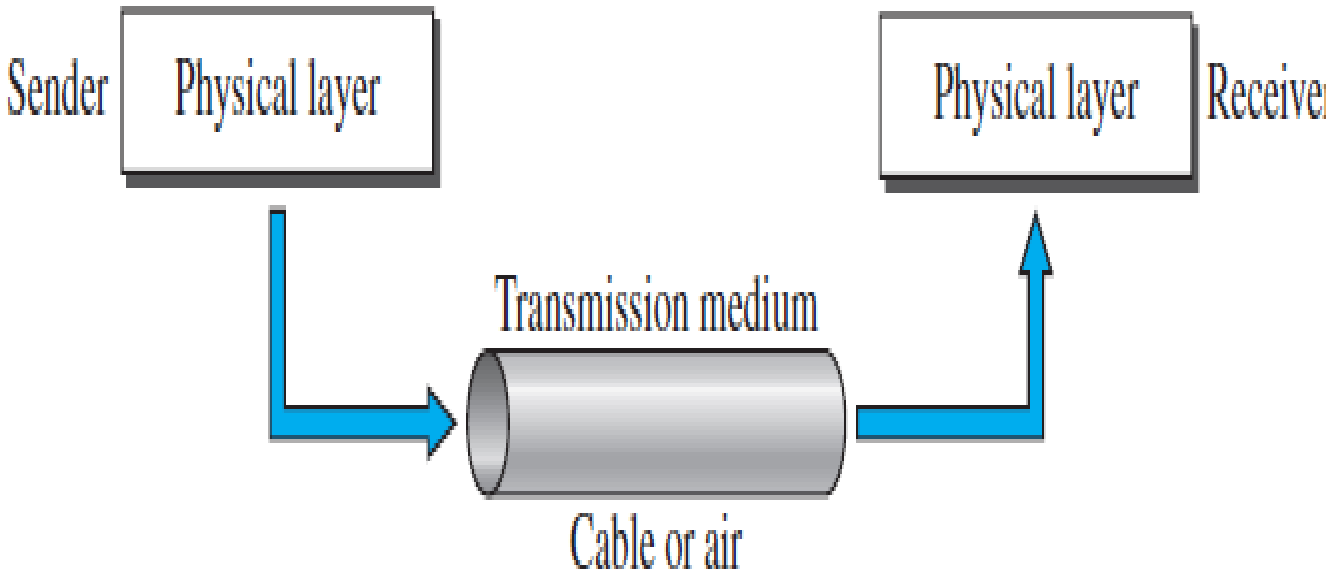
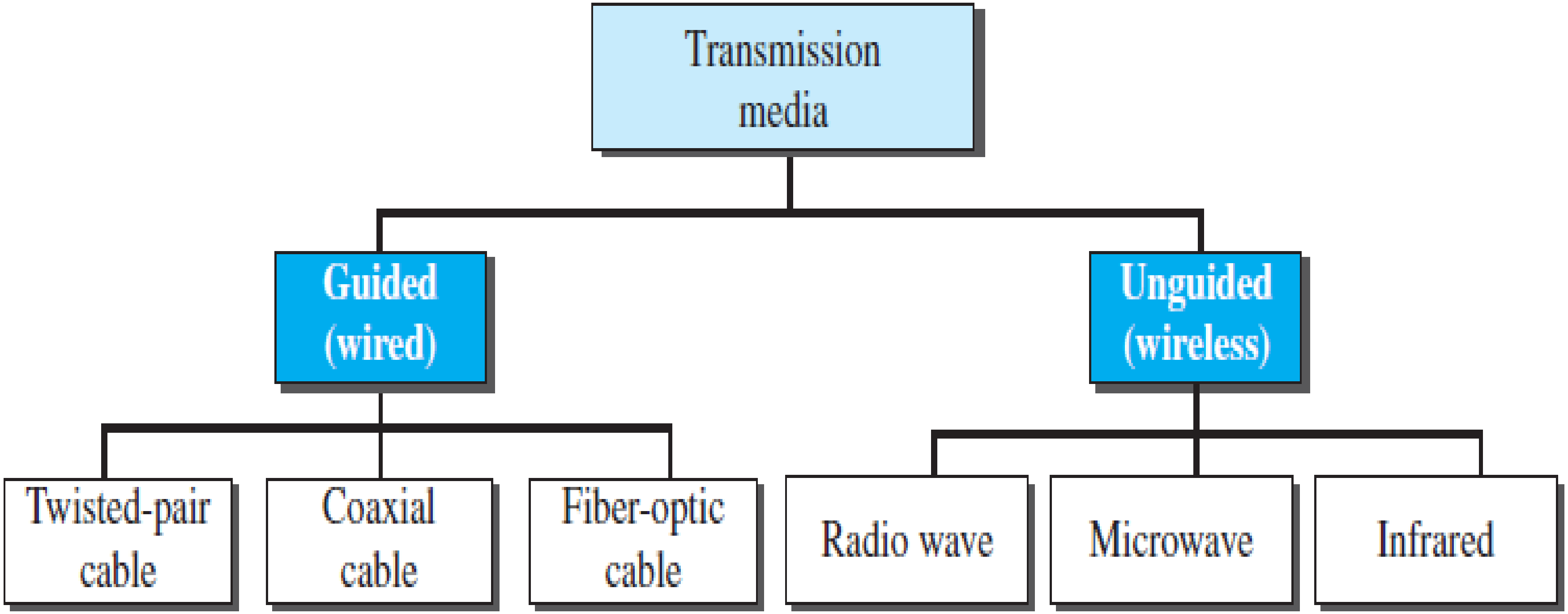
# Transmission Media

- A transmission **medium** can be broadly defined as anything that can carry information from a source to a destination.

- For example, the transmission medium for two people having a dinner conversation is the air.


Sender
Physical layer
Physical layer
Receiver
Transmission medium
Cable or air

# Classes of transmission media

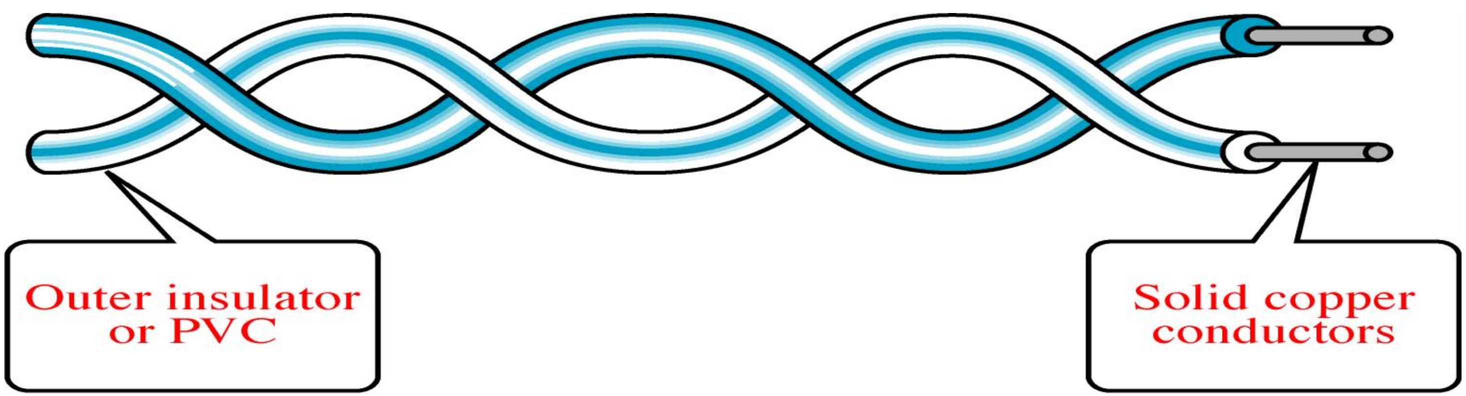


Guided media, which are those that provide a conduit from one device to another.

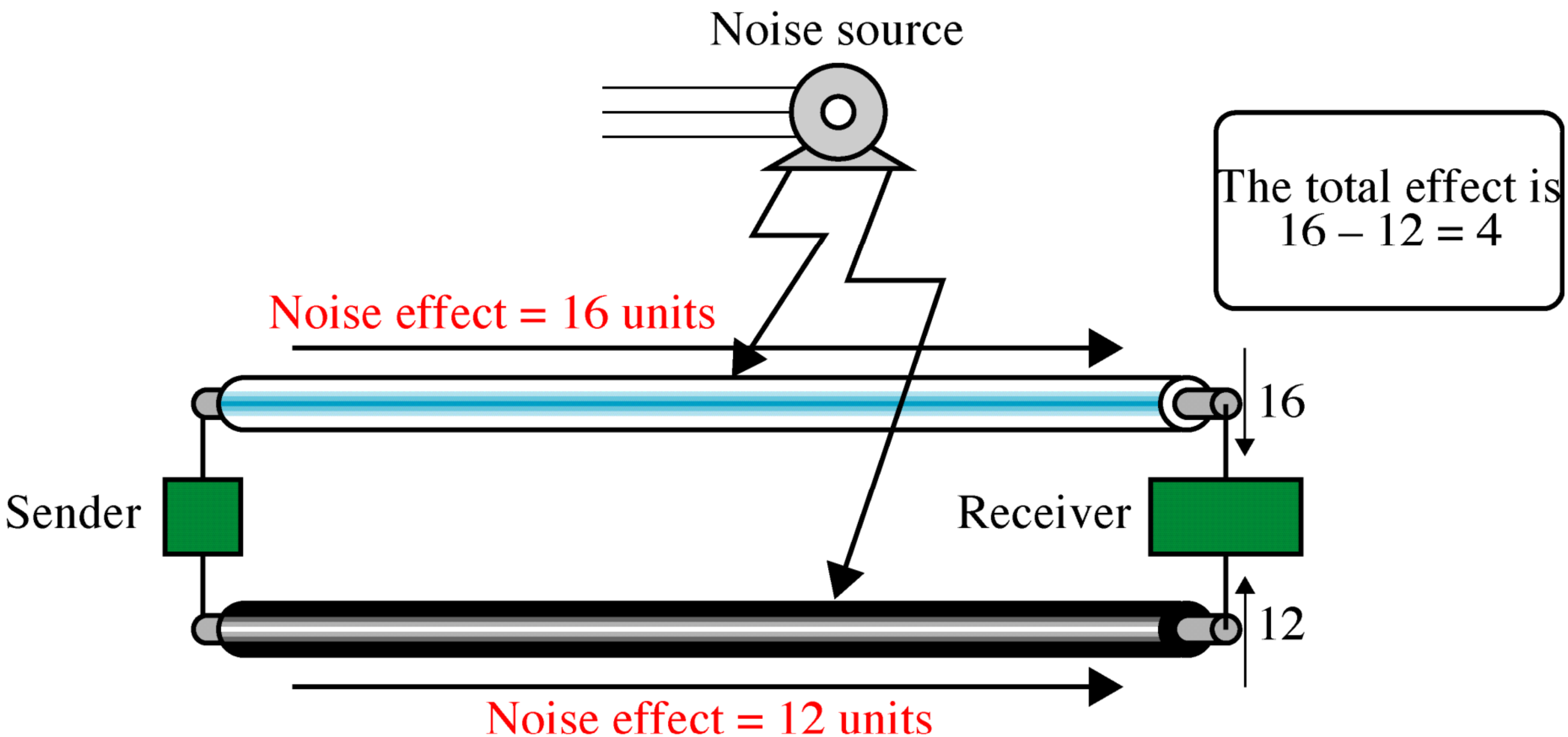
Unguided media transport electromagnetic waves without using a physical conductor.

# Twisted-Pair Cable

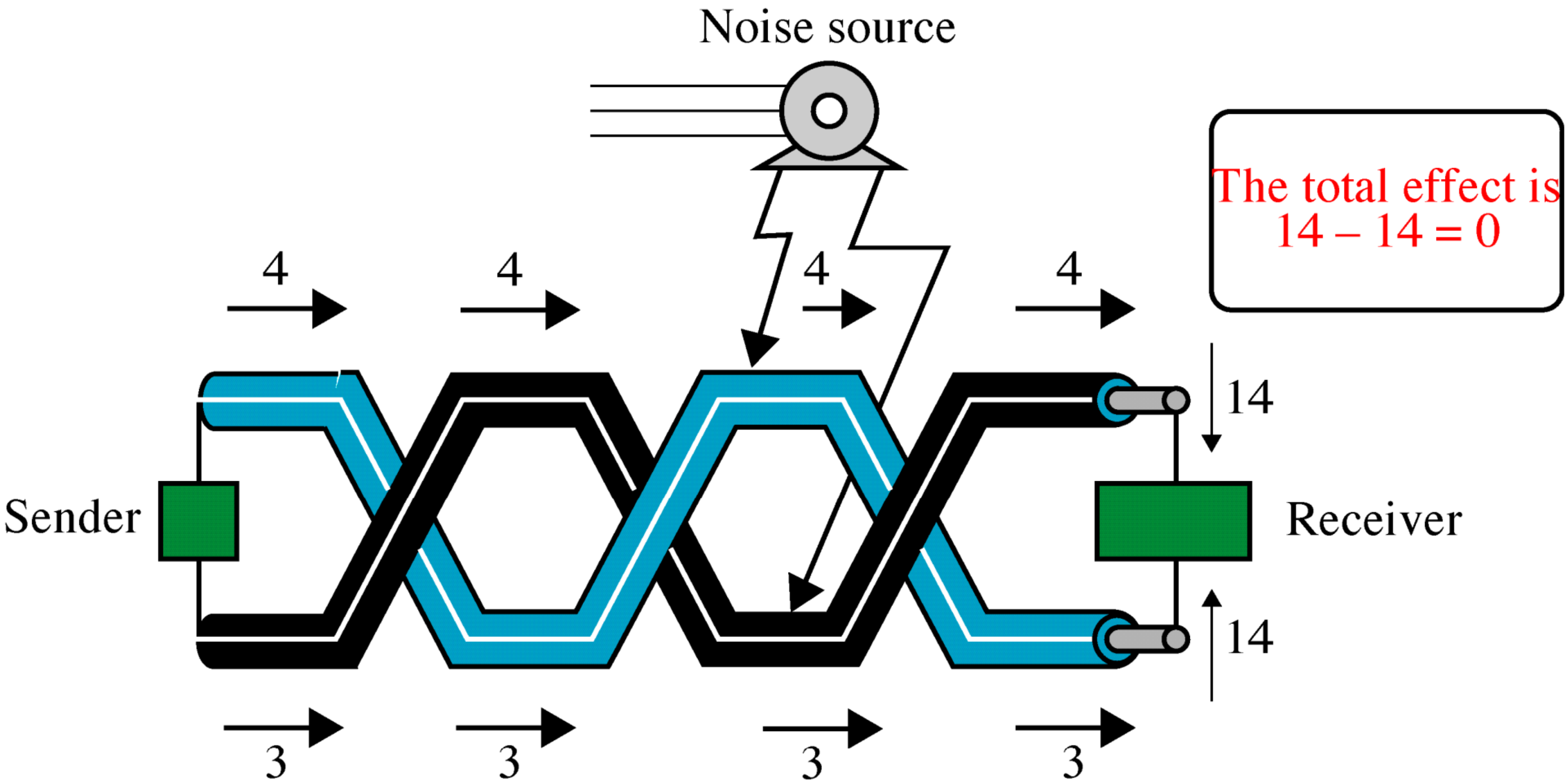
Twisted Pair and Coax use metallic(Copper) conductors that accept and transport the signals in the form of Electrical Current.

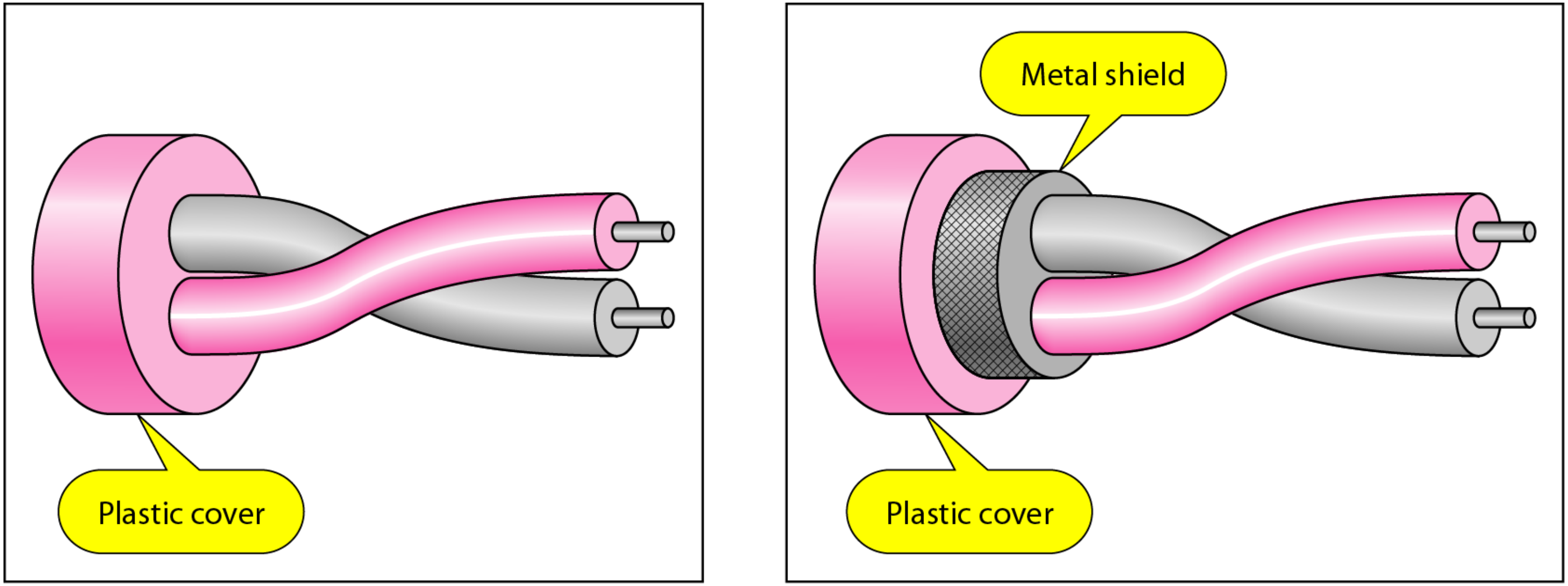
# Effect of Noise on Parallel Lines



# Noise on Twisted-Pair Lines



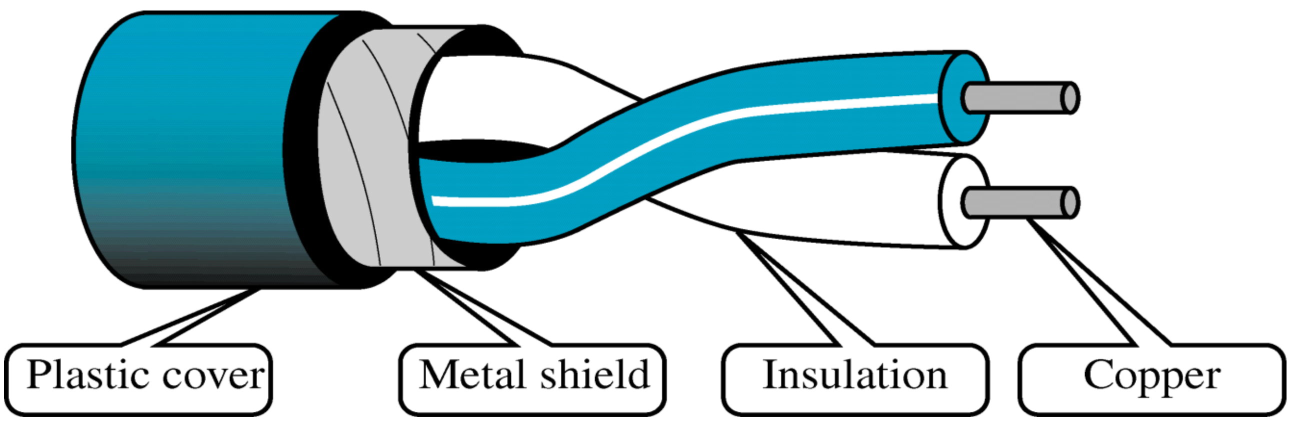
# UTP and STP cables




a. UTP b. STP

# Shielded Twisted-Pair Cable

- Metal casing prevents the penetration of electromagnetic noise.
- Eliminate the phenomenon , called CROSSTALK



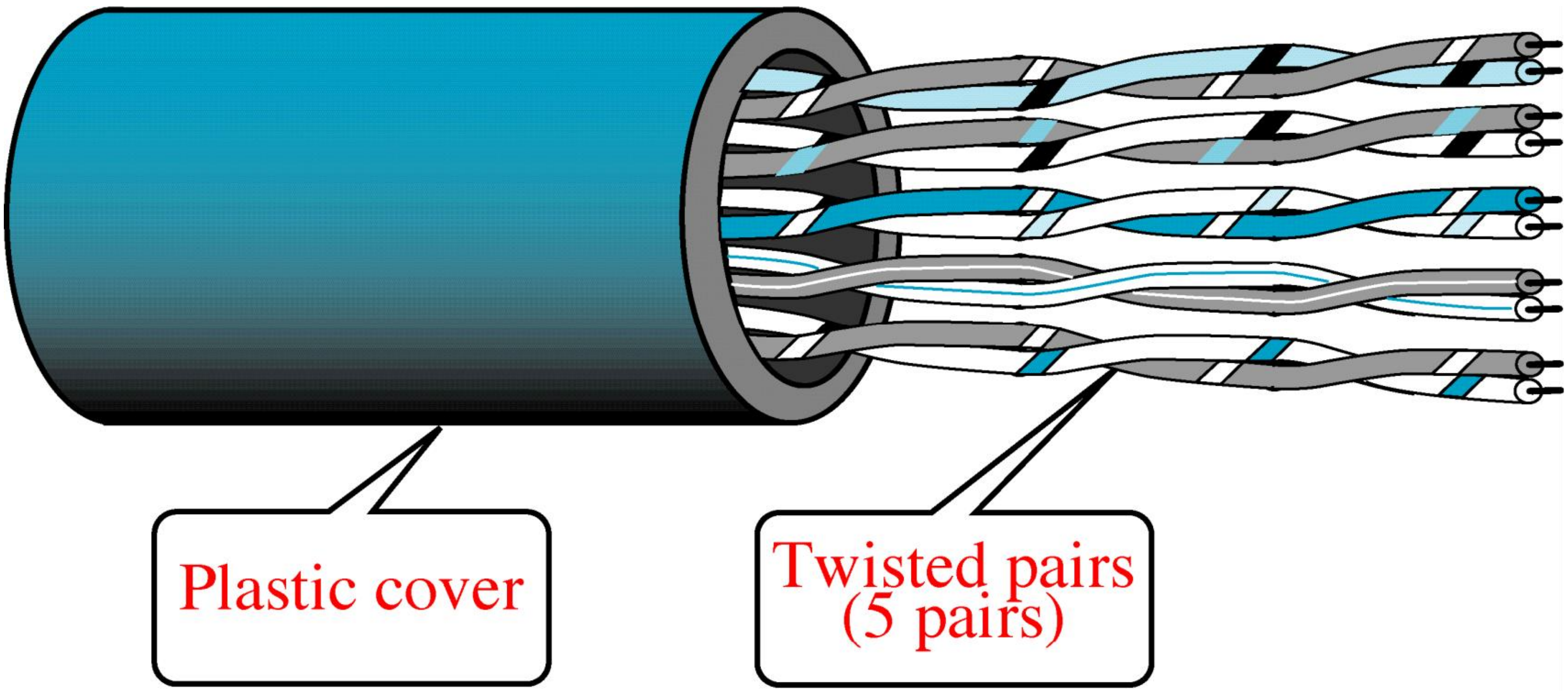
**Advantages :**

1. Cheaper
2. Less susceptible to electrical interference caused by nearby equipment or wires.
3. In turn are less likely to cause interference themselves.
4. Because it is electrically "cleaner", STP wire can carry data at a faster speed.

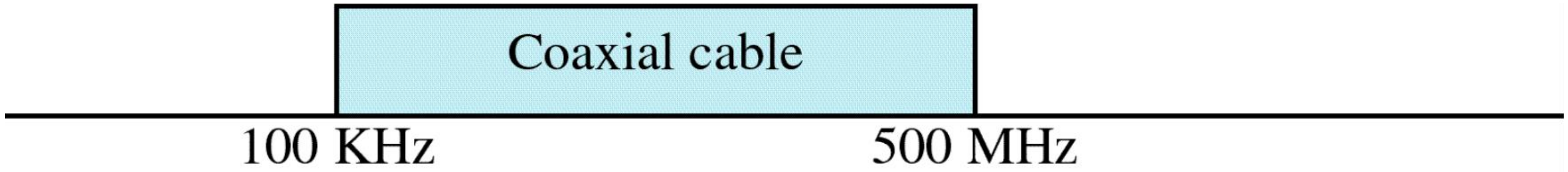
**Disadvantages :**

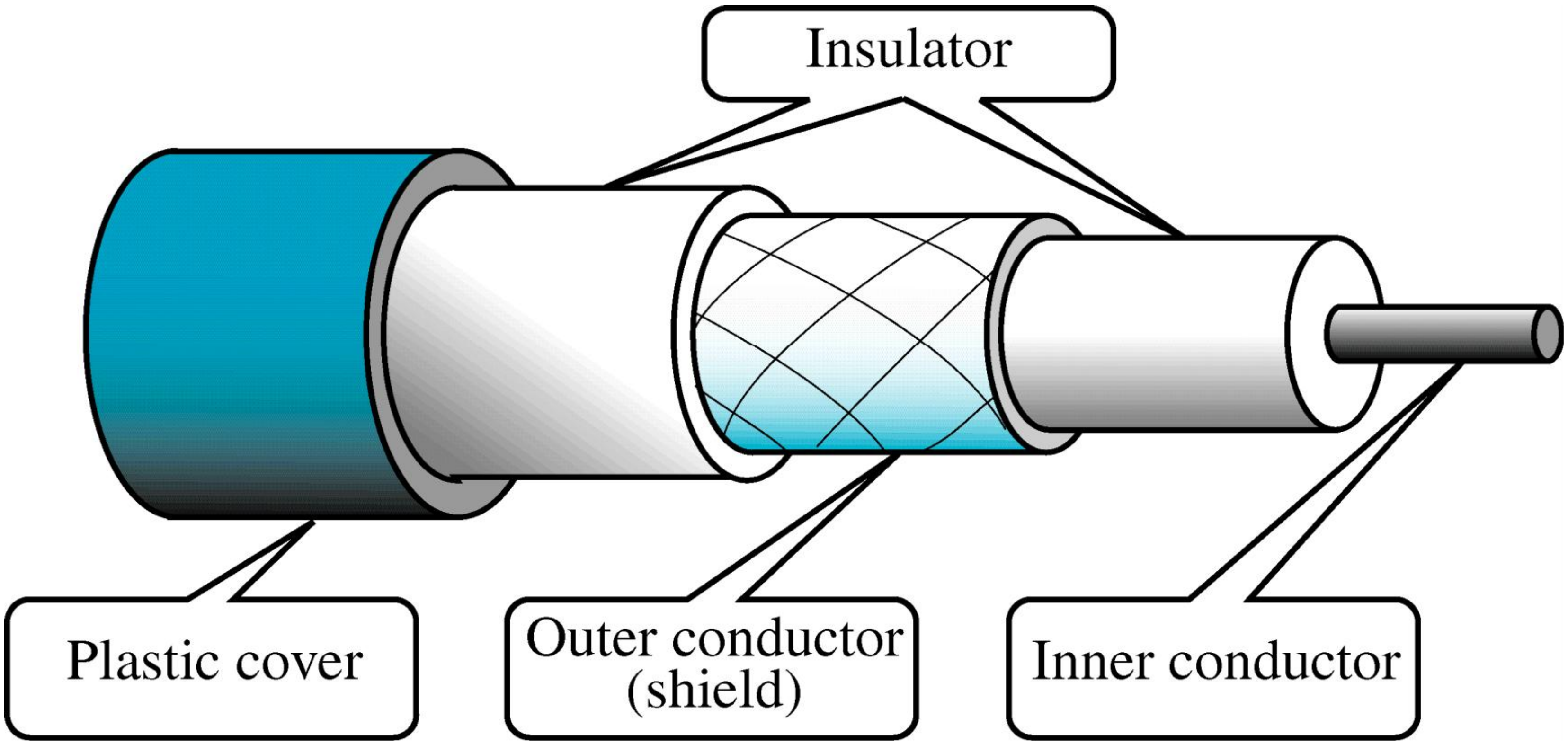
1. STP wire is that it is physically larger and more expensive than twisted pair wire.

# Unshielded Twisted-Pair Cable



# Coaxial Cable



# Two kinds of coaxial cable

- ✓ One kind, 50-ohm cable, is commonly used when it is intended for digital transmission from the start.
- ✓ The other kind, 75-ohm cable, is commonly used for analog transmission and cable television.
  - ✓ Cable TV operators began to provide Internet access over cable, which has made 75-ohm cable more important for data communication.

- High bandwidth
- Excellent noise immunity.
- The bandwidth possible depends on the cable quality and length.
- Used within the telephone system, cable television and MAN
- For long-distance lines, but have now replaced by fiber optics on long distance routes.

# Categories of coaxial cables

| *Category* | *Impedance* | *Use* |
|---|---|---|
| RG-59 | 75 Ω | Cable TV |
| RG-58 | 50 Ω | Thin Ethernet |
| RG-11 | 50 Ω | Thick Ethernet |

# Optical Fiber Cable



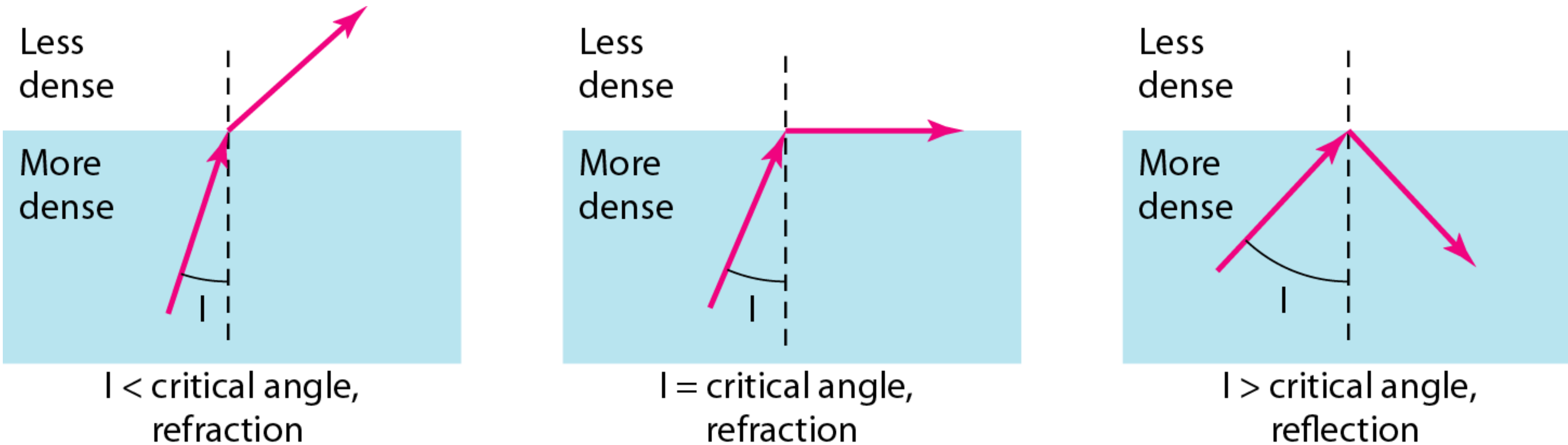
Optical Fiber is a glass or plastic cable that accept and transport the signals in the form of Light.

Advantages:

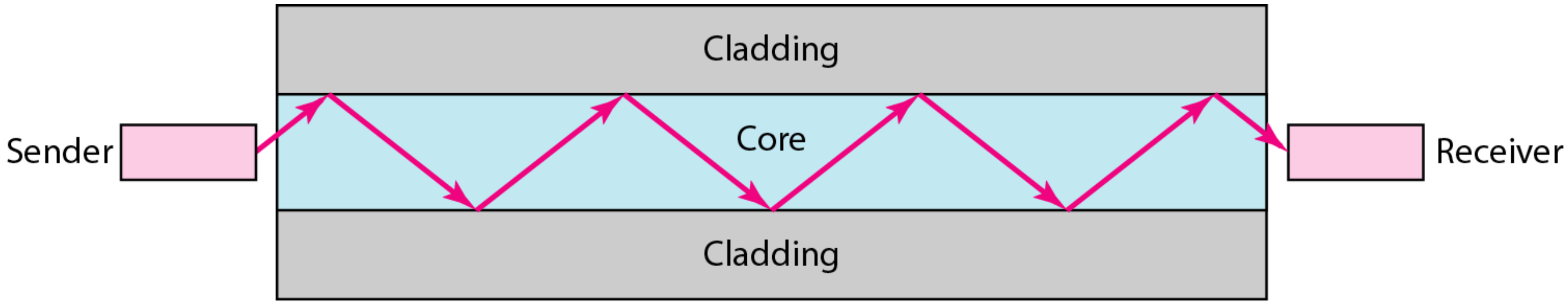
- ❑ Noise Resistance
- ❑ Less Signal Attenuation
- ❑ Higher BW

Disadvantages:

- ❑ Cost
- ❑ Installation/Maintenance
- ❑ Fragility(Broken Wire)


Less dense
More dense
I
I < critical angle, refraction
Less dense
More dense
I
I = critical angle, refraction
Less dense
More dense
I
I > critical angle, reflection

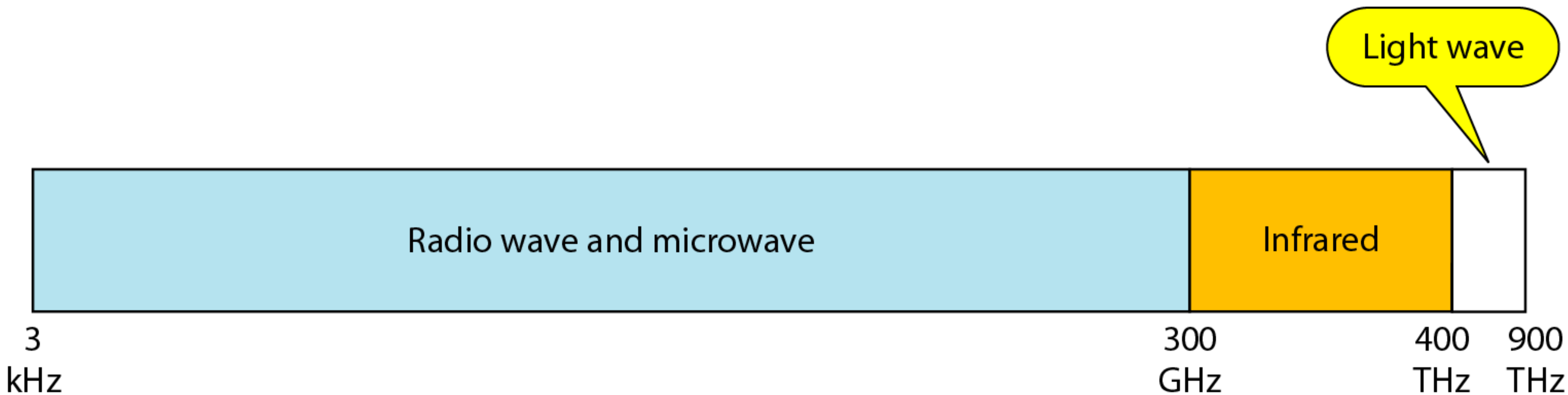
# Optical fiber



# UNGUIDED MEDIA: WIRELESS

***Unguided media transport electromagnetic waves without using a physical conductor. This type of communication is often referred to as wireless communication.***

# *Electromagnetic spectrum for wireless communication*



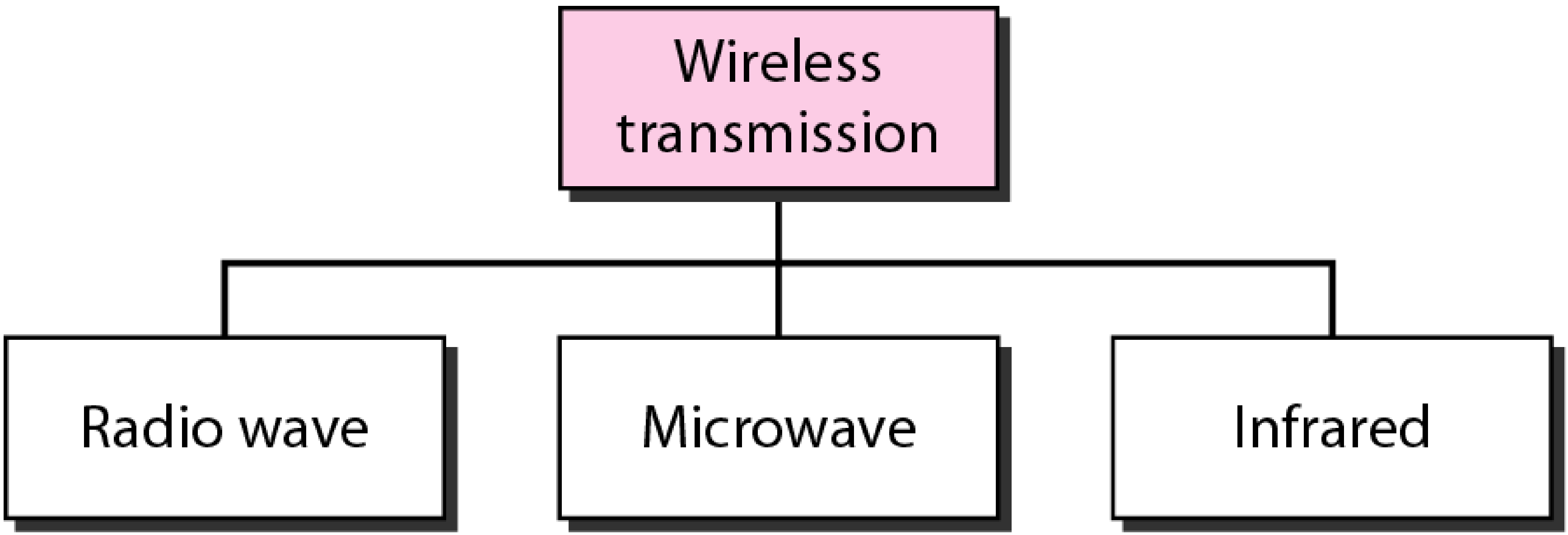
# Propagation Methods

- Ground Propagation
- Sky Propagation
- Line-of-Sight Propagation

# Bands

| *Band* | *Range* | *Propagation* | *Application* |
|---|---|---|---|
| VLF (very low frequency) | 3–30 kHz | Ground | Long-range radio navigation |
| LF (low frequency) | 30–300 kHz | Ground | Radio beacons and navigational locators |
| MF (middle frequency) | 300 kHz–3 MHz | Sky | AM radio |
| HF (high frequency) | 3–30 MHz | Sky | Citizens band (CB), ship/aircraft communication |
| VHF (very high frequency) | 30–300 MHz | Sky and line-of-sight | VHF TV, FM radio |
| UHF (ultrahigh frequency) | 300 MHz–3 GHz | Line-of-sight | UHF TV, cellular phones, paging, satellite |
| SHF (superhigh frequency) | 3–30 GHz | Line-of-sight | Satellite communication |
| EHF (extremely high frequency) | 30–300 GHz | Line-of-sight | Radar, satellite |

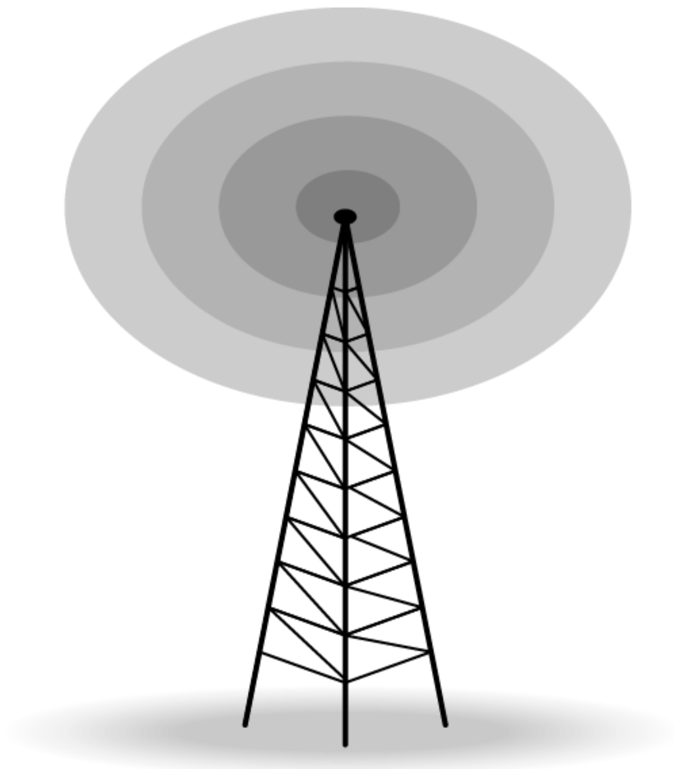
# *Wireless transmission waves*



*Note*

**Radio waves are used for multicast communications, such as radio and television.**
**They can penetrate through walls.**
**Use Omni directional antennas**

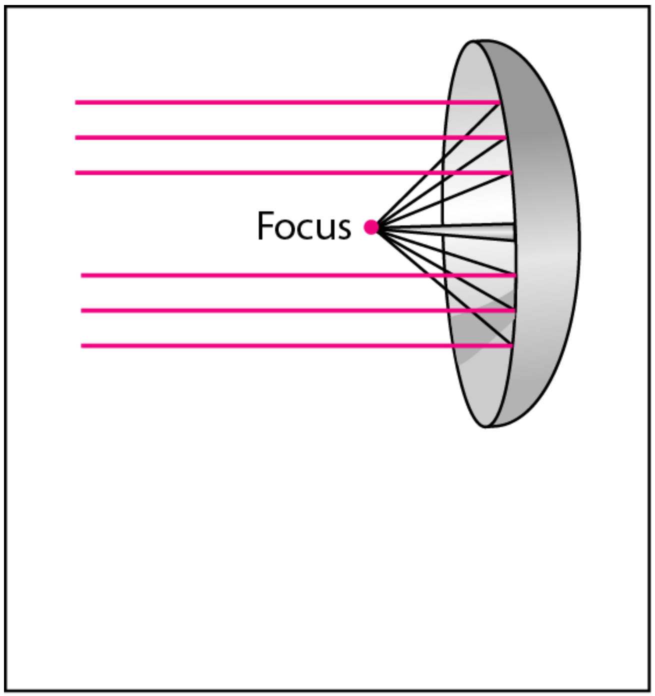
*Omnidirectional antenna*



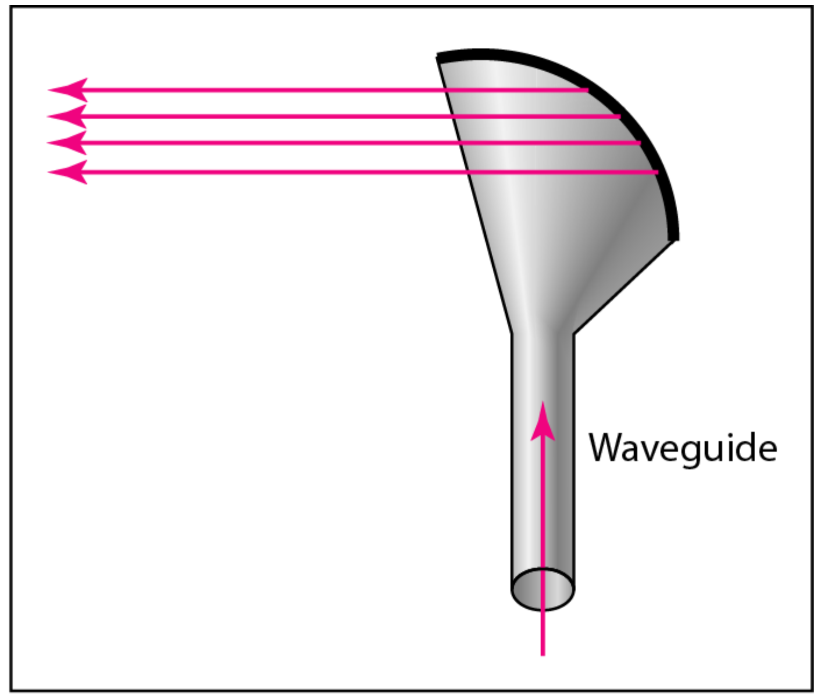
*Note*

**Microwaves are used for unicast communication such as cellular telephones and wireless LANs.**
**Higher frequency ranges cannot penetrate walls.**
**Use directional antennas - point to point line of sight communications.**

# *Unidirectional antennas*




a. Dish antenna




b. Horn antenna

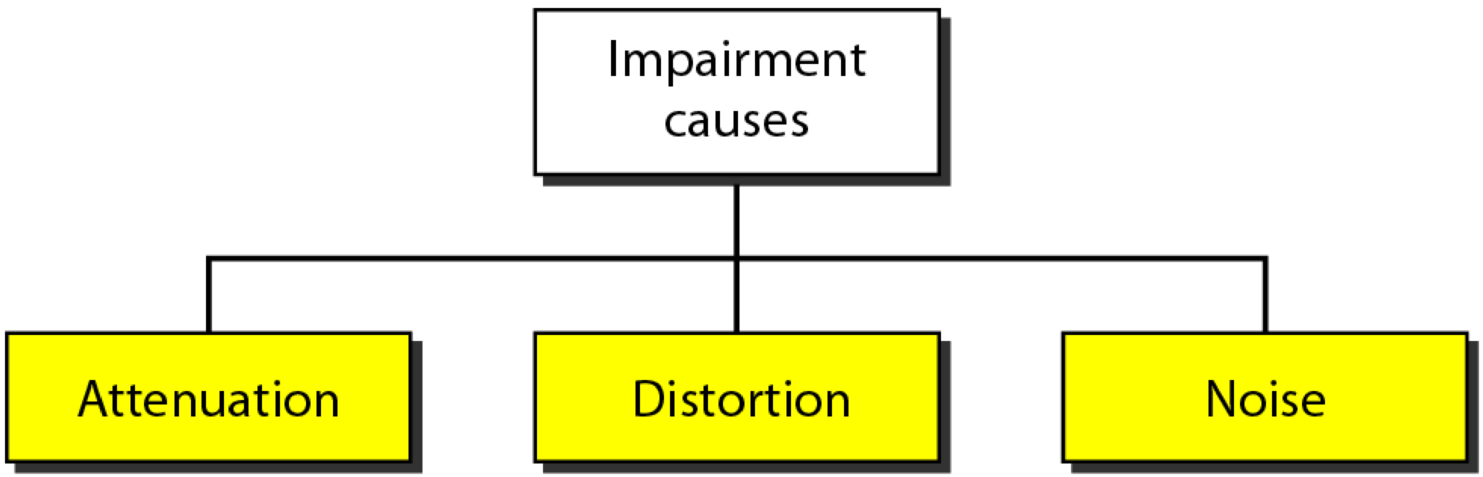
***Note***

**Infrared signals can be used for short-range communication in a closed area using line-of-sight propagation.**

# Transmission Impairment

- Signal transmit through medium that are not perfect.
- This imperfection cause signal impairment.
- What is sent is not received.

# *Causes of impairment*



# Attenuation

- Means loss of energy -> weaker signal
- When a signal travels through a medium it loses energy overcoming the resistance of the medium
- Amplifiers are used to compensate for this loss of energy by amplifying the signal.

# Measurement of Attenuation

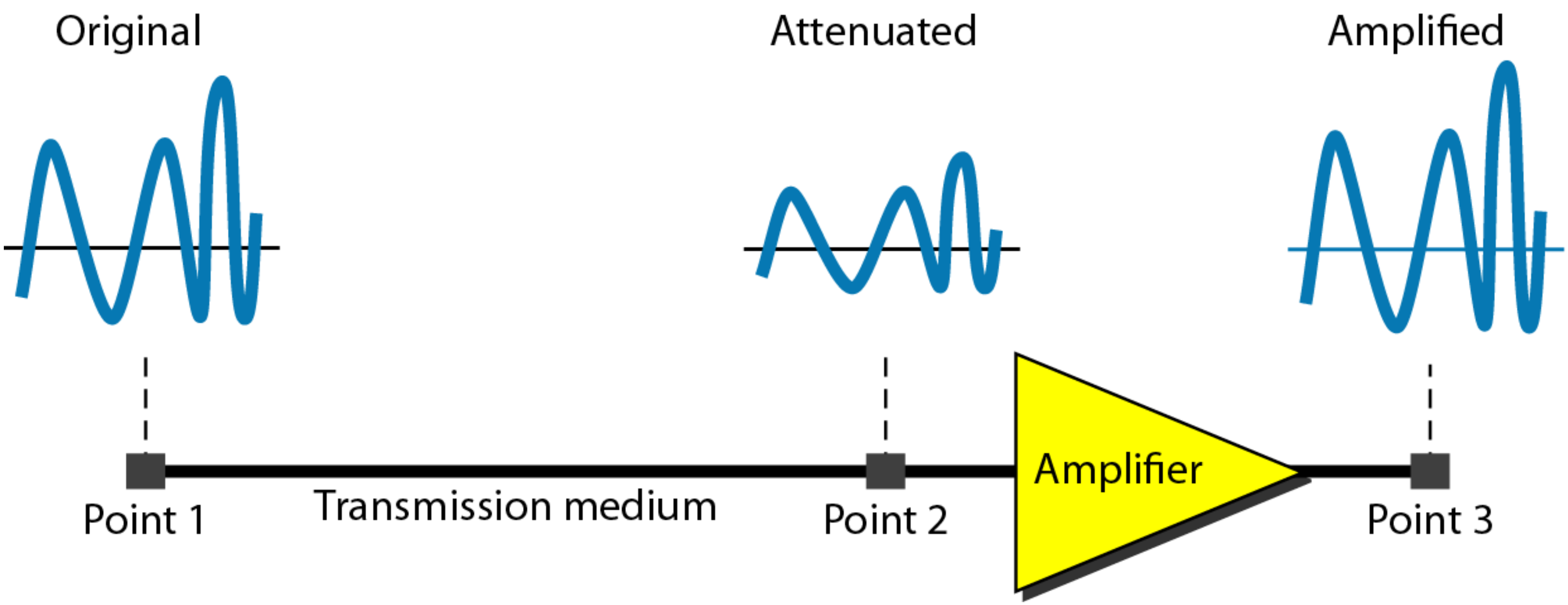
- To show the loss or gain of energy the unit "decibel" is used.

$$dB = 10\log_{10}P_2/P_1$$

$P_1$ - input signal

$P_2$ - output signal

# *Attenuation*



- *Suppose a signal travels through a transmission medium and its power is reduced to one-half. This means that $P_2$ is $(1/2)P_1$. In this case, the attenuation (loss of power) can be calculated as*

# *Example 3.26*

$$\boxed{10\log_{10}\frac{P_2}{P_1} = 10\log_{10}\frac{0.5P_1}{P_1} = 10\log_{10}0.5 = 10(-0.3) = -3\text{ dB}}$$

***A loss of 3 dB (–3 dB) is equivalent to losing one-half the power.***

# *Example 3.27*

***A signal travels through an amplifier, and its power is increased 10 times. This means that $P_2 = 10P_1$. In this case, the amplification (gain of power) can be calculated as***

$$\boxed{10 \log_{10} \frac{P_2}{P_1} = 10 \log_{10} \frac{10P_1}{P_1}}$$

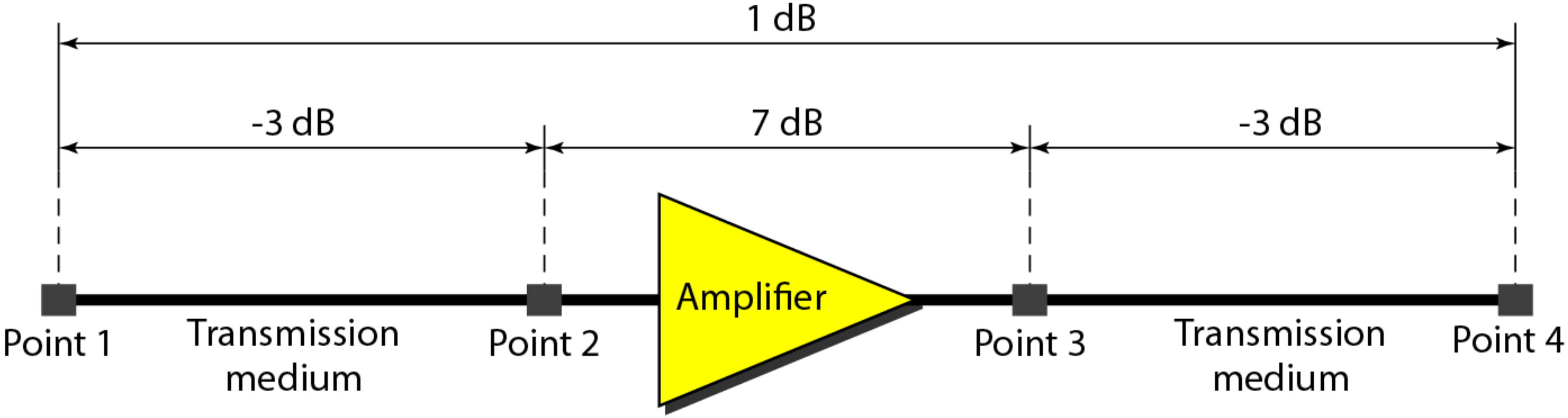
$$\boxed{= 10 \log_{10} 10 = 10(1) = 10 \text{ dB}}$$

# *Example 3.28*

***One reason that engineers use the decibel to measure the changes in the strength of a signal is that decibel numbers can be added (or subtracted) when we are measuring several points (cascading) instead of just two. In Figure 3.27 a signal travels from point 1 to point 4. In this case, the decibel value can be calculated as***

$$\boxed{\mathrm{dB} = -3 + 7 - 3 = +1}$$

# *Decibels for Example 3.28*



# *Example 3.29*

***Sometimes the decibel is used to measure signal power in milliwatts. In this case, it is referred to as $dB_m$ and is calculated as $dB_m = 10 \log10 P_m$, where $P_m$ is the power in milliwatts. Calculate the power of a signal with $dB_m = -30$.***

## *Solution*

***We can calculate the power in the signal as***

$$\mathrm{dB_m} = 10 \log_{10} P_m = -30$$

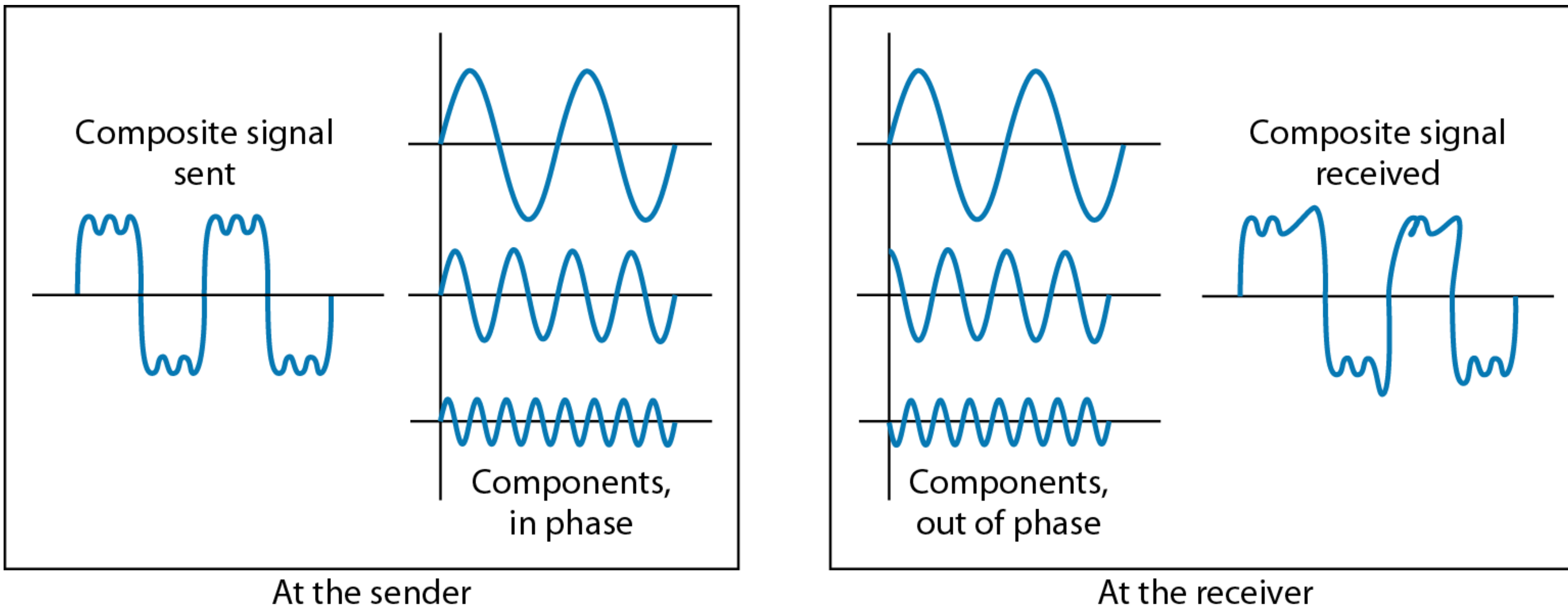
$$\log_{10} P_m = -3 \qquad P_m = 10^{-3}\ \mathrm{mW}$$

# Distortion

- Means that the signal changes its form or shape
- Distortion occurs in composite signals
- Each frequency component has its own propagation speed traveling through a medium.
- The different components therefore arrive with different delays at the receiver.
- That means that the signals have different phases at the receiver than they did at the source.

# Distortion

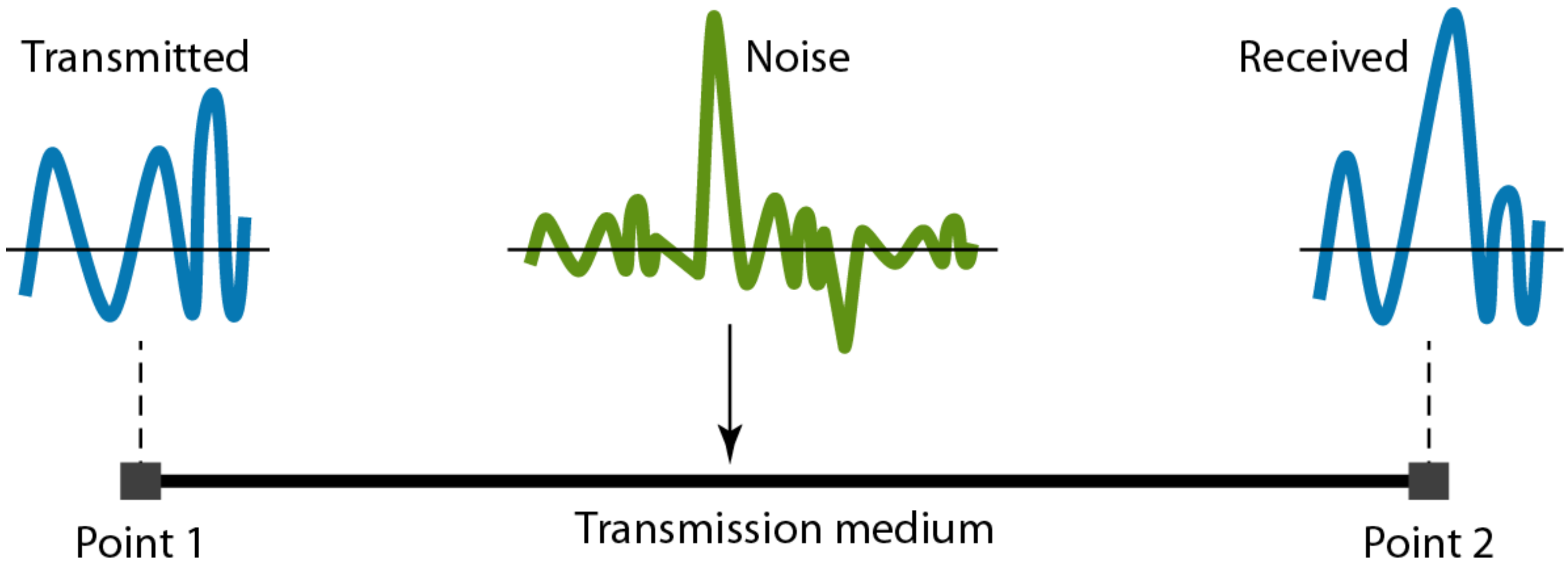



Composite signal
sent
Components,
in phase
At the sender
Composite signal
received
Components,
out of phase
At the receiver

# Noise

- There are different types of noise
  - Thermal - random noise of electrons in the wire creates an extra signal
  - Crosstalk - same as above but between two wires.
  - Impulse - Spikes that result from power lines, lightening, etc.
  - Induced

# *Noise*


Transmitted
Noise
Received
Point 1
Transmission medium
Point 2

# Signal to Noise Ratio (SNR)

- To measure the quality of a system the SNR is often used. It indicates the strength of the signal wrt the noise power in the system.
- It is the ratio between two powers.
- It is usually given in dB and referred to as $SNR_{dB.}$

# *Example 3.31*

***The power of a signal is 10 mW and the power of the noise is 1 μW; what are the values of SNR and $SNR_{dB}$?***

# Example 3.32

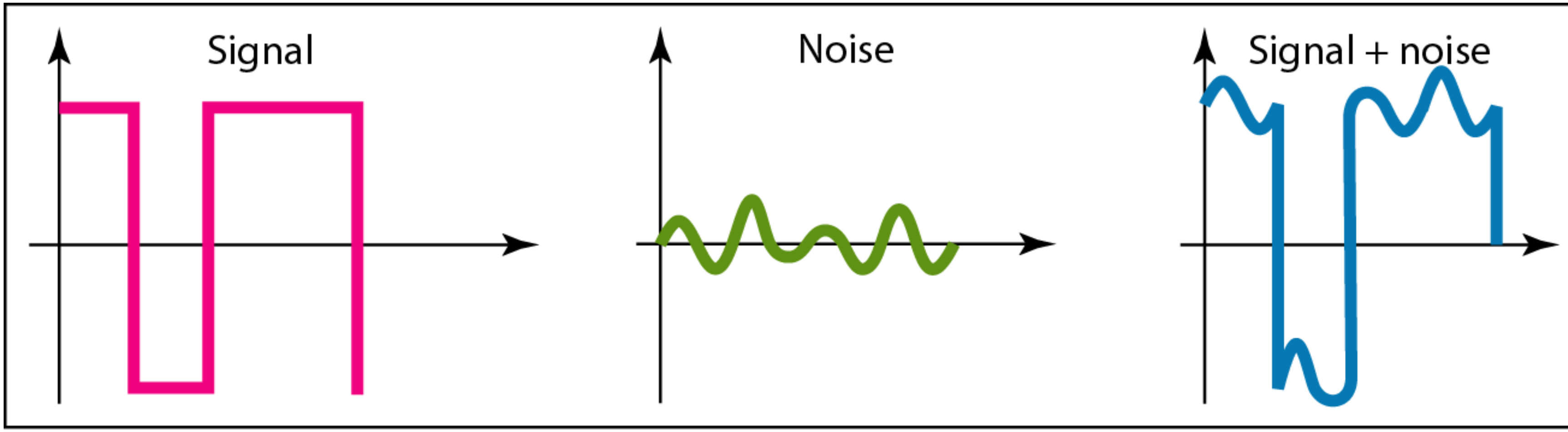
***The values of SNR and SNR$_{dB}$ for a noiseless channel are***

$$\mathrm{SNR} = \frac{\text{signal power}}{0} = \infty$$

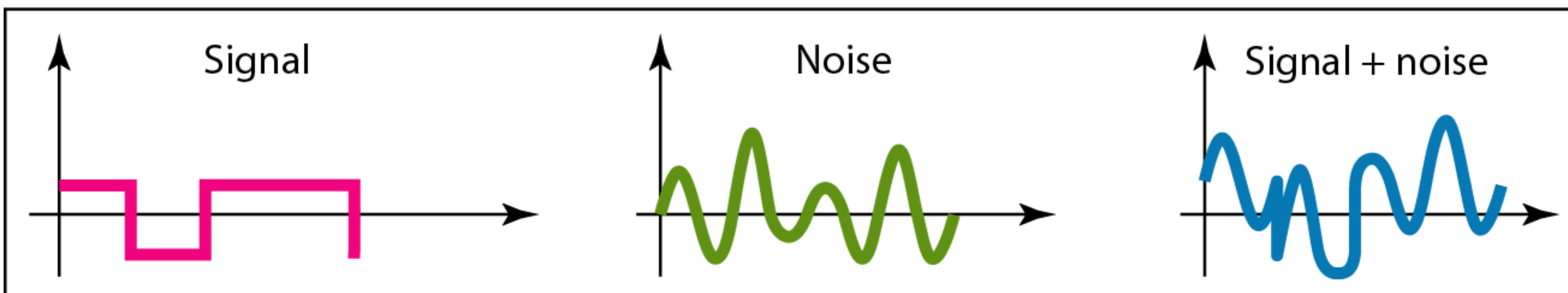
$$\mathrm{SNR_{dB}} = 10 \log_{10} \infty = \infty$$

***We can never achieve this ratio in real life; it is an ideal.***

# Figure 3.30 *Two cases of SNR: a high SNR and a low SNR*




a. Large SNR




b. Small SNR