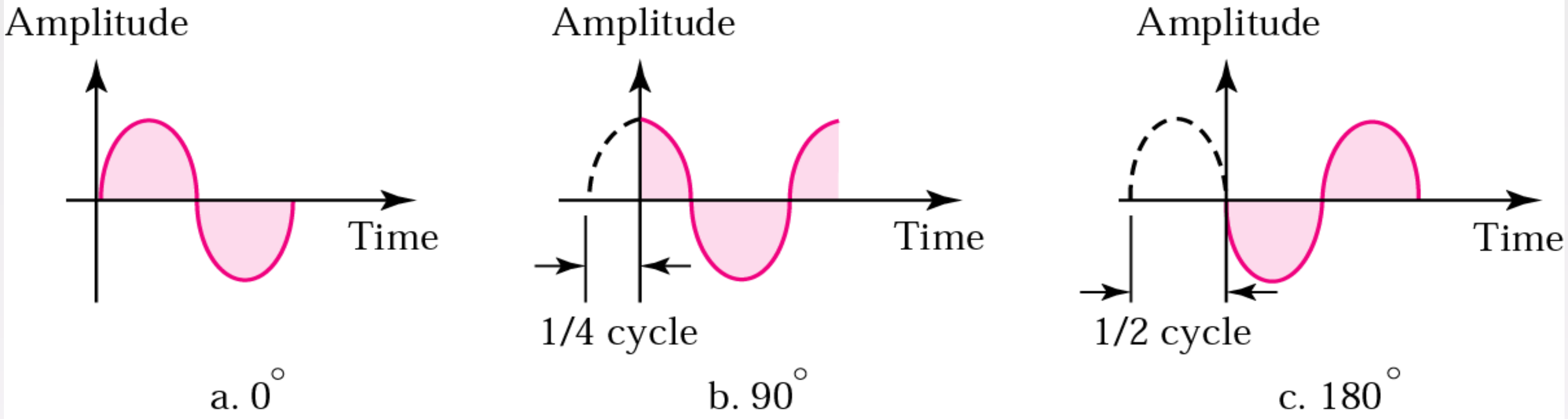
If a signal does not change at all, its frequency is zero. If a signal changes instantaneously, its frequency is infinite.



Note:

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

Figure 3.5 *Relationships between different phases*



Digital Signals

Digital Signaling

A digital signal is a sequence of voltage pulses that may be transmitted over a copper wire medium; for example, a constant positive voltage level may represent binary 0 and a constant negative voltage level may represent binary 1.

Figure 3.16 *A digital signal*

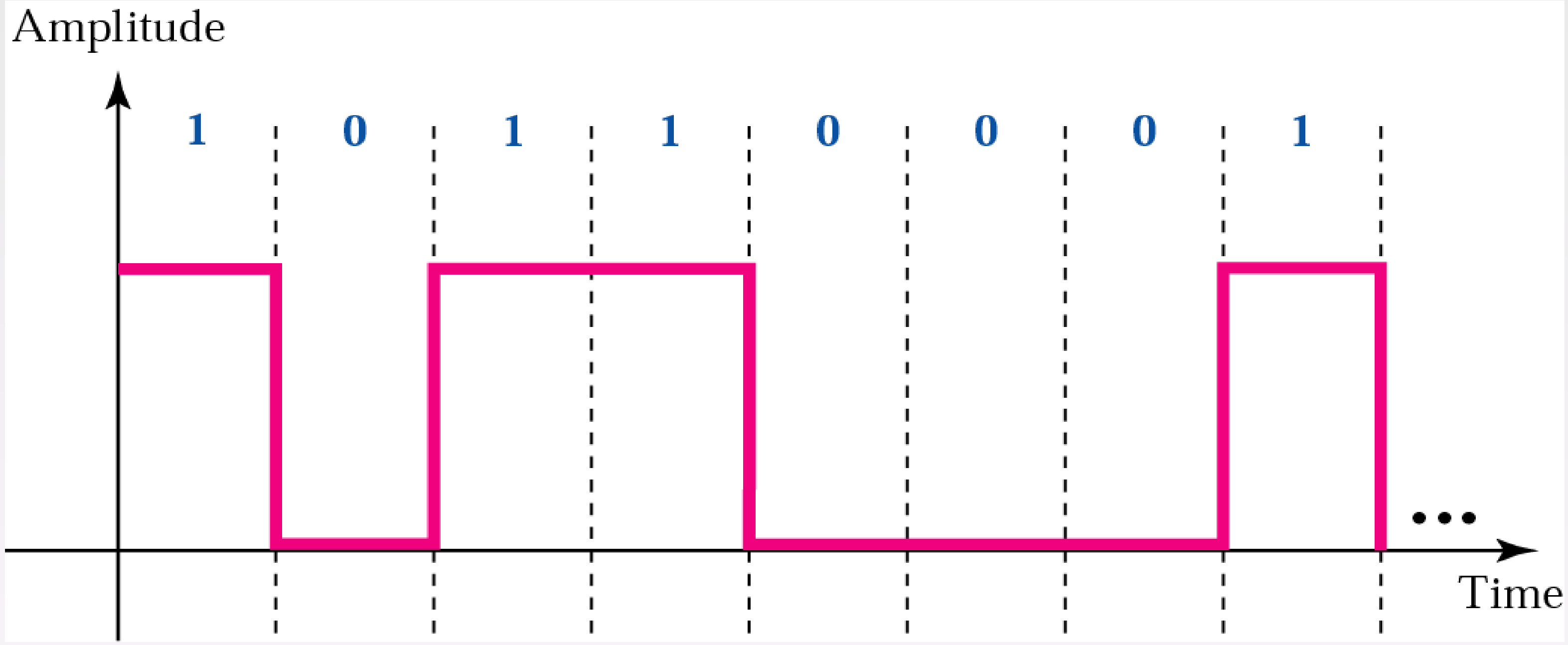
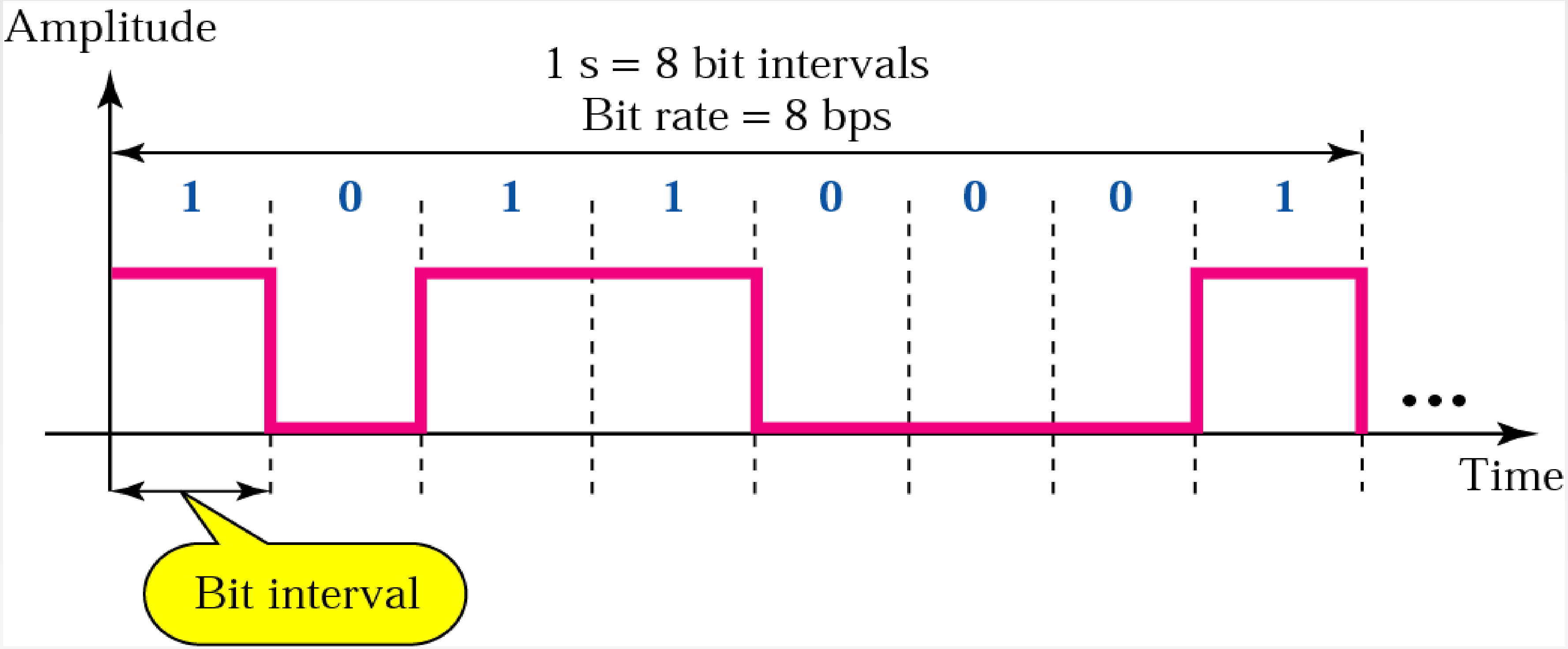


Figure 3.17 *Bit rate and bit interval*



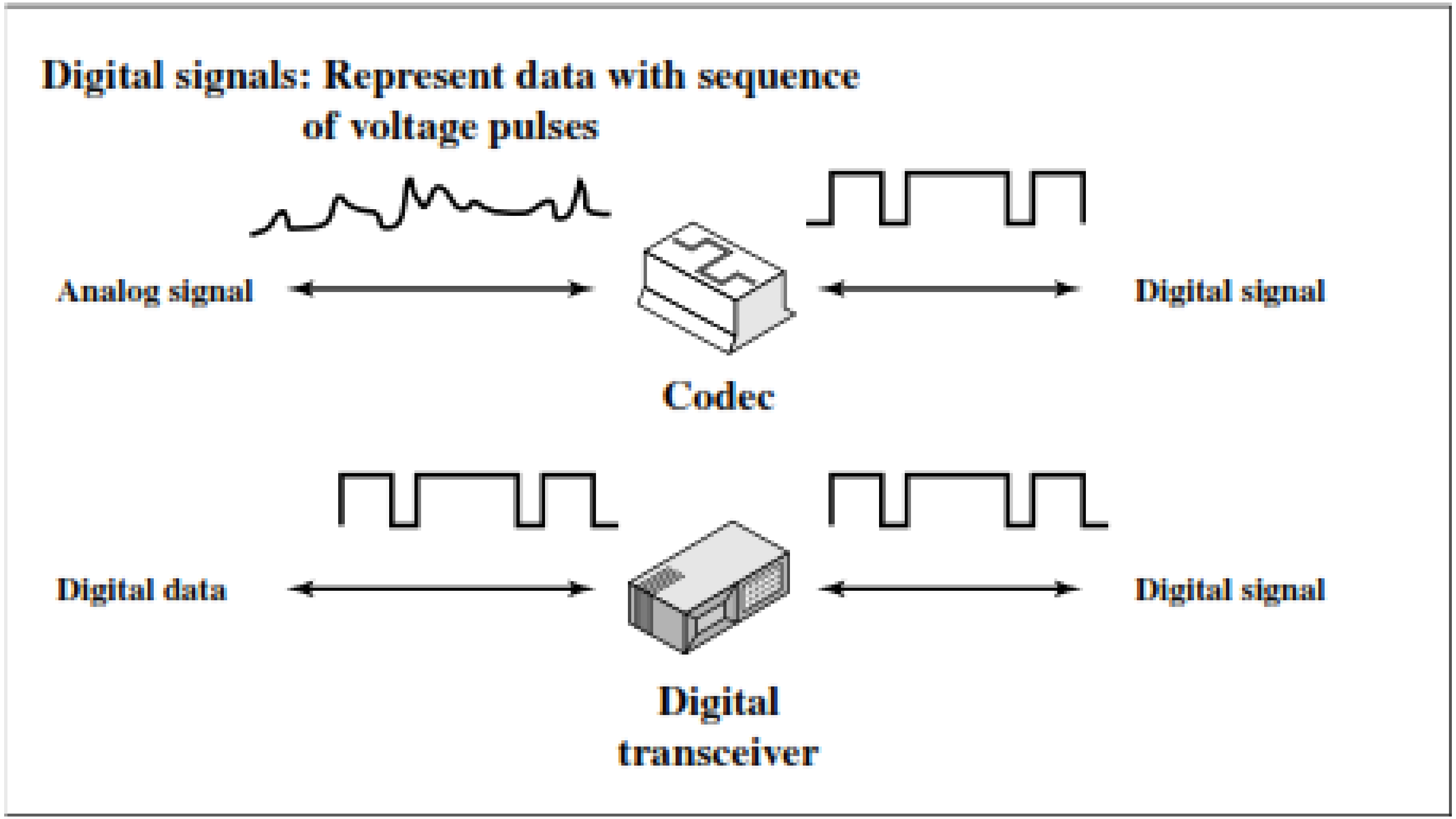
Example 6

A digital signal has a bit rate of 2000 bps. What is the duration of each bit (bit interval)

Solution

The bit interval is the inverse of the bit rate.

Bit interval = 1/ 2000 s = 0.000500 s
= 0.000500 x 10^6 μs = 500 μs


Digital signals: Represent data with sequence of voltage pulses
Analog signal
Digital signal
Codec
Digital data
Digital signal
Digital transceiver

Channel Capacity

There are four concepts here that we are trying to relate to one another:

Data rate: This is the rate, in bits per second (bps), at which data can be communicated.

Bandwidth: This is the bandwidth of the transmitted signal as constrained by the transmitter and the nature of the transmission medium, expressed in cycles per second, or Hertz.

Noise: For this discussion, we are concerned with the average level of noise over the communications path.

Error rate: This is the rate at which errors occur, where an error is the reception of a 1 when a 0 was transmitted or the reception of a 0 when a 1 was

Note:

The bit rate and the bandwidth are proportional to each other.

Note:

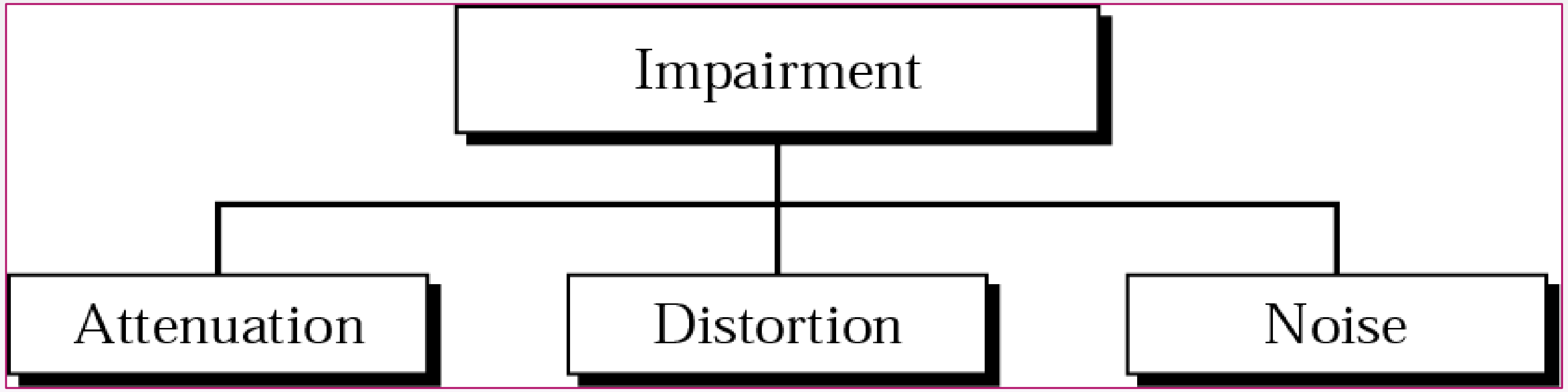
The analog bandwidth of a medium is expressed in hertz; the digital bandwidth, in bits per second.

Transmission Impairment

Attenuation

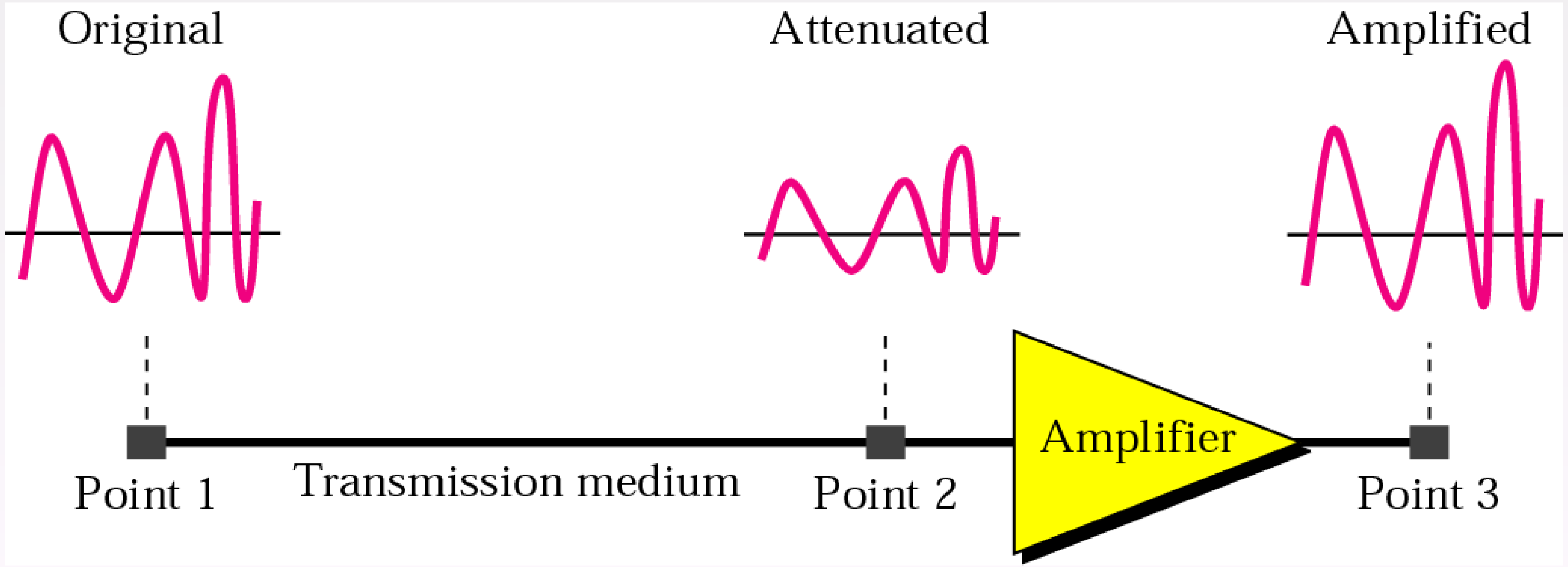
Distortion

Noise



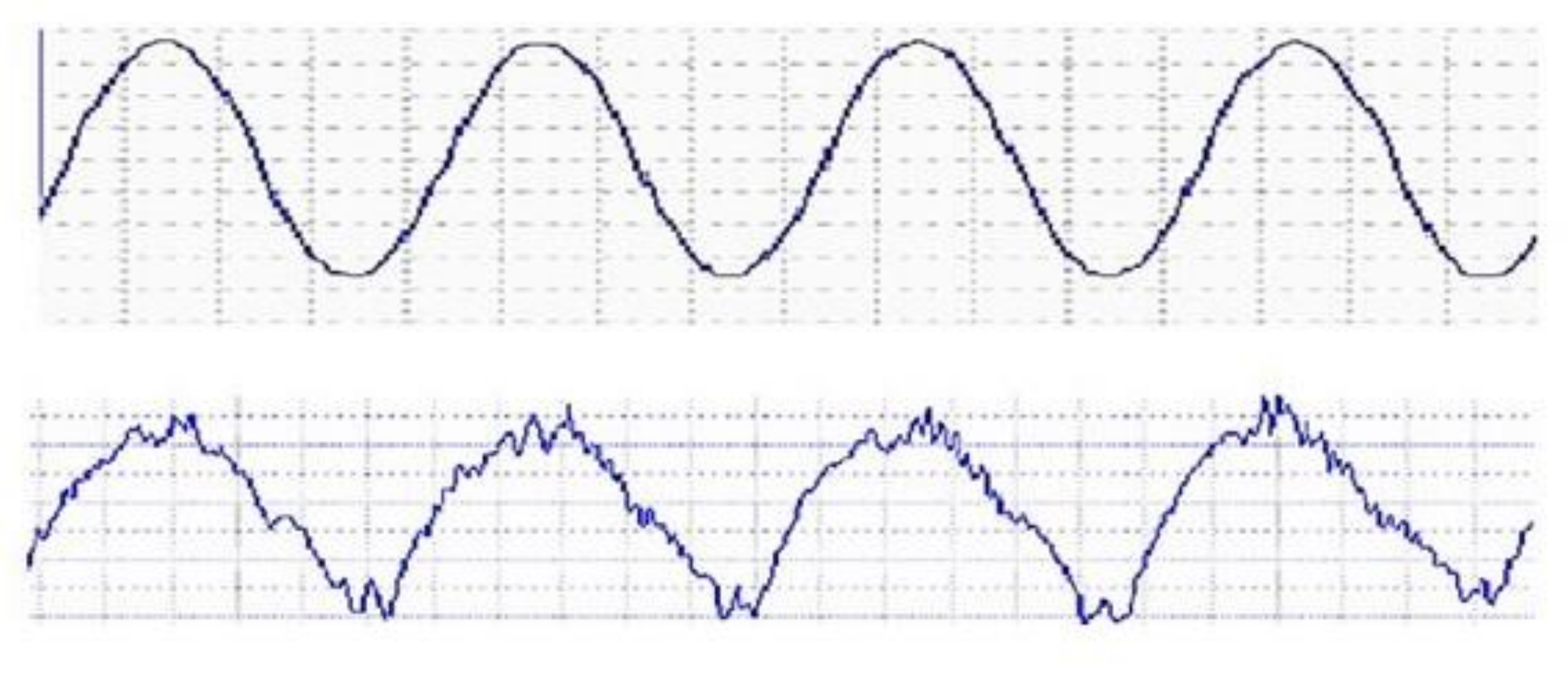
Attenuation

Attenuation is the loss of signal strength in networking cables or connections. This typically is measured in decibels (dB) or voltage and can occur due to a variety of factors. It may cause signals to become distorted or indiscernible. An example of this is Wi-Fi signal and strength getting noticeably weaker the farther that your device is from the router.



Distortion

Distortion, in acoustics and electronics, any change in a signal that alters the basic waveform or the relationship between various frequency components; it is usually a degradation of the signal.



Noise

Noise in a communication system is basically undesirable or unwanted signals that get randomly added to the actual information carrying signal. Resultantly, causes disturbances in the original signal being transmitted from an end to another.

The presence of noise in the system causes interference in the signal being transmitted and this ultimately causes errors in the communication system.

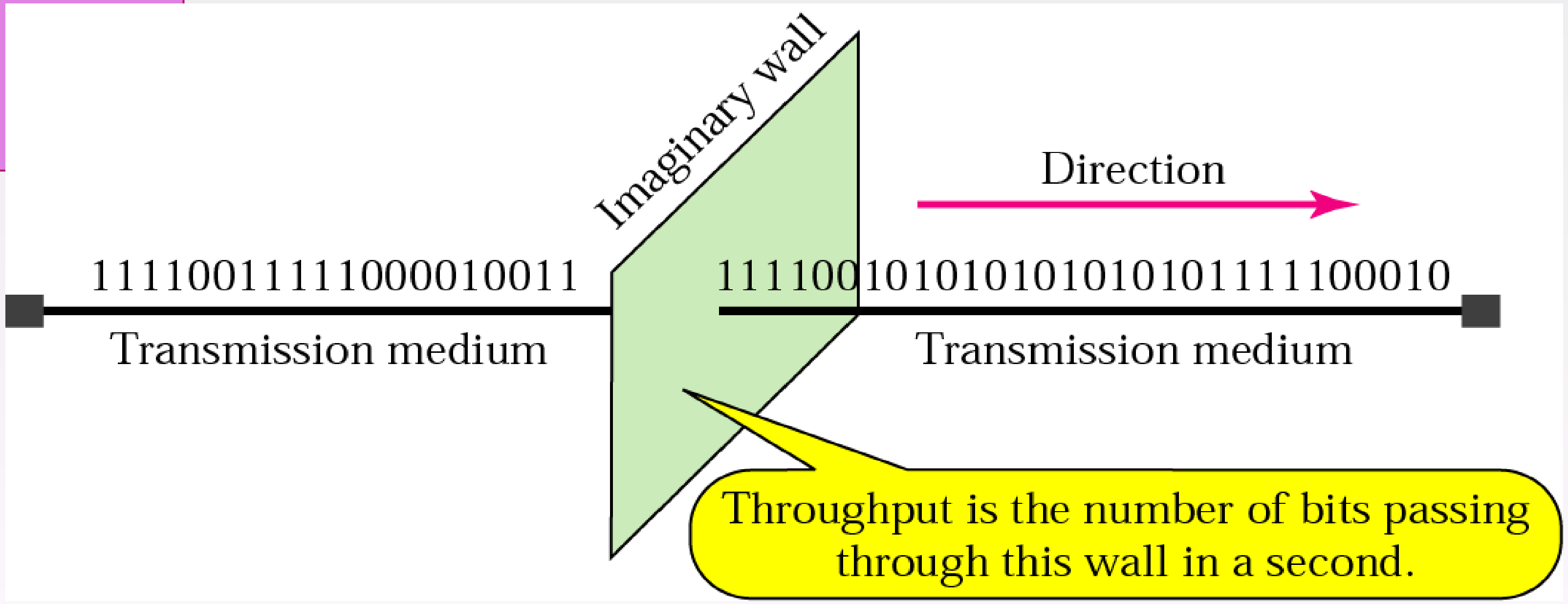
More About Signals

Throughput

Propagation Speed

Propagation Time

Wavelength



More About Signals

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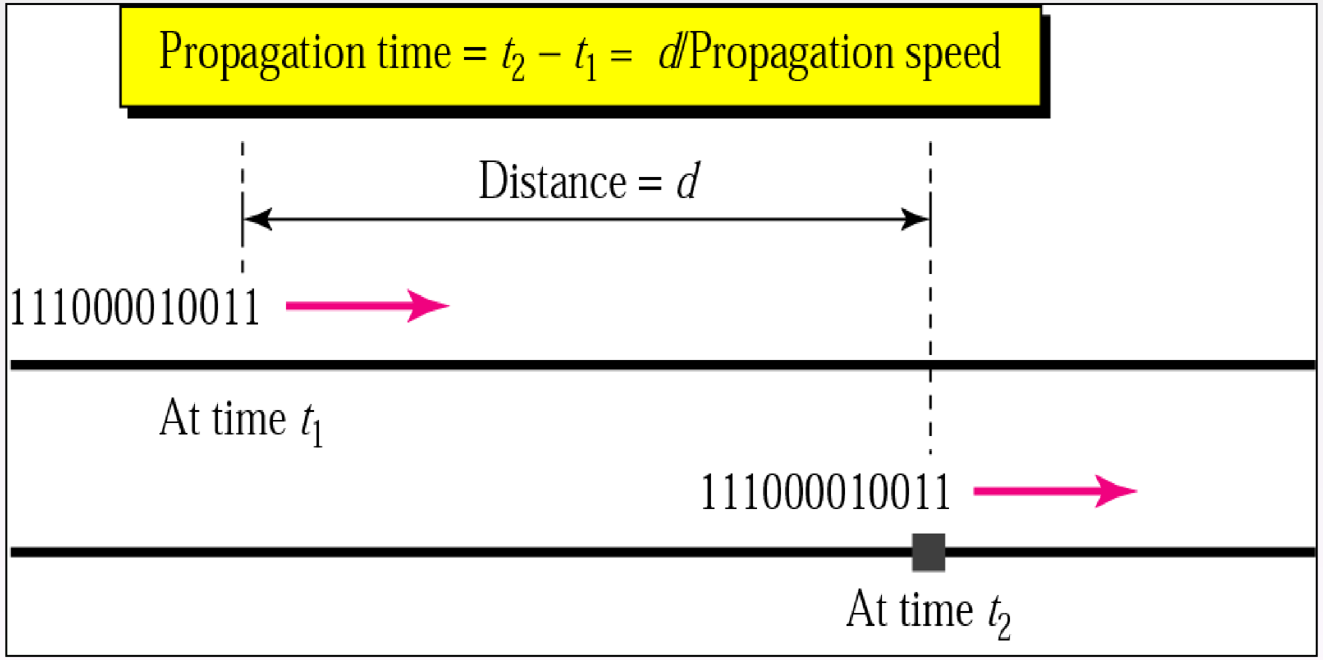

More About Signals

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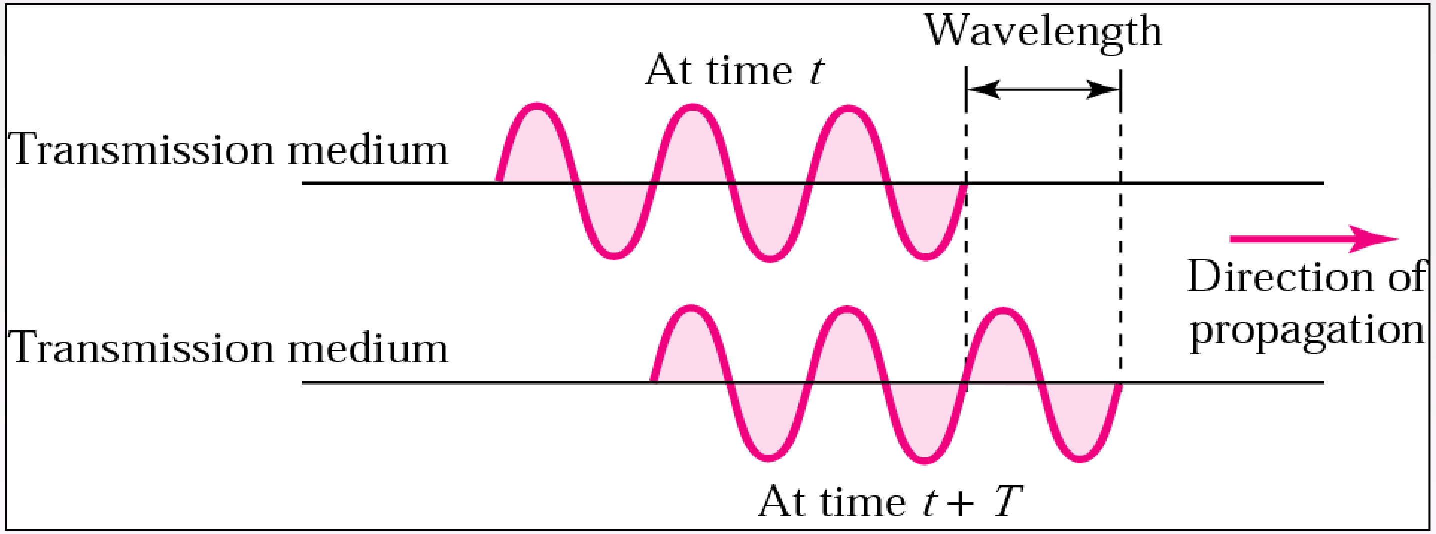

Multiple Choice Questions

____________ is a type of transmission impairment in which the signal loses strength due to the resistance of the transmission medium

a. Attenuation
b. Distortion
c. Noise
d. Rectification

. __________________ is a type of transmission impairment in which the signal loses strength due to the different propagation speeds of each frequency that makes up the signal.

a. Attenuation
b. Distortion
c. Noise
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Multiple Choice Questions

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Multiple Choice Questions

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Multiple Choice Questions

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See you in next class