

# Open system Interconnection (OSI)

## Physical Layer

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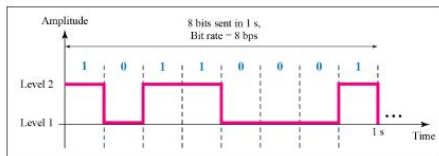
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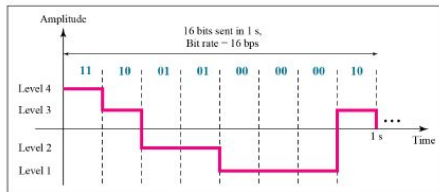
# Digital Signal

- In addition to being represented by an analog signal, information can also be represented by a digital signal.
- A digital signal has eight levels. How many bits are needed per level? We calculate the number of bits from the formula

$$\text{Number of bits per level} = \log_2 8 = 3$$



a. A digital signal with two levels



b. A digital signal with four levels



# Bit Rate

- Most digital signals are non-periodic, and thus period and frequency are not appropriate characteristics.
- Another term-bit rate (instead of frequency)-is used to describe digital signals.
- The bit rate is the number of bits sent in **1s**, expressed in **bits per second (bps)**
- Assume we need to download text documents at the rate of 100 pages per minute. What is the required bit rate of the channel?

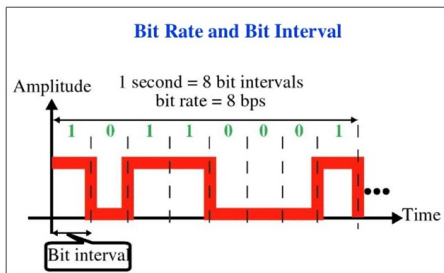
$$100 \times 24 \times 80 \times 8 = 1,636,000 \text{ bps} = 1.636 \text{ Mbps}$$



# Bit Length

- We discussed the concept of the wavelength for an analog signal: the distance one cycle occupies on the transmission medium.
- We can define something similar for a digital signal: the bit length
- The bit length is the distance one bit occupies on the transmission medium.

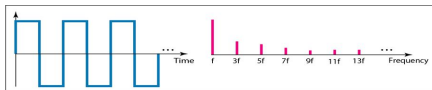
$$\text{Bit length} = \text{propagation speed} \times \text{bit duration}$$



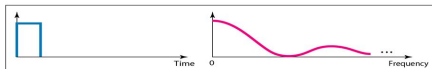
# Digital Signal as a Composite Analog Signal

- Based on Fourier analysis, a digital signal is a composite analog signal
- A digital signal, in the time domain, comprises connected vertical and horizontal line segments.
- A vertical line in the time domain means a frequency of infinity (sudden change in time)
- A horizontal line in the time domain means a frequency of zero (no change in time)

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



a. Time and frequency domains of periodic digital signal



b. Time and frequency domains of nonperiodic digital signal

*The time and frequency domains of periodic and nonperiodic digital signals. both bandwidths are infinite, but the periodic signal has discrete frequencies while the nonperiodic signal has continuous frequency*



# Transmission of Digital Signals

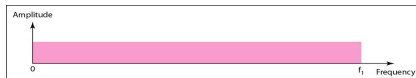
- We can transmit a digital signal by using one of two different approaches:
  - **Baseband transmission**
  - **Broadband transmission (using modulation).**
- Baseband transmission means sending a digital signal over a channel without changing the digital signal to an analog signal.
- We need to remember that a low-pass channel with infinite bandwidth is ideal

Figure 3.18 Baseband transmission

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



Figure 3.19 Bandwidths of two low-pass channels



a. Low-pass channel, wide bandwidth



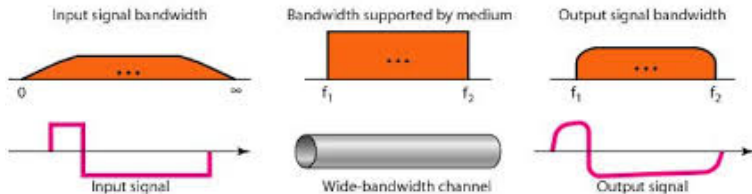
b. Low-pass channel, narrow bandwidth



# Transmission Difficulty

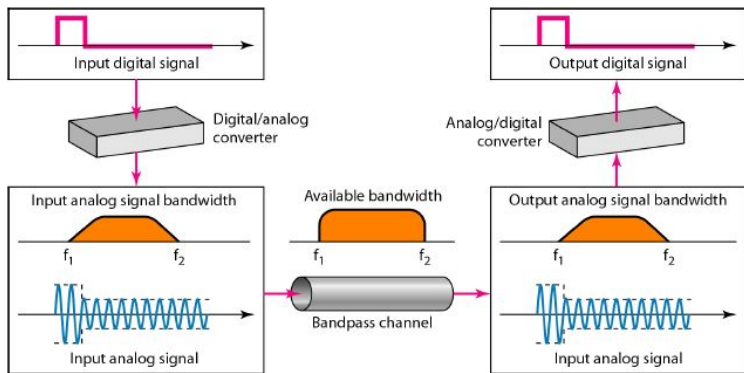
- **Low-Pass Channel with Wide Bandwidth**

- Baseband transmission of a digital signal that preserves the shape of the digital signal is possible only if we have a low-pass channel with an infinite or very wide bandwidth.
- In baseband transmission, the required bandwidth is proportional to the bit rate; if we need to send bits faster, we need more bandwidth.



# Broadband Transmission (Using Modulation)

- Broadband transmission or modulation means changing the digital signal to an analog signal for transmission.
- Modulation allows us to use a bandpass channel-a channel with a bandwidth that does not start from zero.





*Thank You*

