# CAP275: Data Communication and Networking
# Unit-2: Physical Layer

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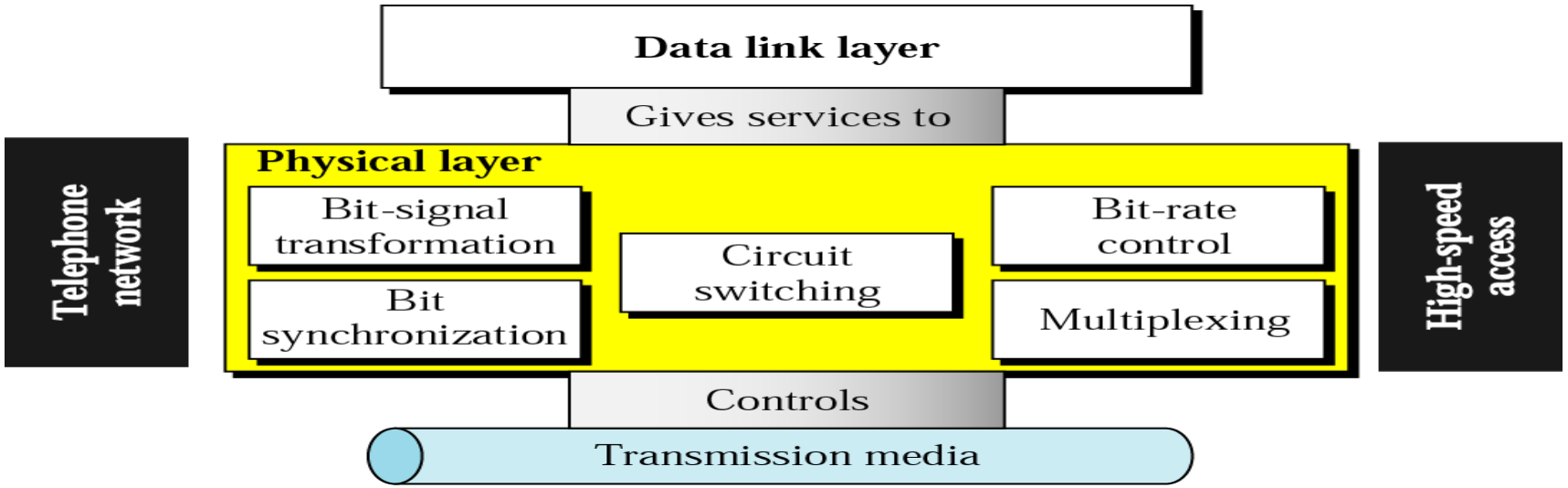
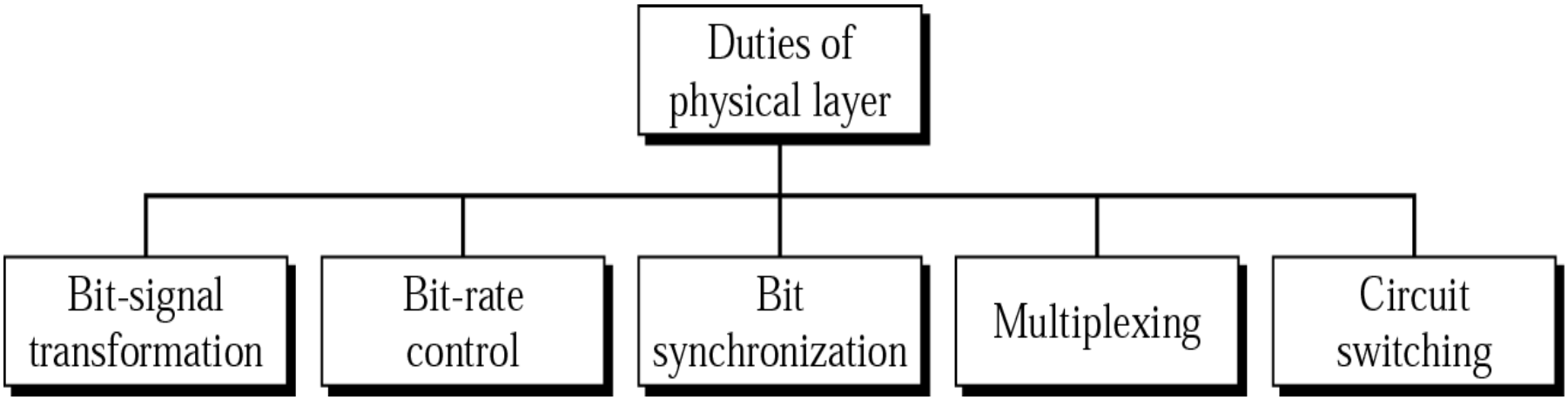
# Physical Layer

- The physical layer is the layer that actually interacts with the transmission media, the physical part of the network that connects network components together.
- This layer is involved in physically carrying information from one node in the network to the next node in the network.
- The physical layer has complex tasks to perform. One major task is to provide services for the data link layer.



# Services of Physical Layer

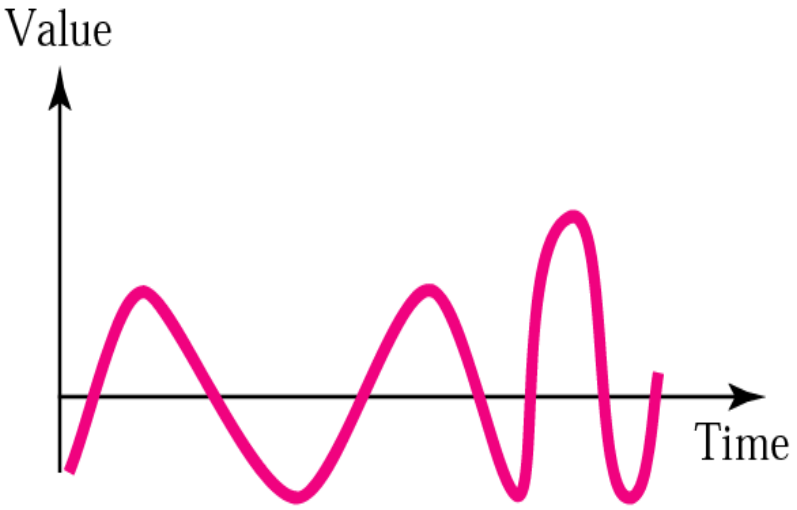


# Data and Signals

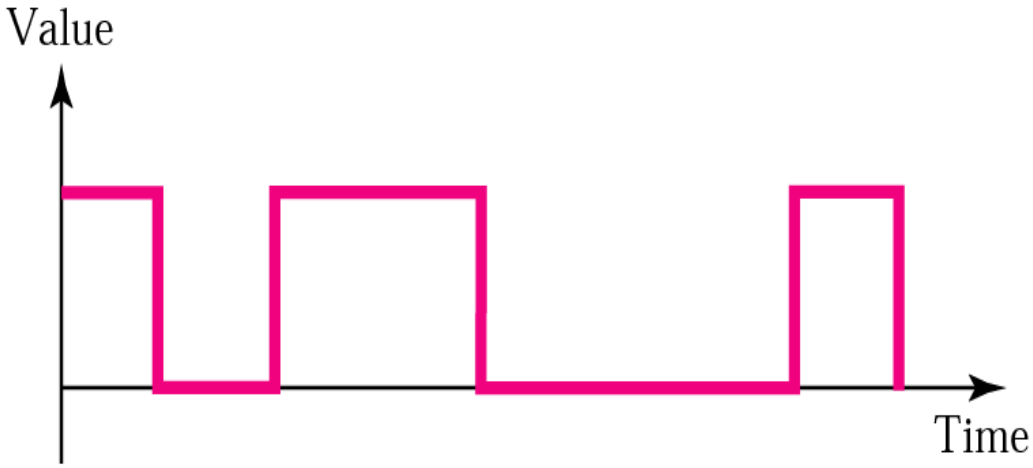
- The data in the data link layer consists of 0s and 1s organized into frames that are ready to be sent across the transmission medium.
- This stream of 0s and 1s must first be converted into another entity: **signals**. One of the services provided by the physical layer is to create a signal that represents this stream of bits.
- The physical layer must also take care of the **physical network**, the transmission medium. The transmission medium is a passive entity; it has no internal program or logic for control like other layers. The transmission medium must be controlled by the physical layer.
- The physical layer decides on the **directions of data flow**. The physical layer decides on the number of logical channels for transporting data coming from different sources.

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

*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



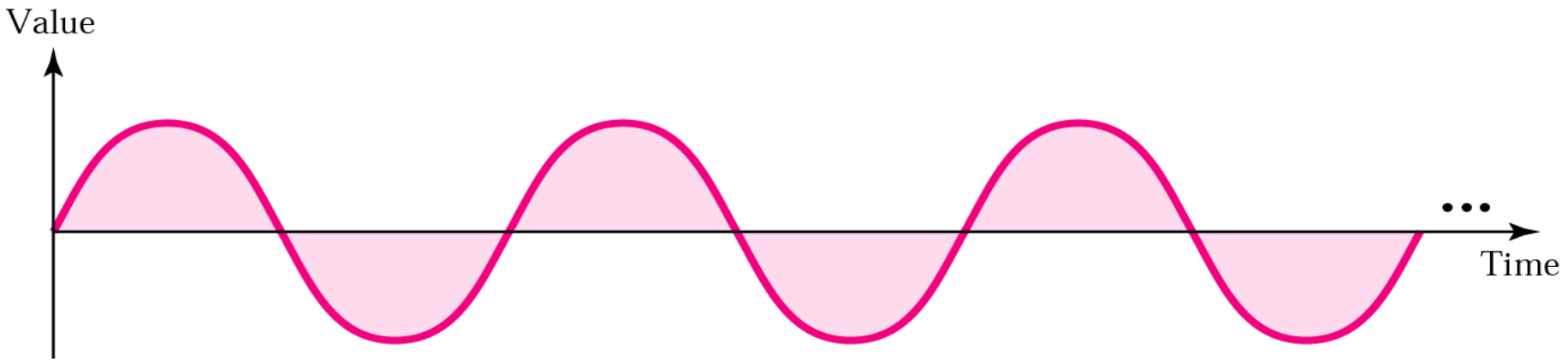

b. Digital signal

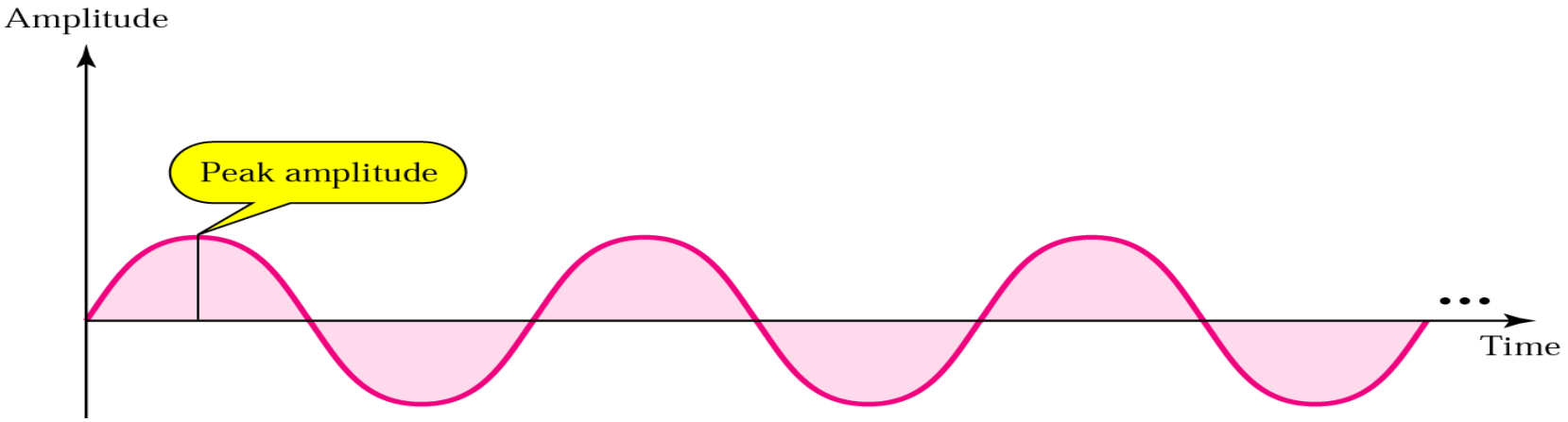
# Periodic and Aperiodic Signals

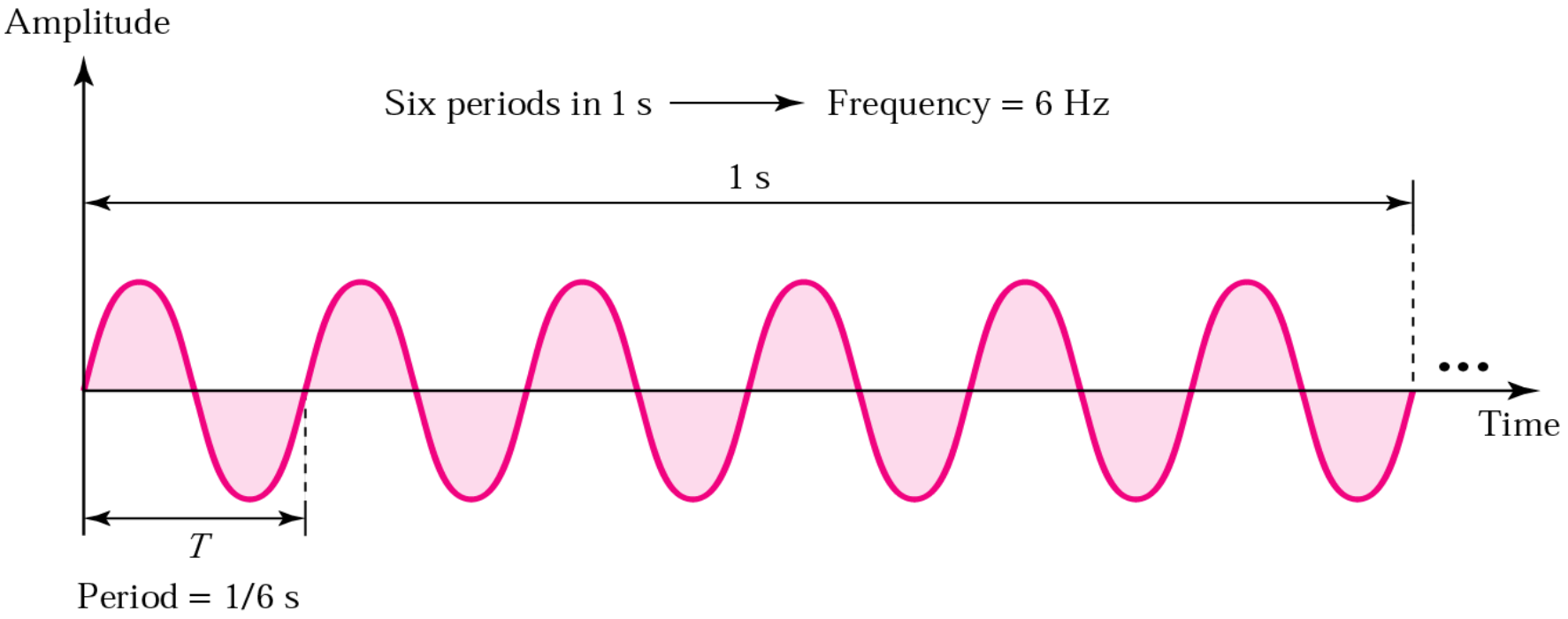
*In data communication, we commonly use periodic analog signals and aperiodic digital signals.*

# 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.



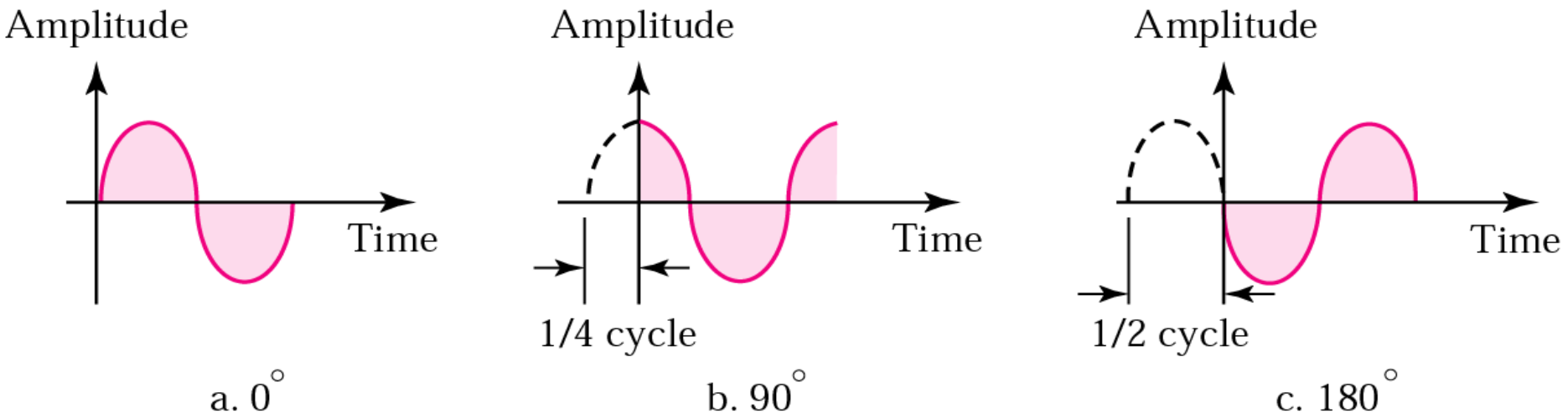

Amplitude
Peak amplitude
Time


Amplitude
Six periods in 1 s
Frequency = 6 Hz
1 s
Time
T
Period = 1/6 s

*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.*

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

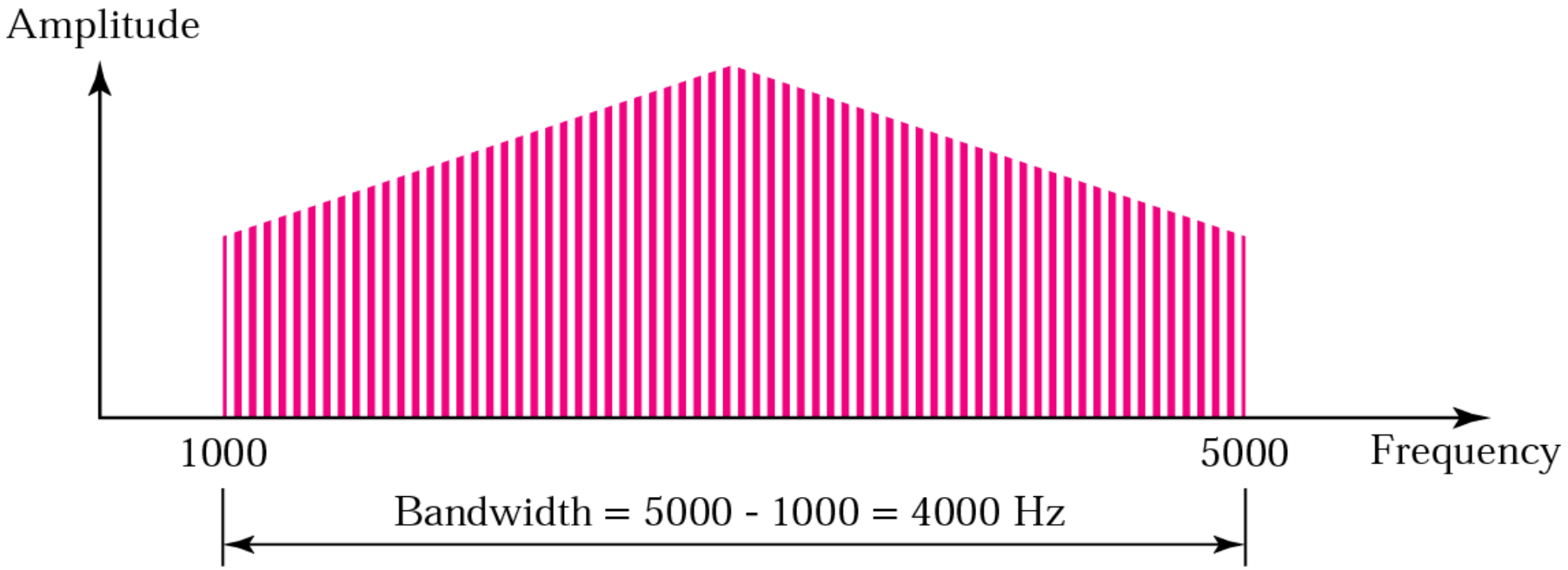



a. 0°

b. 90°

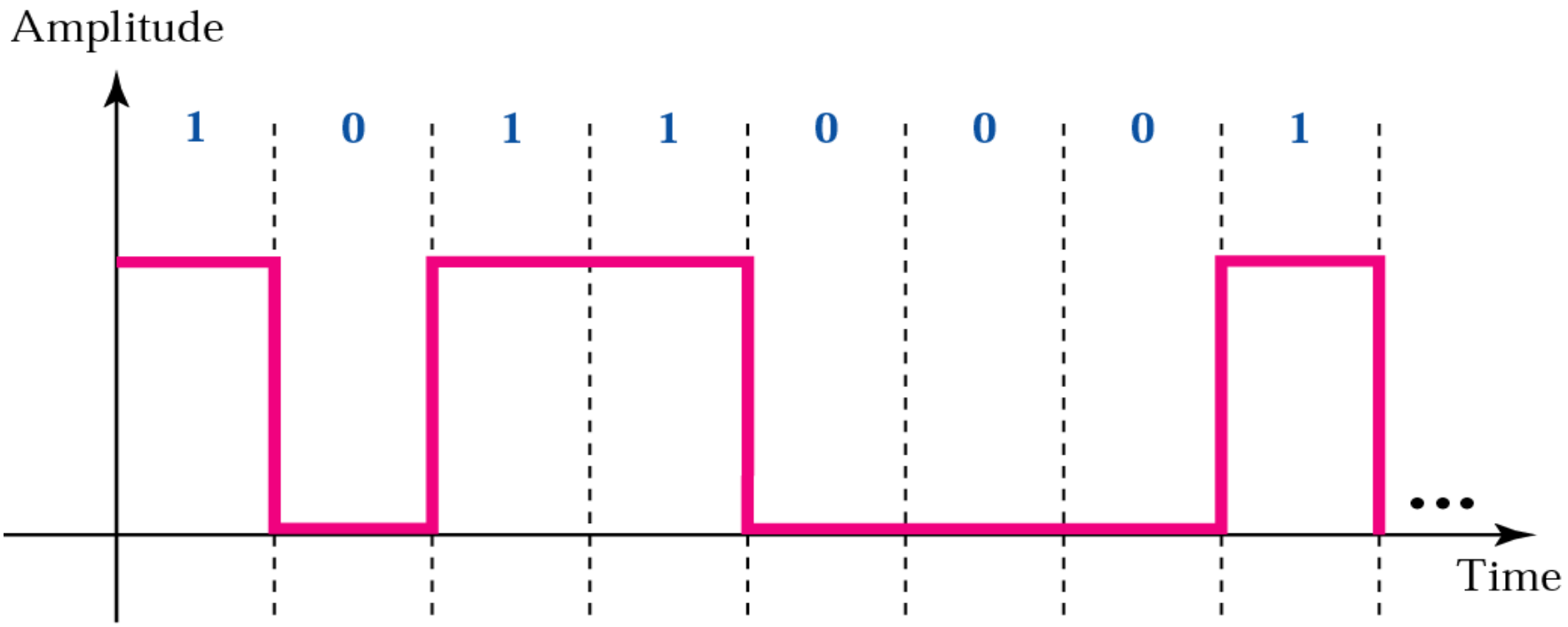
c. 180°

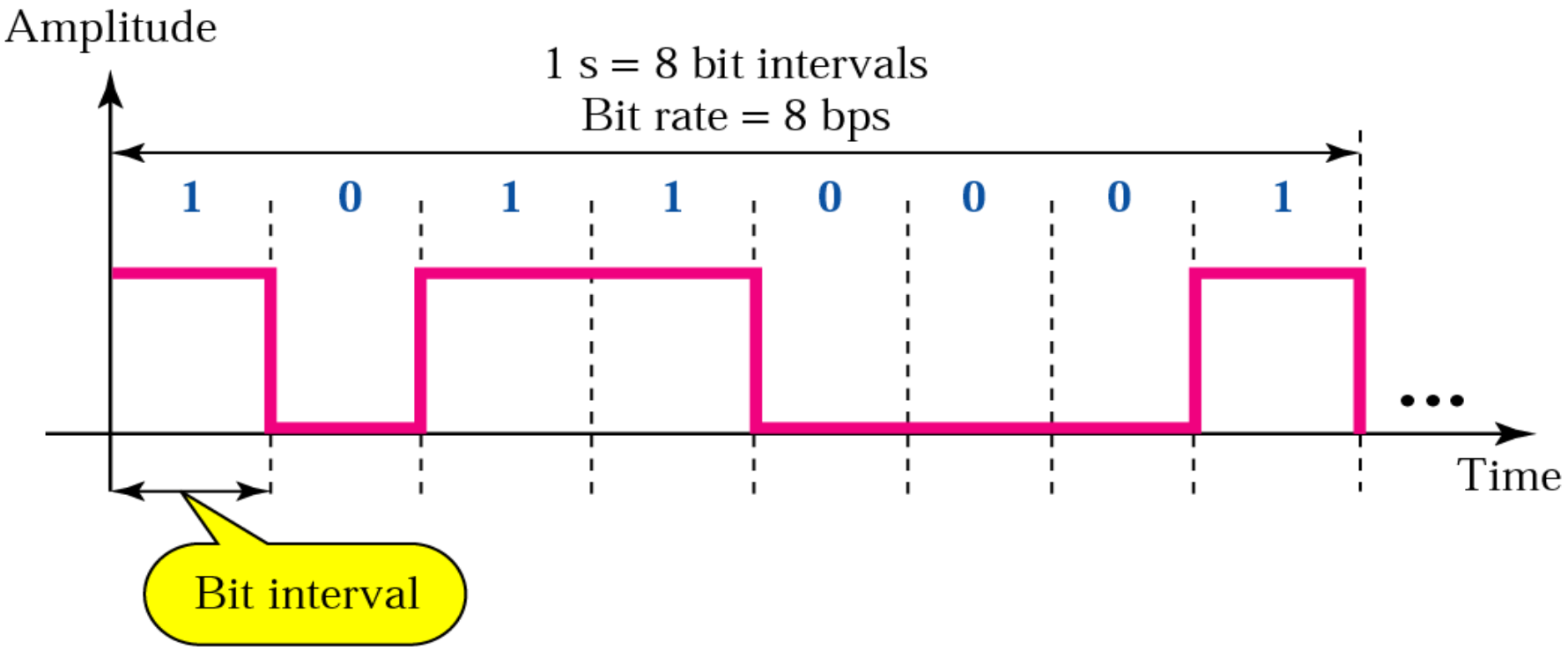
*The bandwidth is a property of a medium: It is the difference between the highest and the lowest frequencies that the medium can satisfactorily pass.*



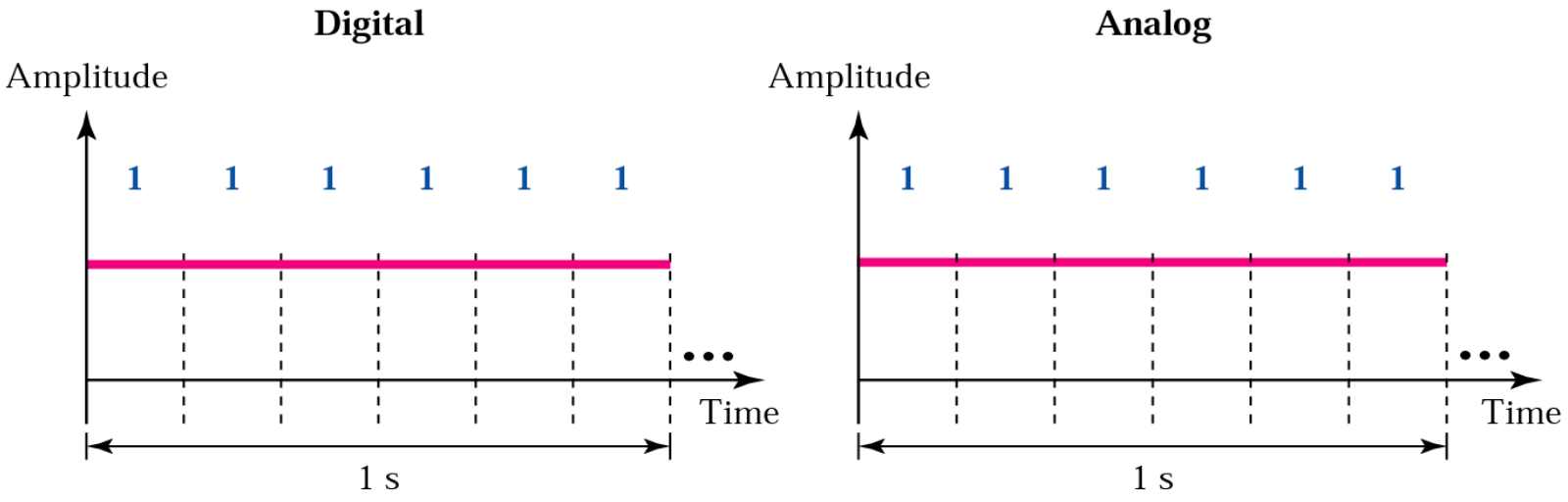
# Digital Signals

*A digital signal is a composite signal with an infinite bandwidth.*

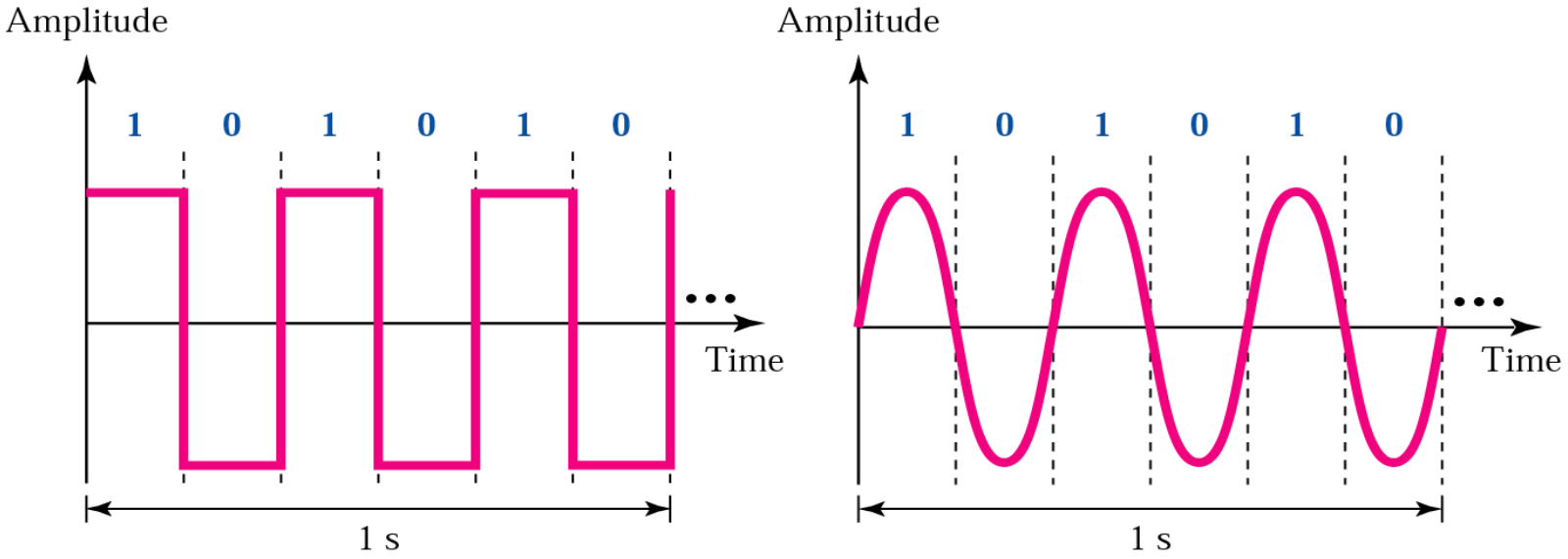



Amplitude
1 s = 8 bit intervals
Bit rate = 8 bps
1 0 1 1 0 0 0 1
Time
Bit interval

# Digital v/s Analog



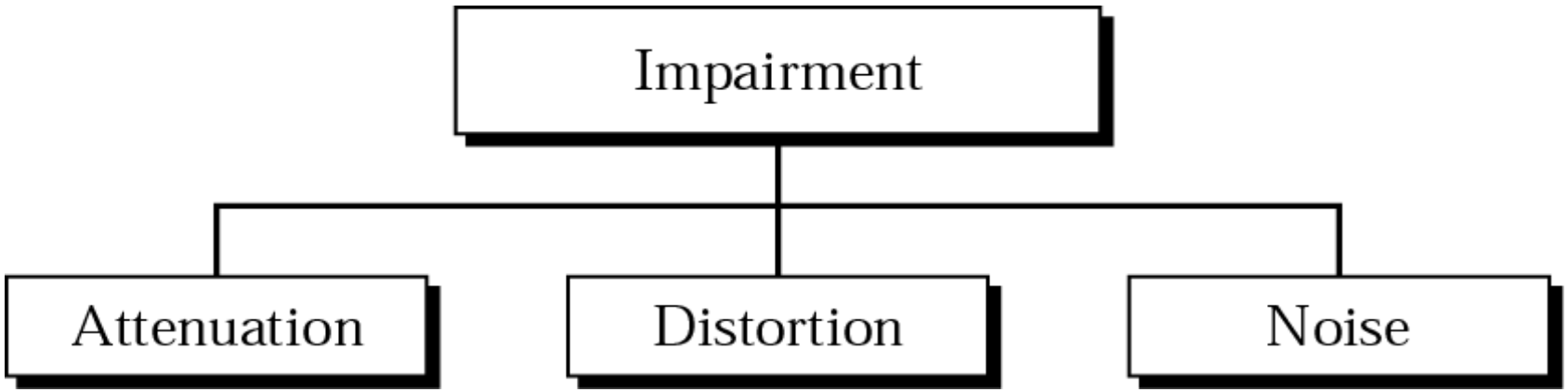

a. Best case, bit rate = 6, $f = 0$



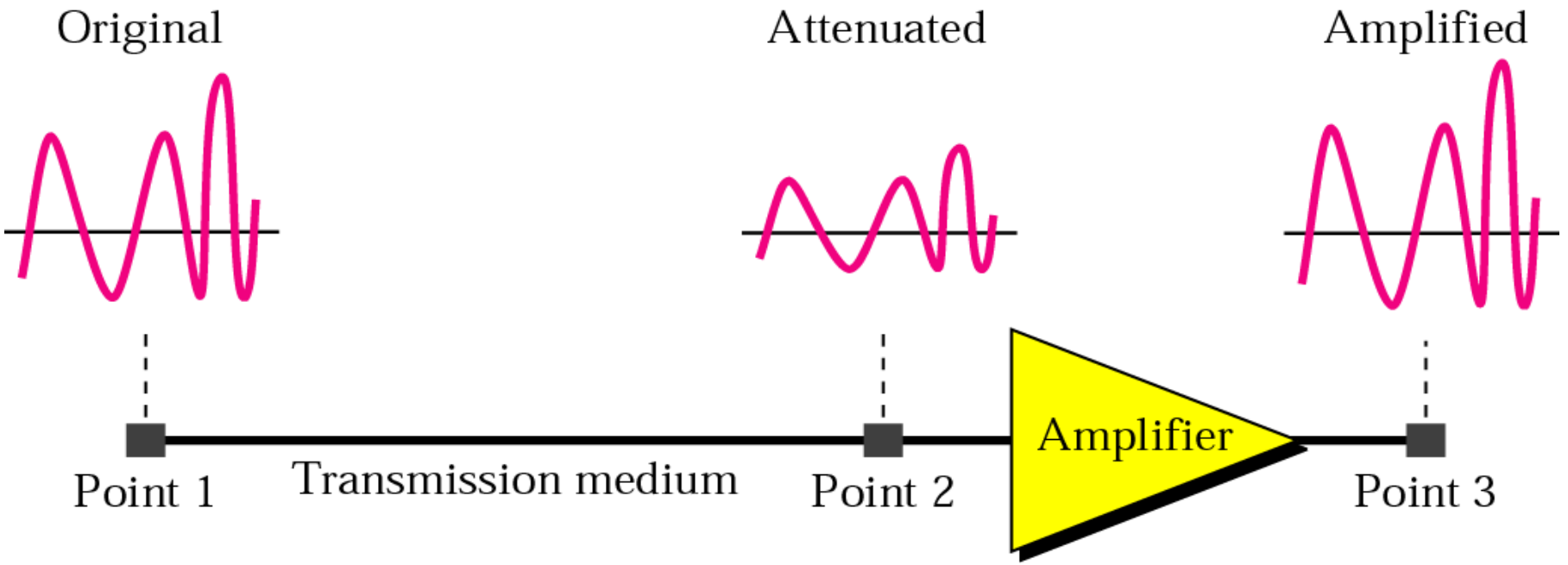

b. Worst case, bit rate = 6, $f = 3$

# Transmission Impairment

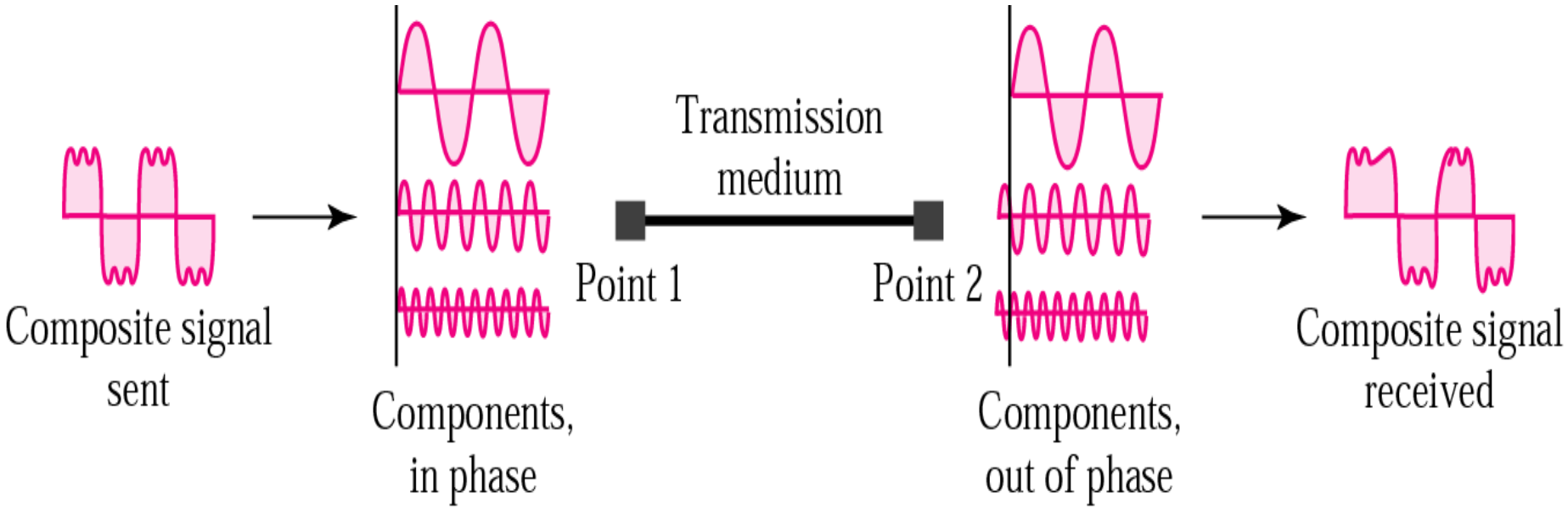
- *Attenuation*
- *Distortion*
- *Noise*



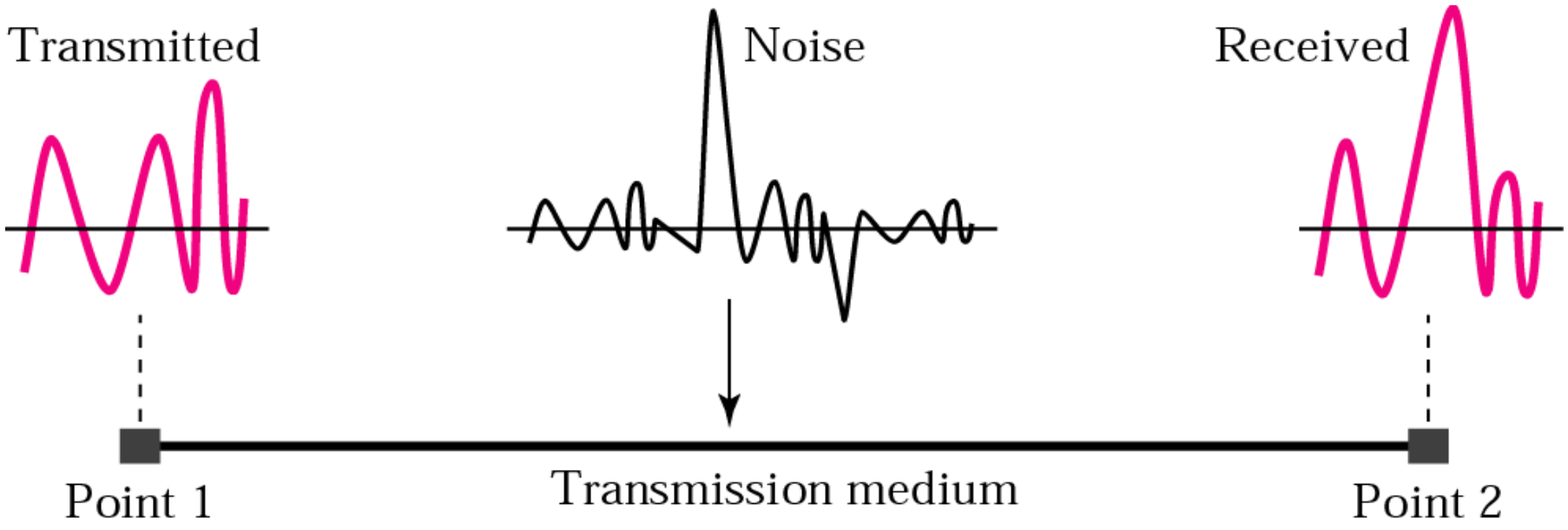
# Attenuation



# Distortion


Composite signal sent
Components, in phase
Transmission medium
Point 1
Point 2
Components, out of phase
Composite signal received

# Noise


Transmitted
Noise
Received
Point 1
Transmission medium
Point 2

# 3.7 More About Signals

*Throughput*

*Propagation Speed*

*Propagation Time*

*Wavelength*

Figure 3.25 *Throughput*

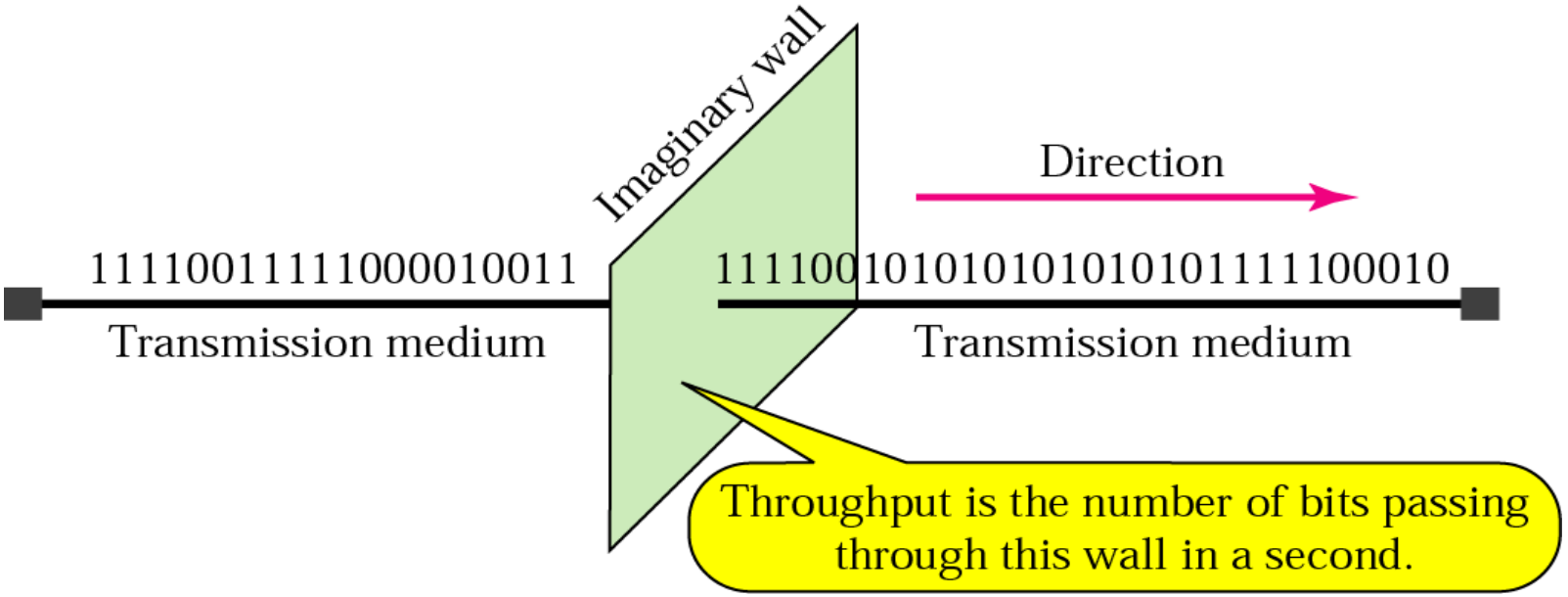


Figure 3.26 *Propagation time*

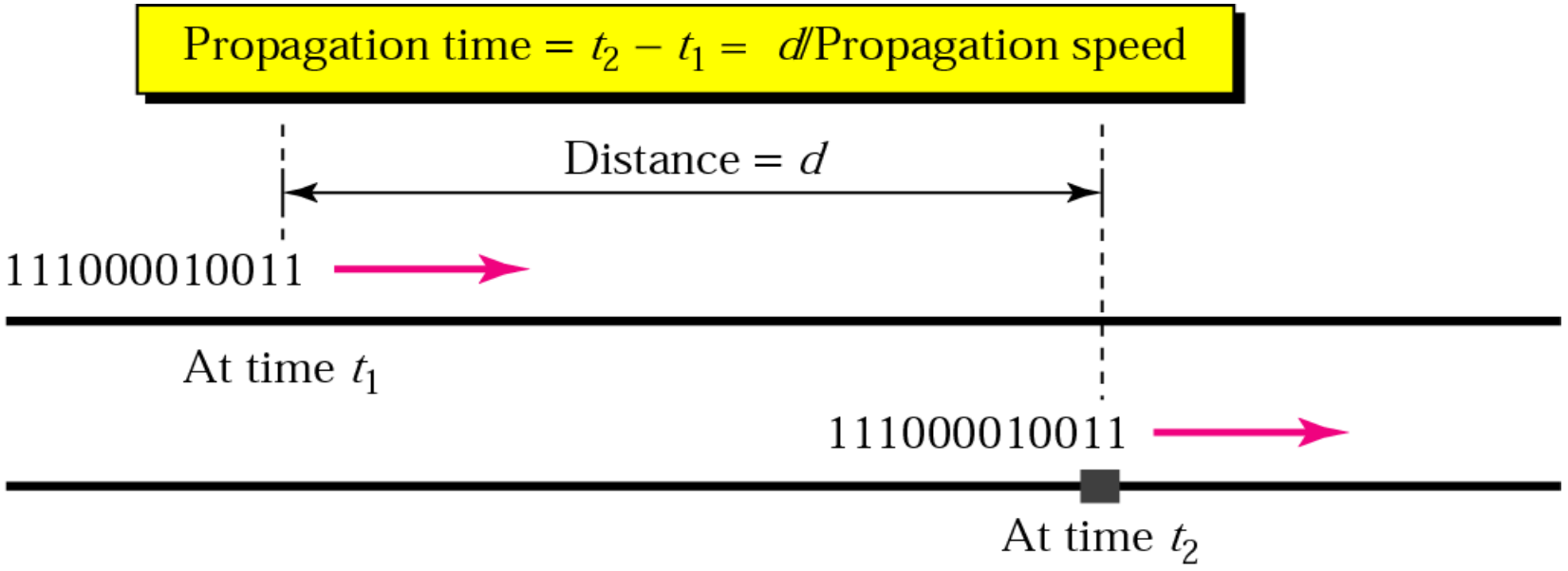


Figure 3.27 *Wavelength*