Chapter 2
Principles of Computer Communications

Physical Layer

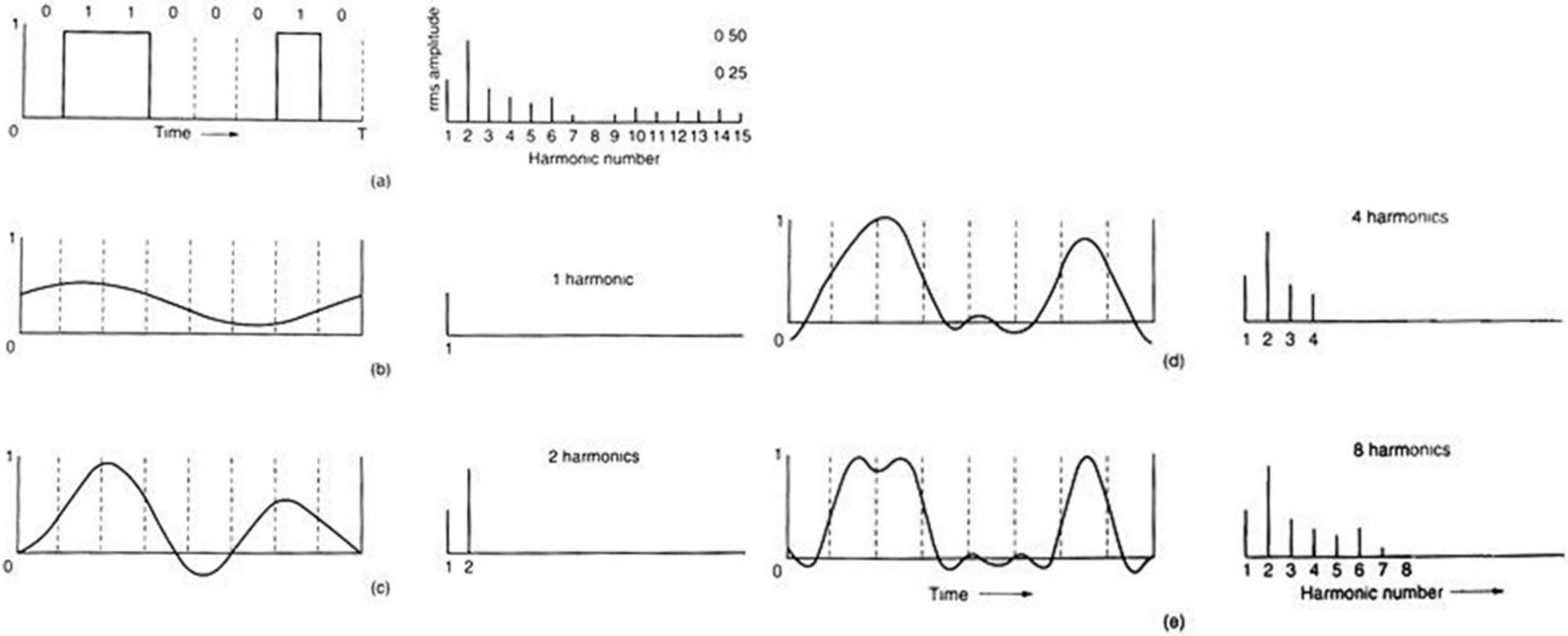
Fourier Analysis

- The French mathematician J.B. Fourier proved that any reasonably behaved period function, *g(t)* with period T can be constructed as the sum of a number of **sines** and **consines**:

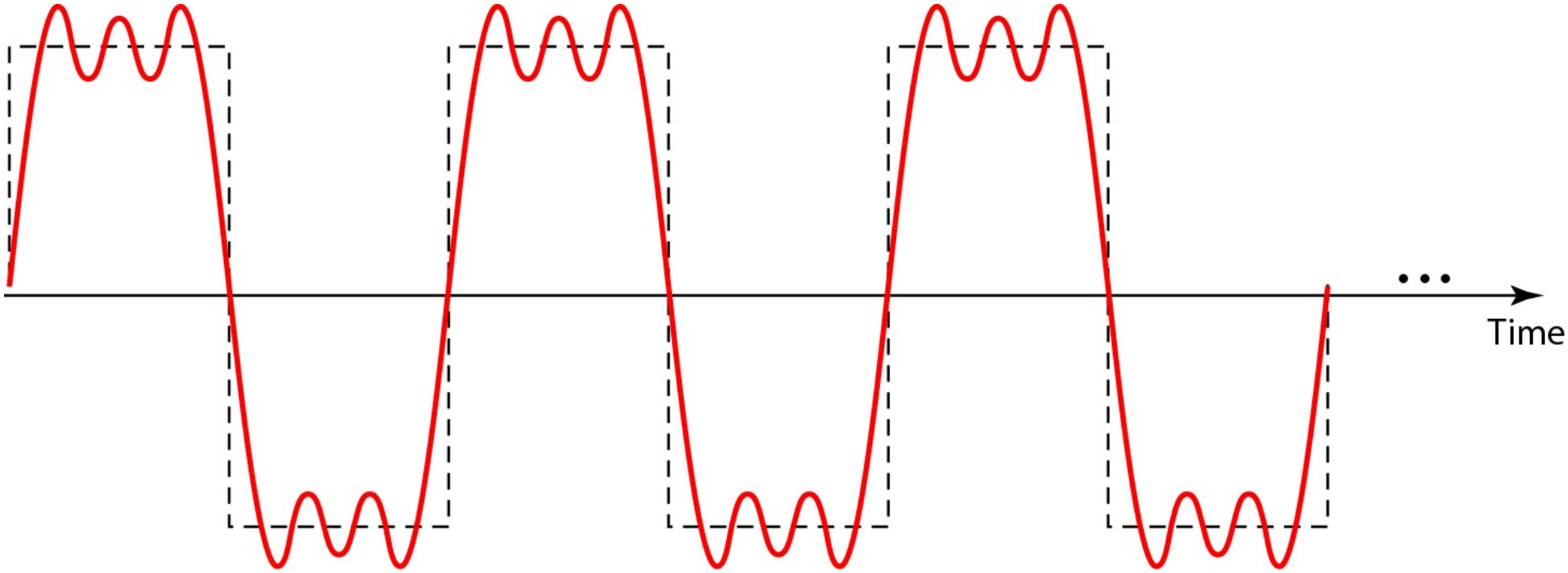
$$g(t) = \frac{1}{2}c + \sum_{n=1}^{\infty} a_n \sin(2\pi nft) + \sum_{n=1}^{\infty} b_n \cos(2\pi nft)$$

Where $f = 1/T$ is the fundamental frequency, a_n and b_n are the sine and cosine amplitudes of the n^{th} harmonics, and c is a constant.

Fourier Analysis



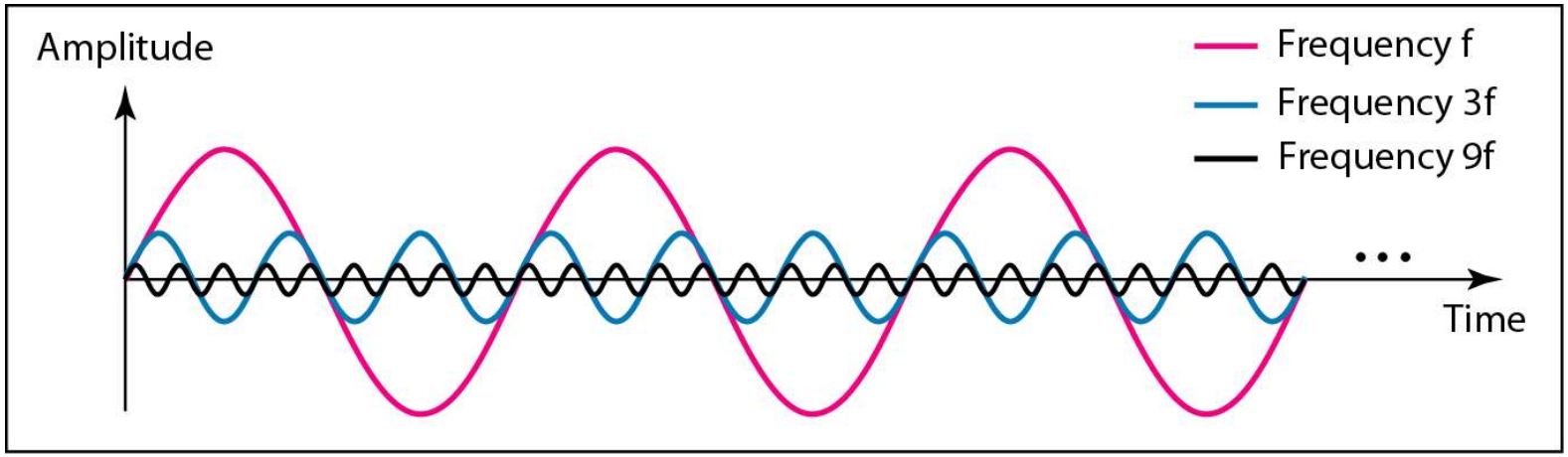
Fourier Analysis



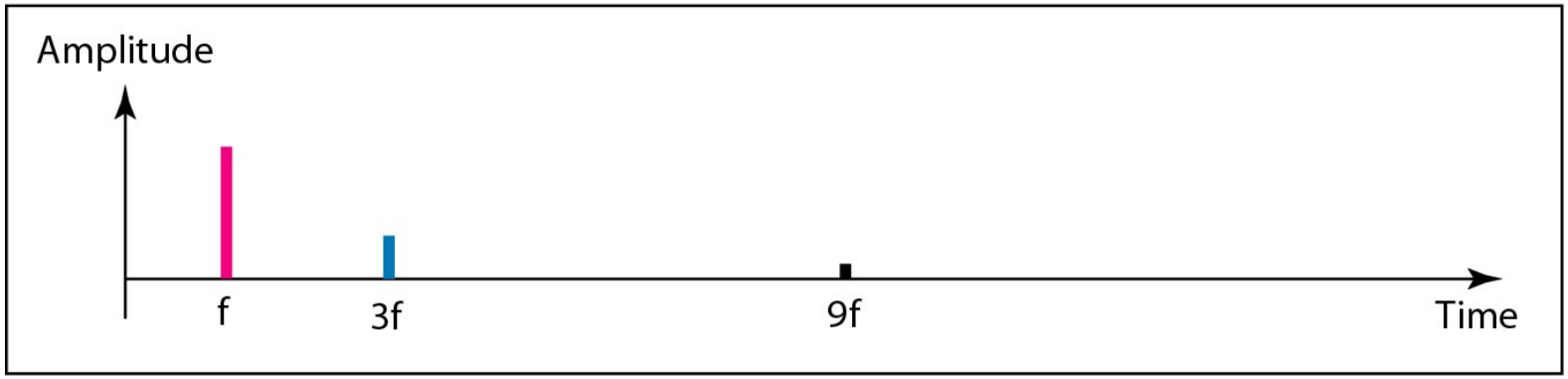
A composite periodic signal

Fourier Analysis

Decomposition of a composite periodic signal in the time and frequency domains

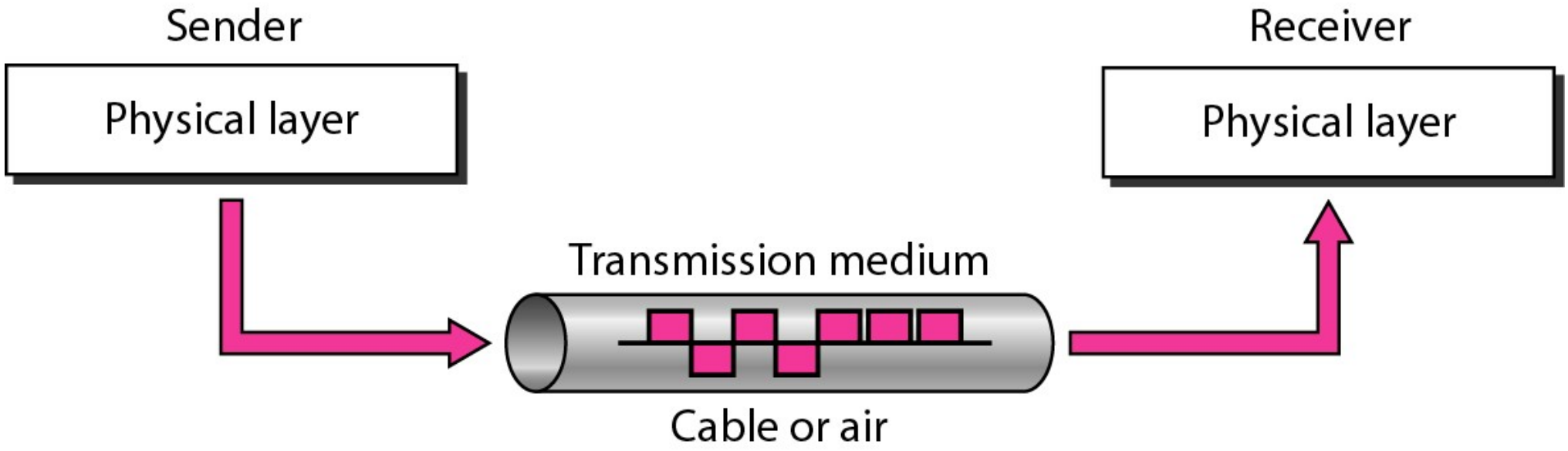


a. Time-domain decomposition of a composite signal

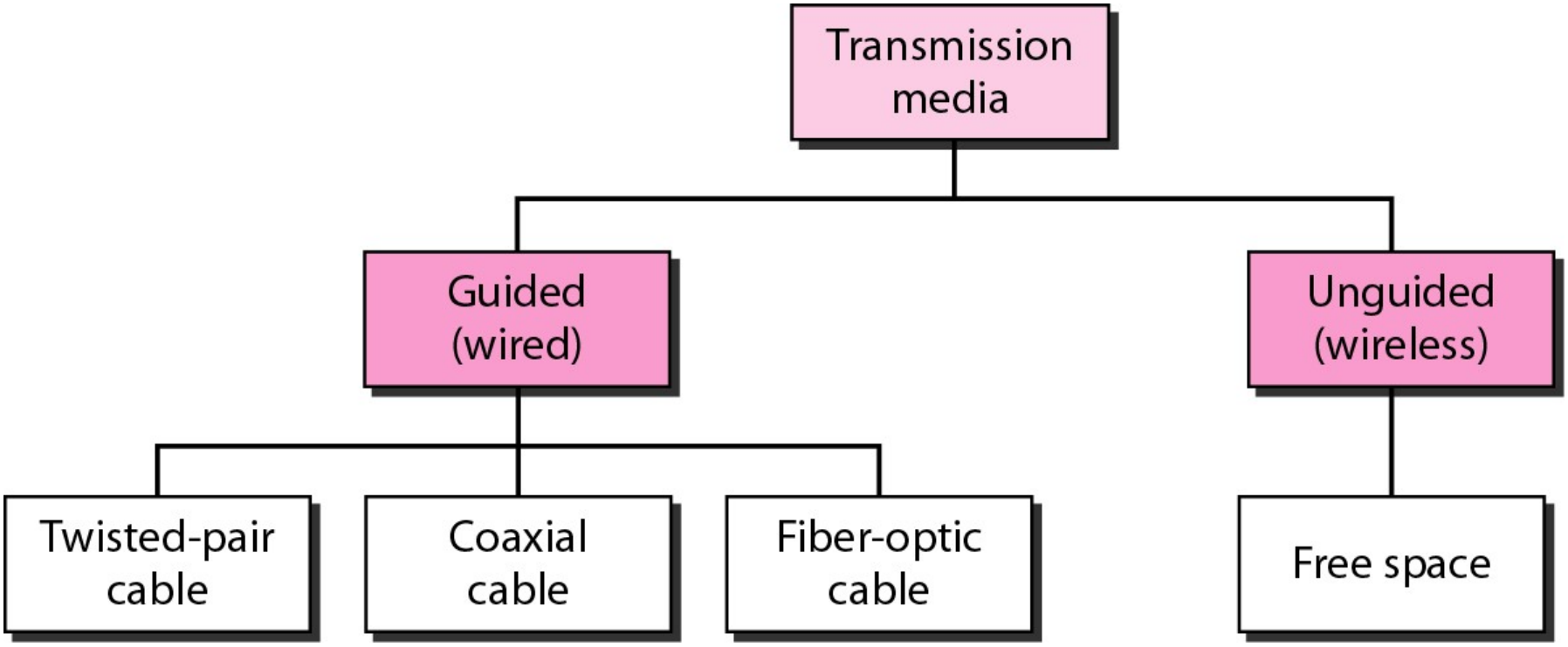


b. Frequency-domain decomposition of the composite signal

Transmission Medium and Physical Layer



Classes of Transmission Media

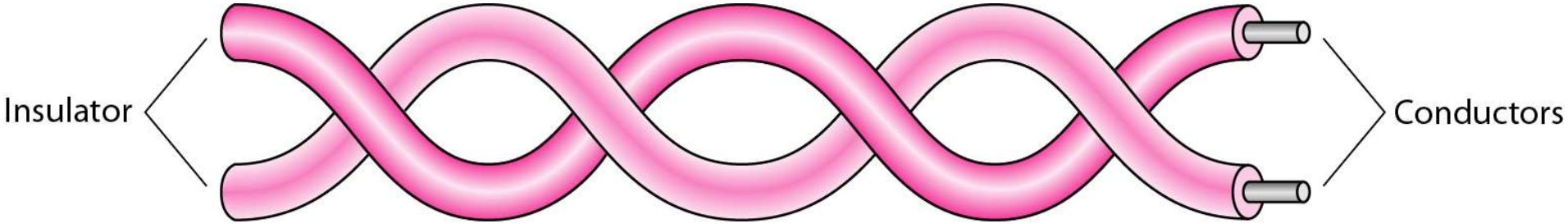


Guided Transmission Media

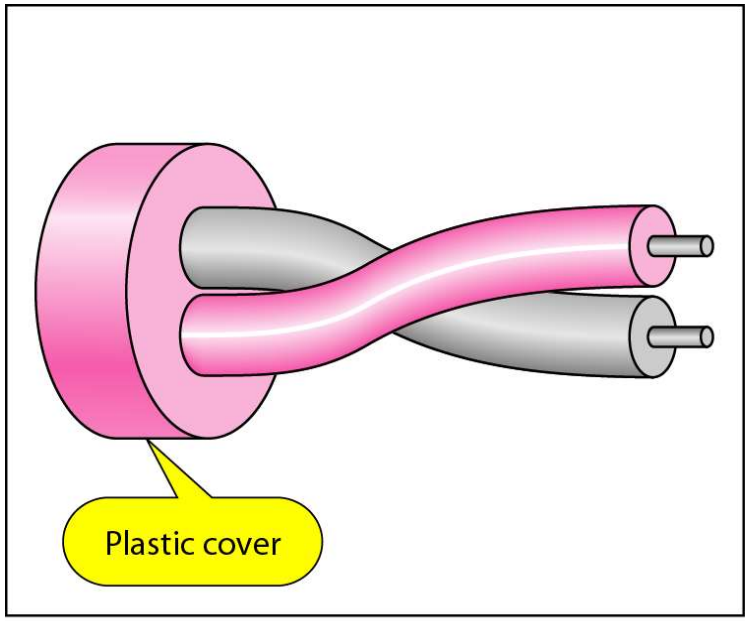
- Guided media, which are those that provide a conduit from one device to another.
- Include twisted-pair cable, coaxial cable, and fiber-optic cable.

Twisted-Pair

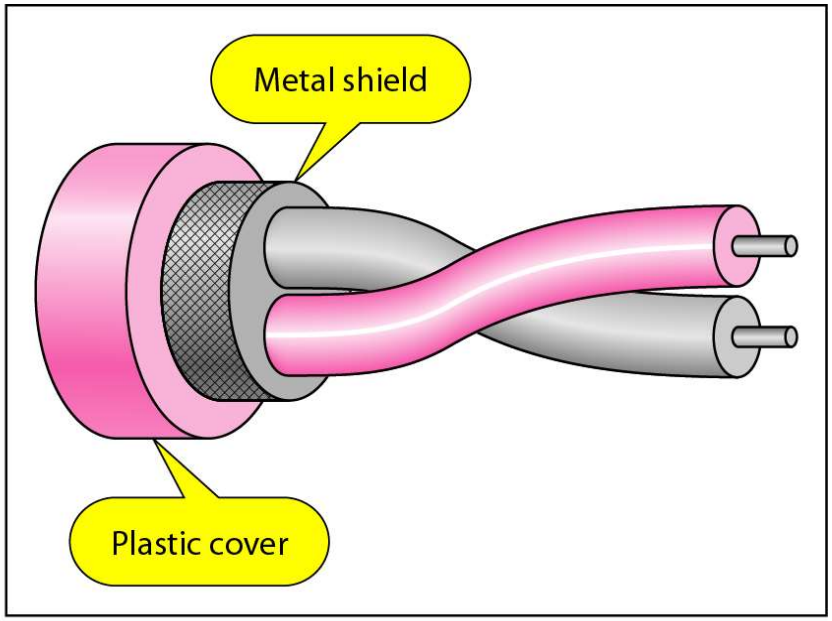
- A twisted pair consists of two insulated copper wires, typically about 1 mm thick.



Twisted-Pair: *UTP and STP cables*



a. UTP

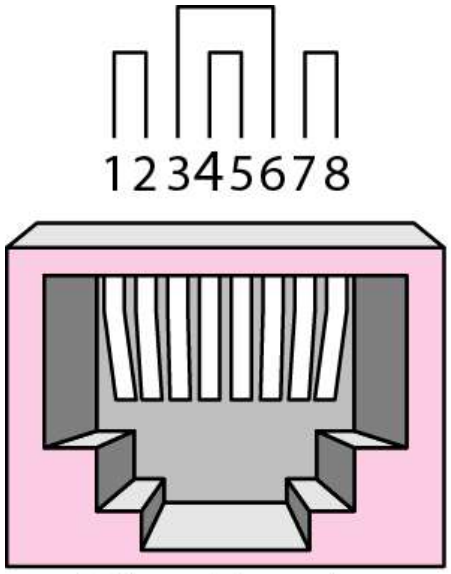


b. STP

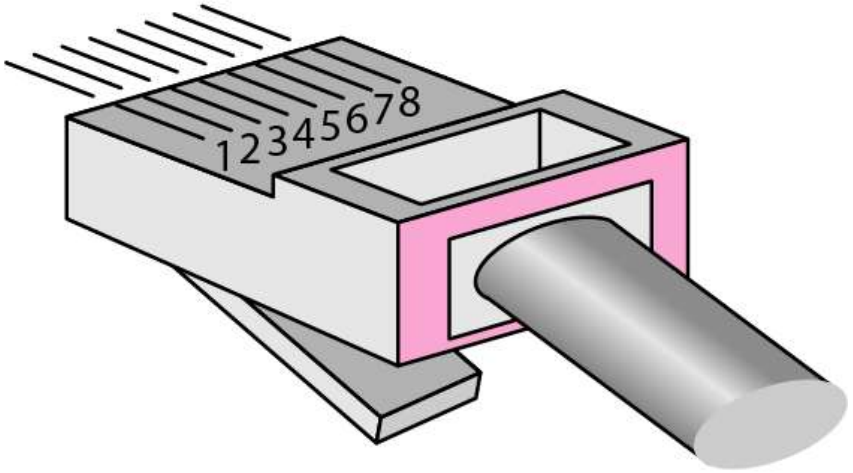
(a) Category 3 UTP.

(b) Category 5 UTP.

Twisted-Pair: UTP Connector

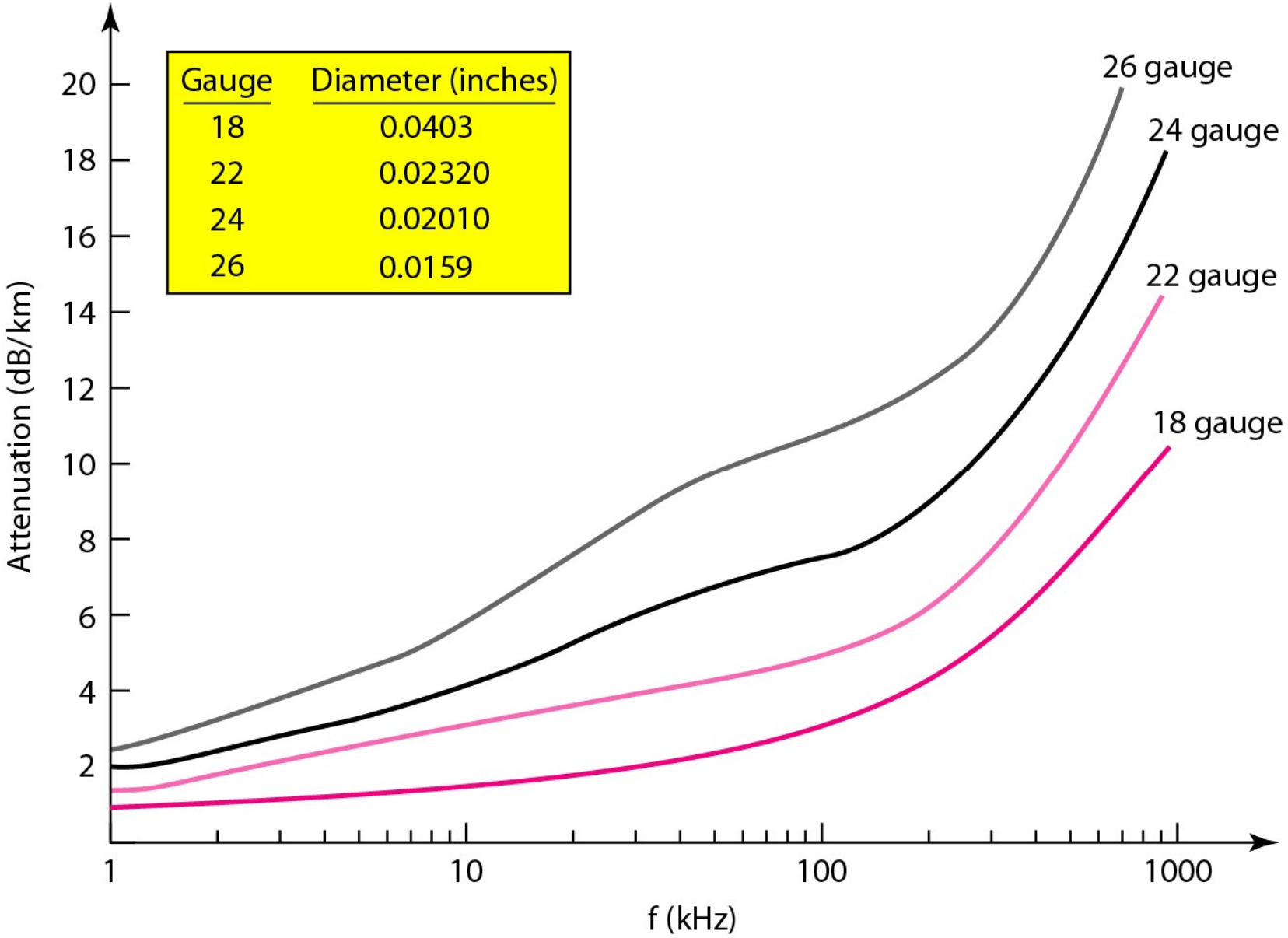


RJ-45 Female



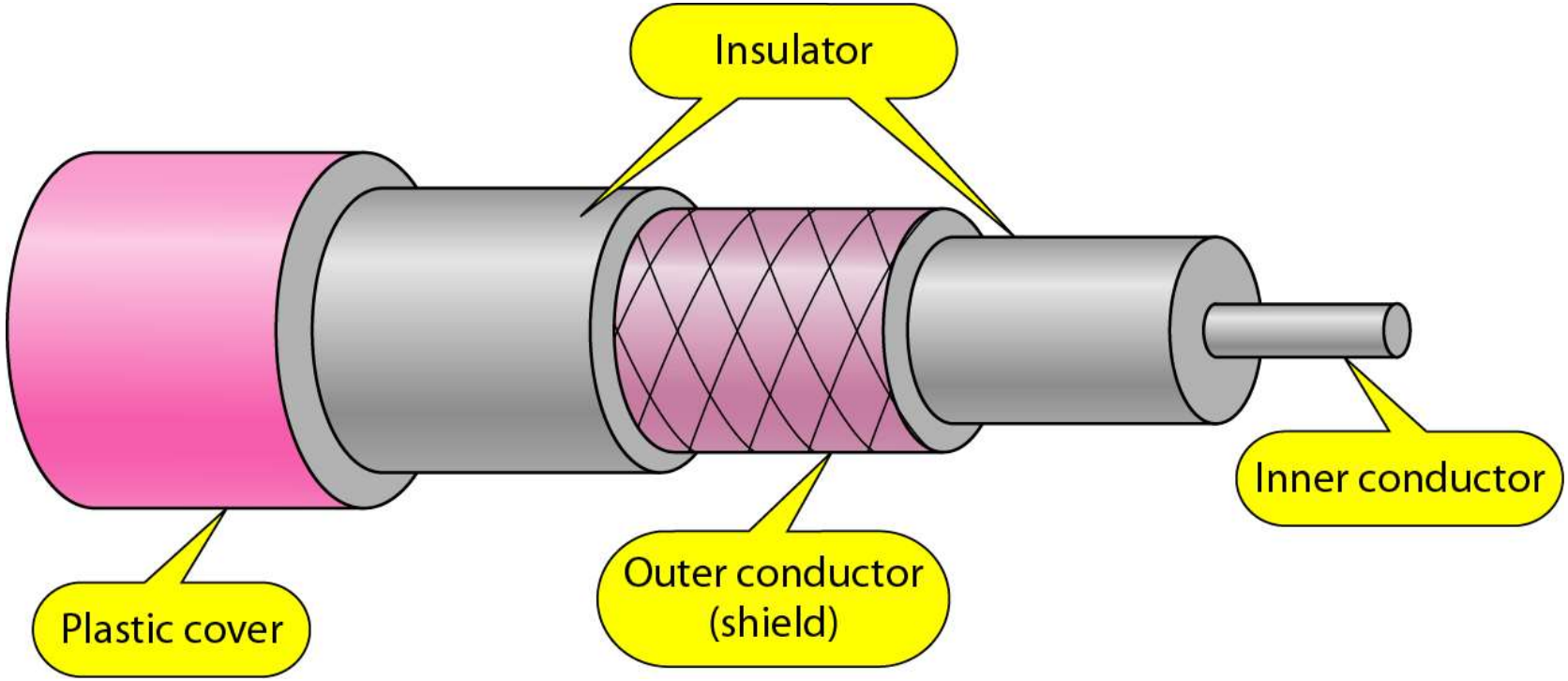
RJ-45 Male

Twisted-Pair: UTP Performance

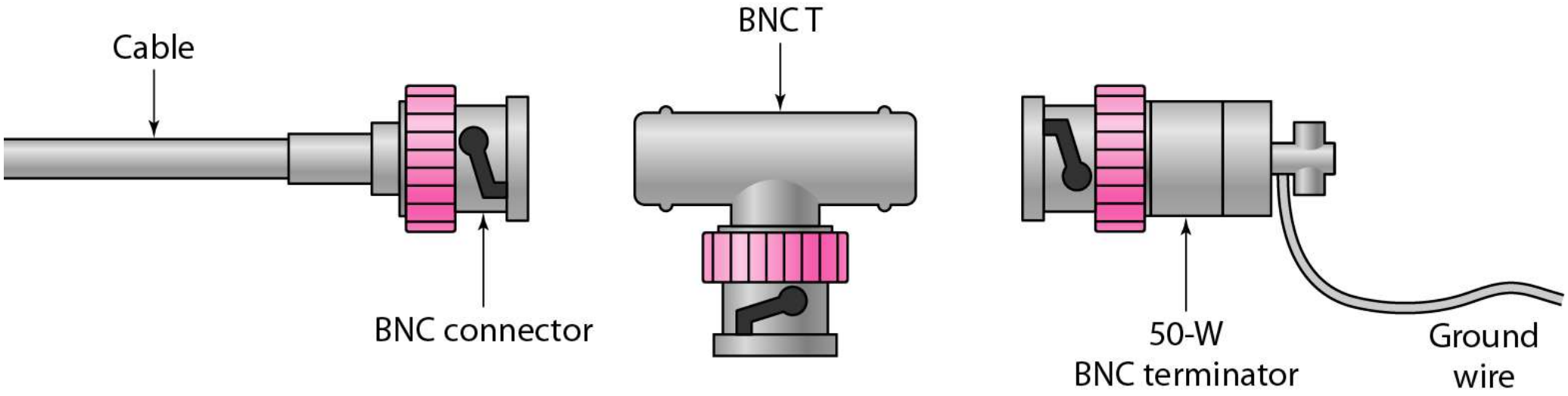


Coaxial Cable

- A coaxial cable consists of a stiff copper wire as the core, surrounded by an insulating material.
- The insulator is encased by a cylindrical conductor.
- The outer conductor is covered in a protective plastic sheath.

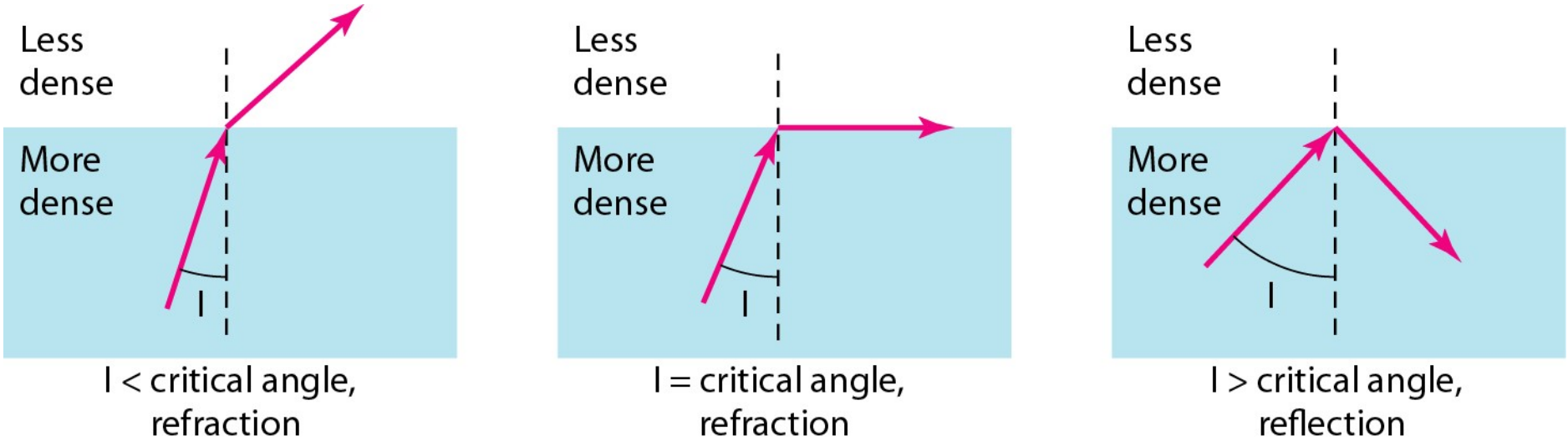


Coaxial Cable: BNC Connectors

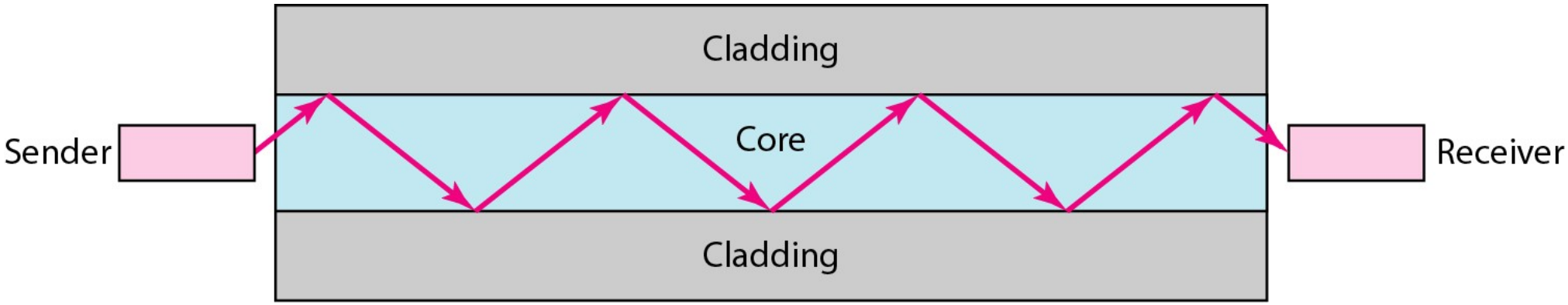


Optical fiber

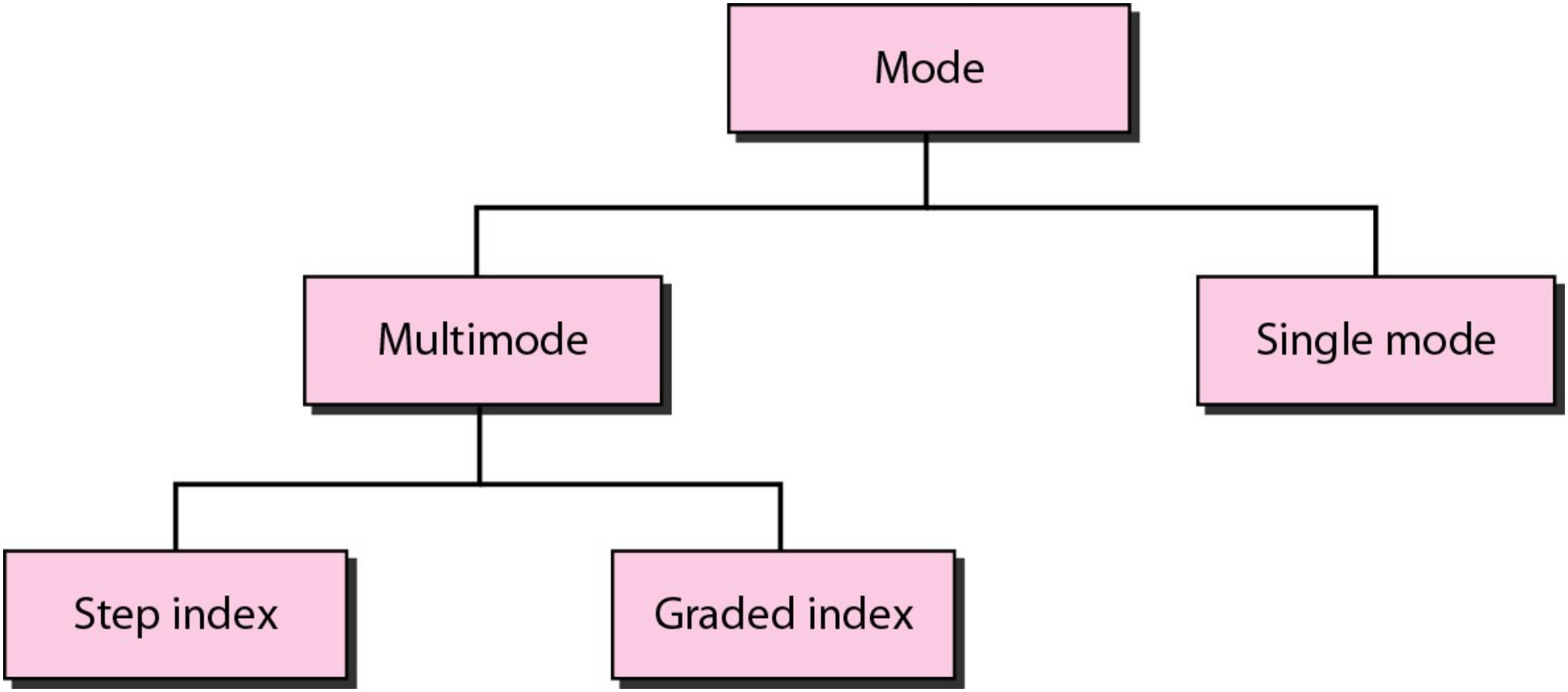
- The core of fiber optic cable is surrounded by a glass cladding with a lower index of refraction than the core
- To keep all the light in the core as follows:



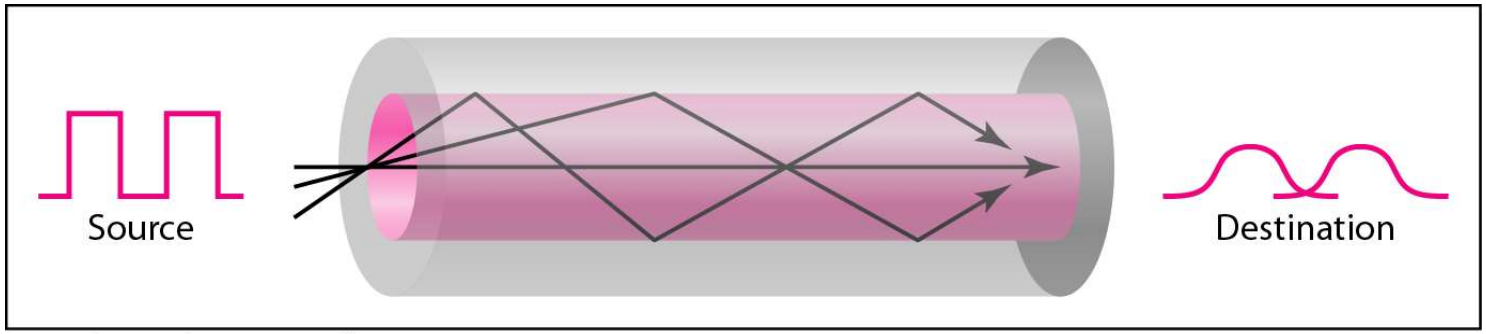
Optical fiber



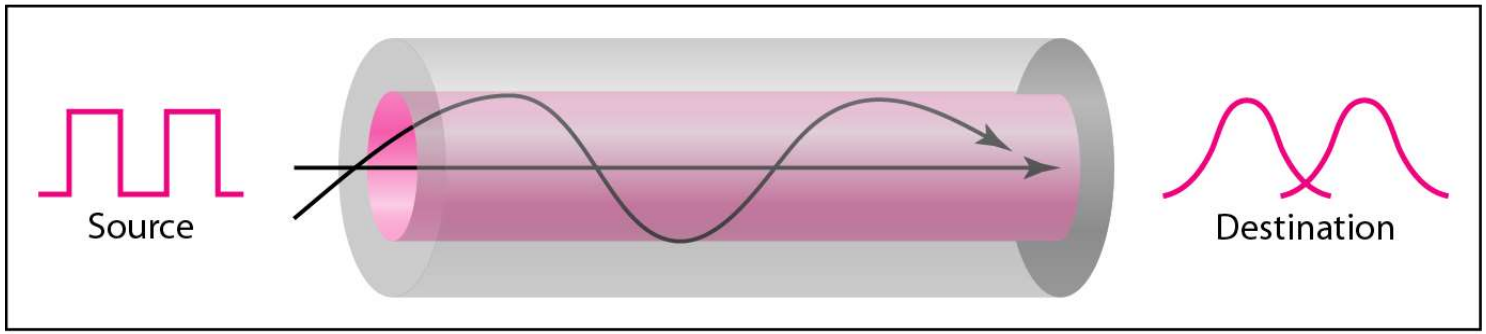
Optical fiber: Propagation modes



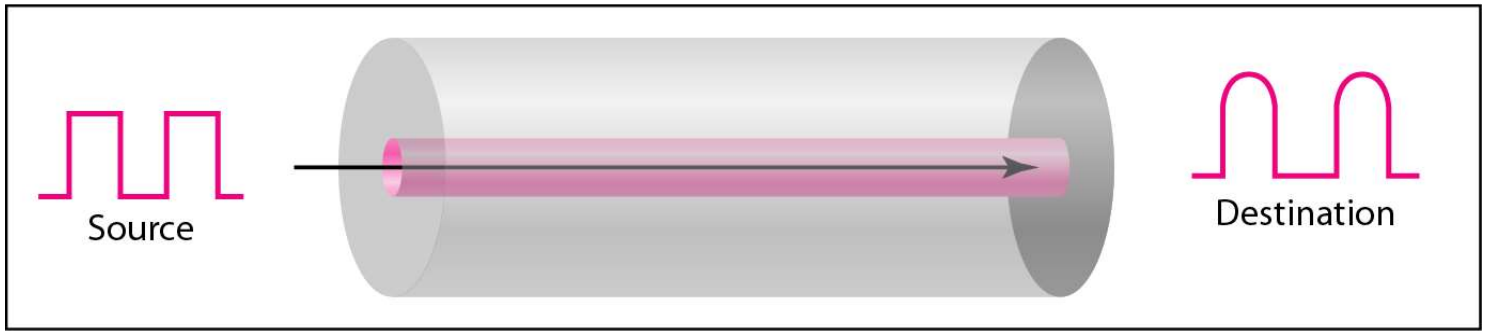
Optical fiber: Different Modes



a. Multimode, step index

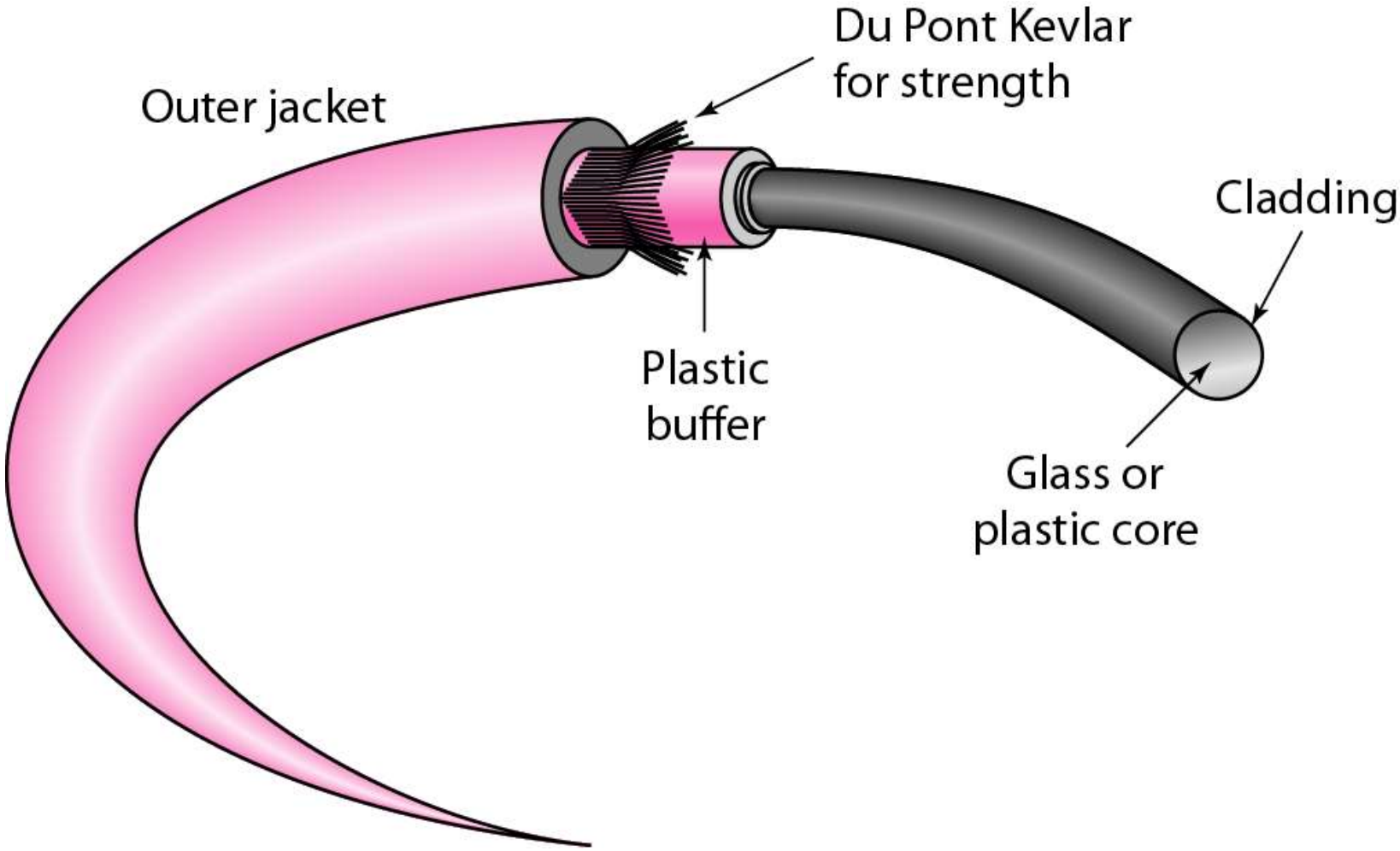


b. Multimode, graded index

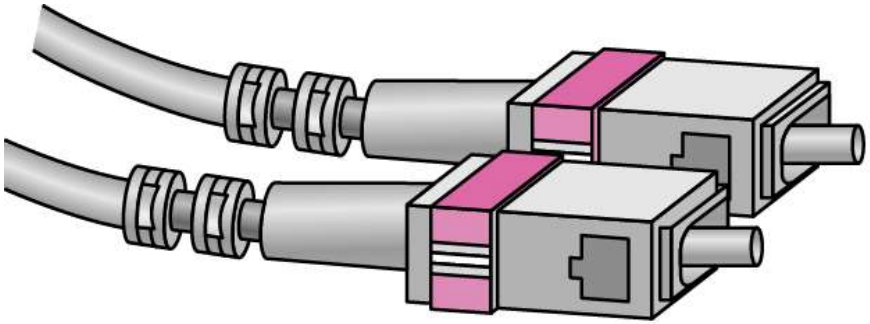


c. Single mode

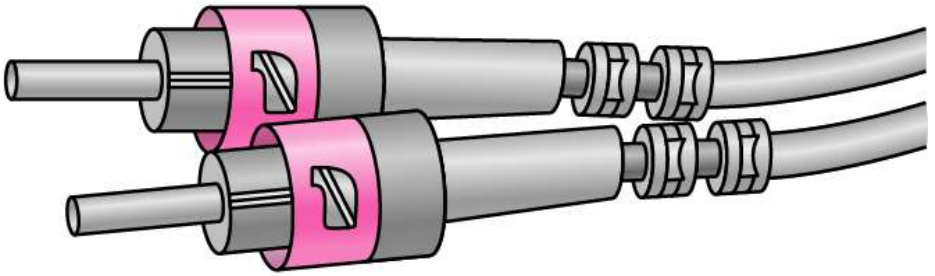
Fiber Construction



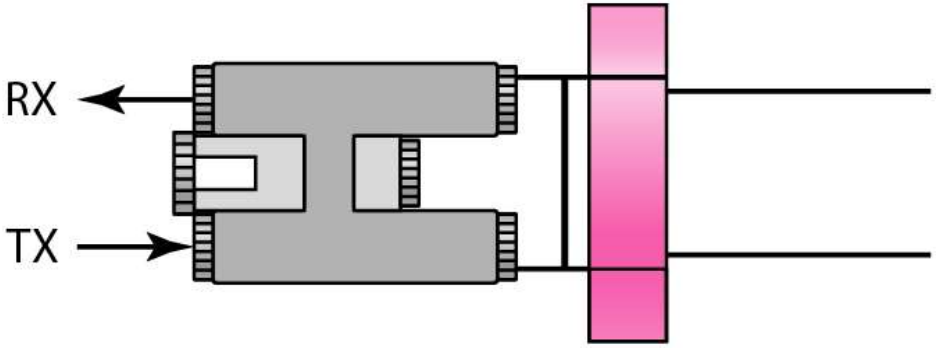
Optical Fiber Cable Connectors



SC connector



ST connector



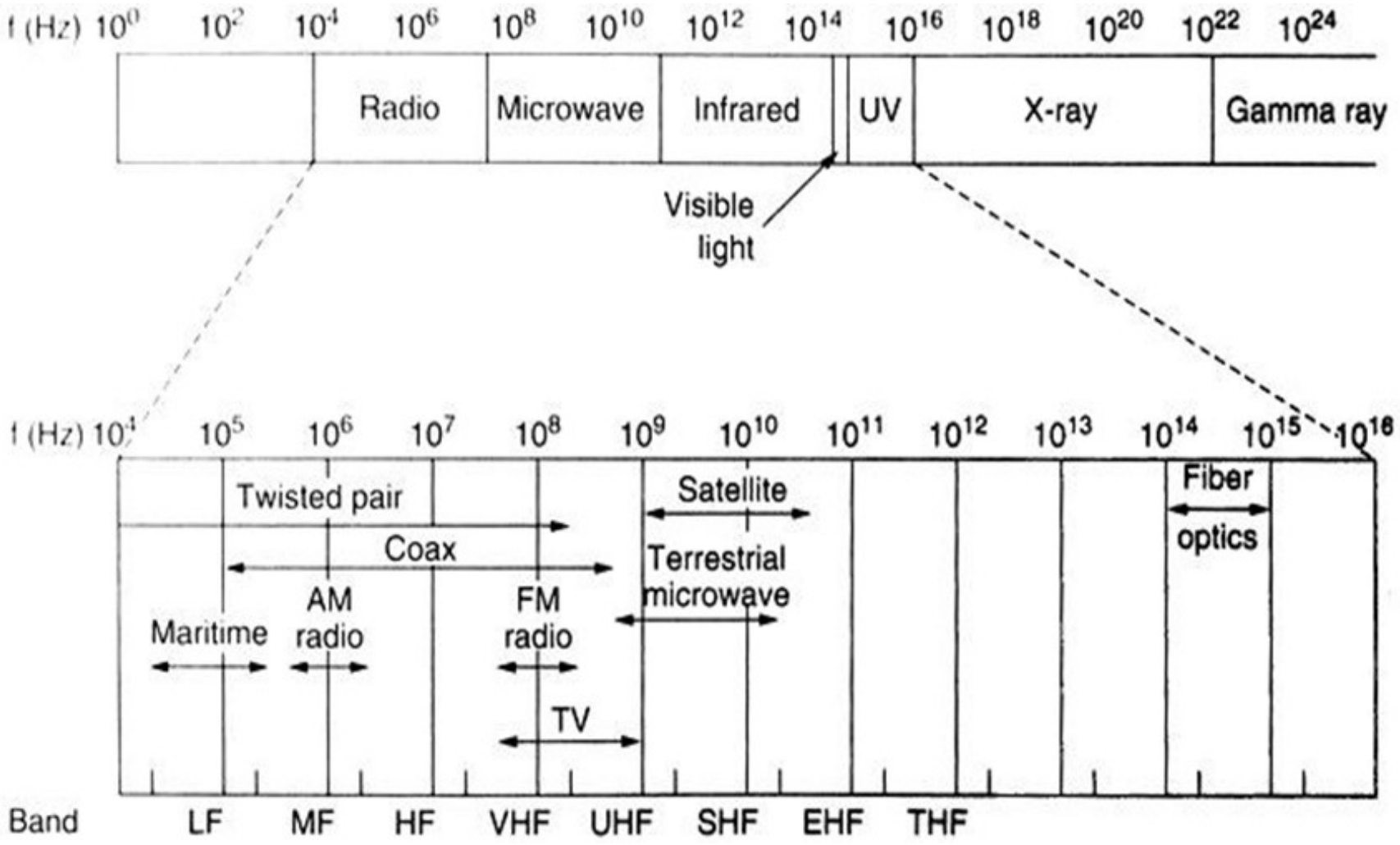
MT-RJ connector

Wireless Transmission

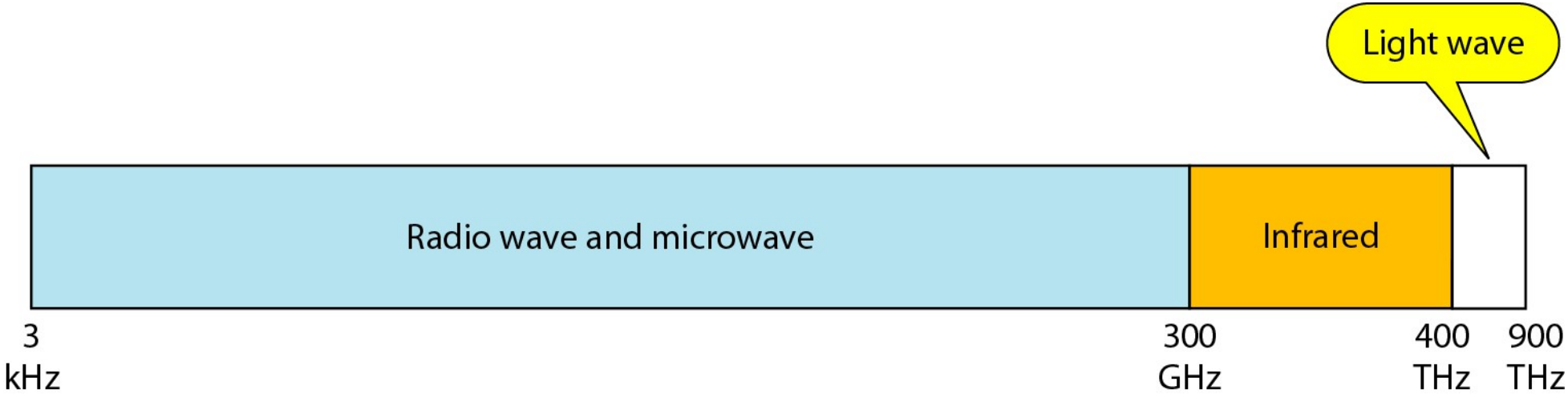
- Unguided media transport electromagnetic waves without using a physical conductor.
- This type of communication is often referred to as wireless communication.
- Tow common signal encoding methods:
  - Frequency hopping spread spectrum (e.g., Bluetooth)
  - Direct sequence spread spectrum (e.g., CDMA mobile network)

Wireless Transmission

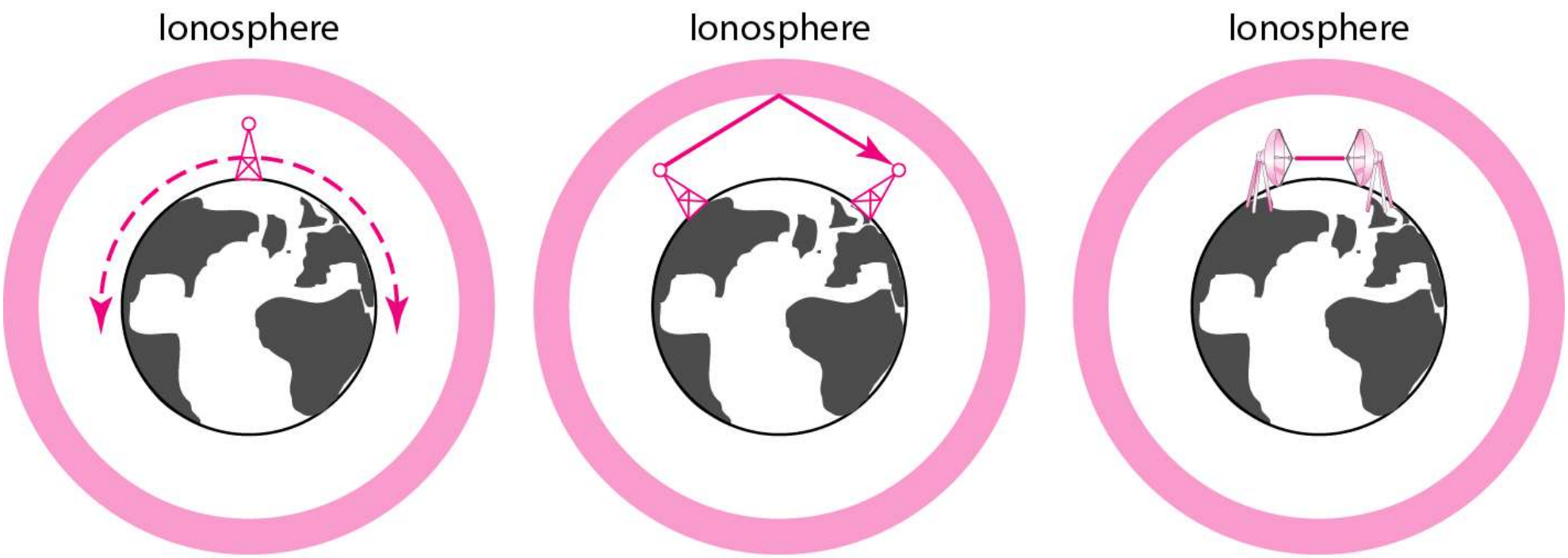
- The Electromagnetic Spectrum



Electromagnetic Spectrum for Wireless Communication



Propagation Methods



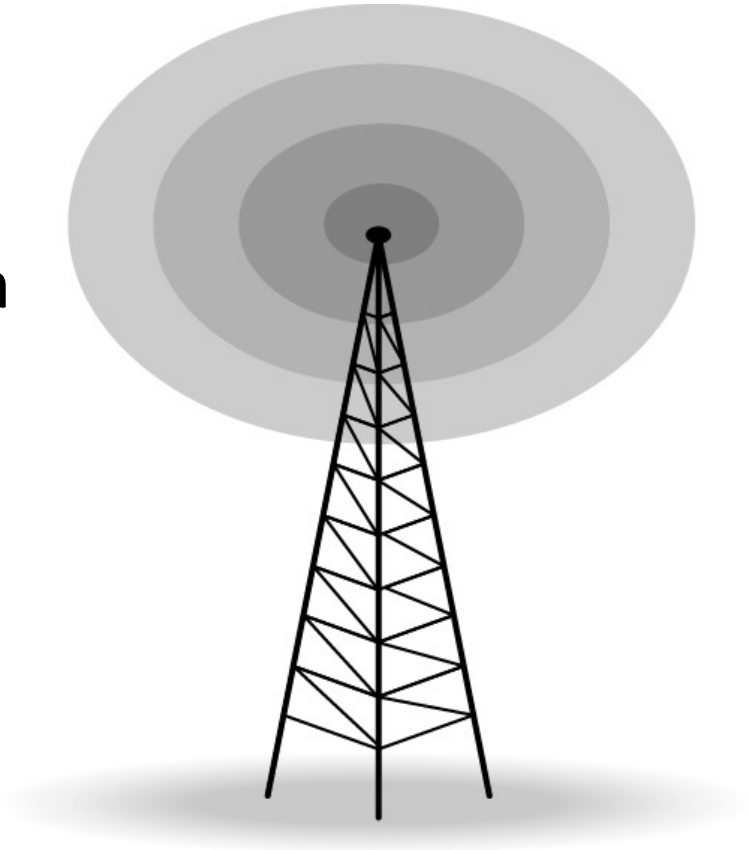
Ground propagation
(below 2 MHz)

Sky propagation
(2–30 MHz)

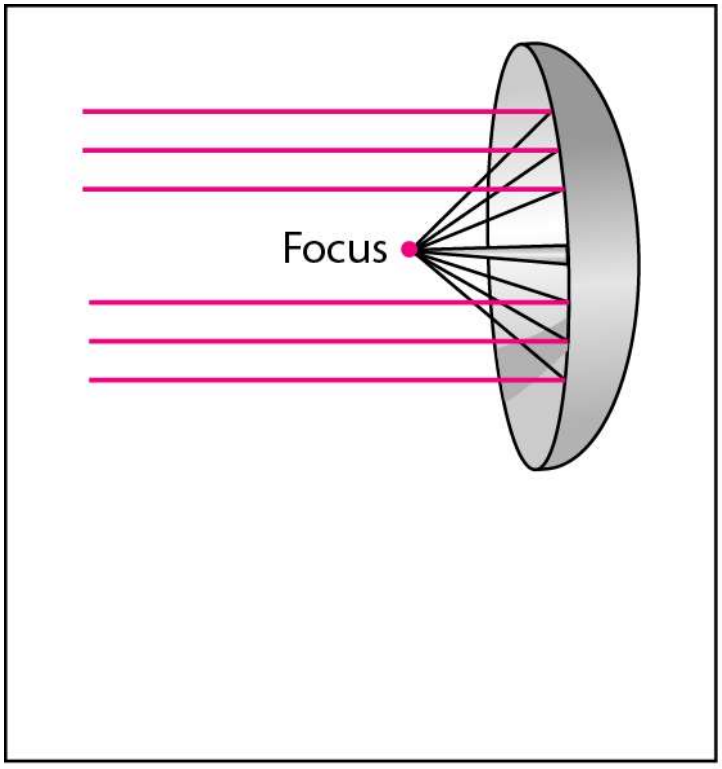
Line-of-sight propagation
(above 30 MHz)

Omnidirectional Antenna

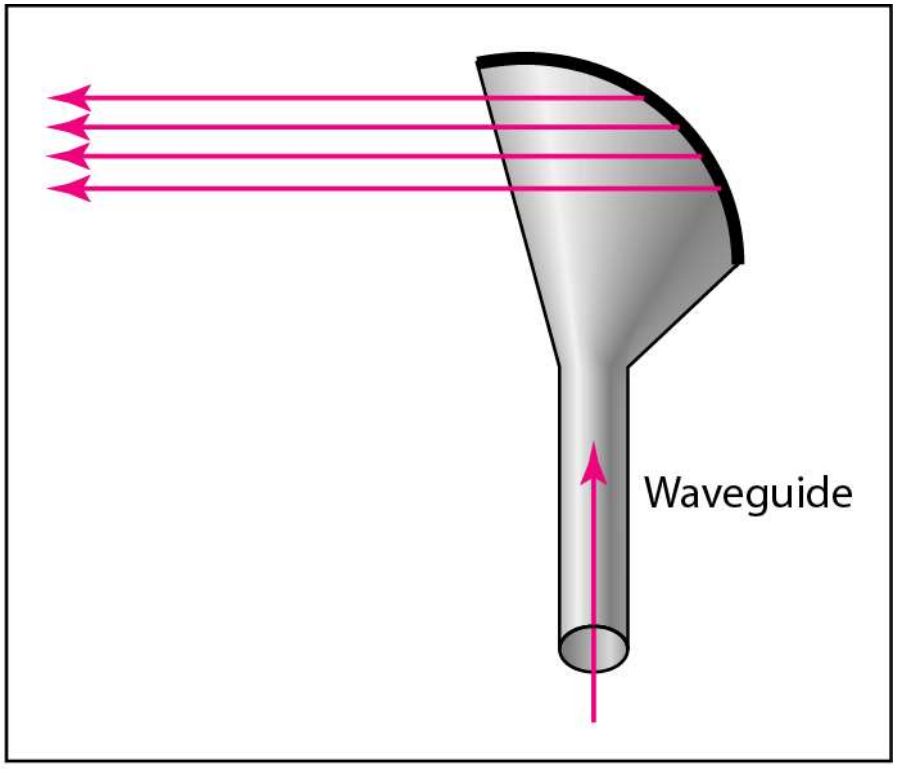
- Receiving signals from or transmitting in all directions



Unidirectional Antennas



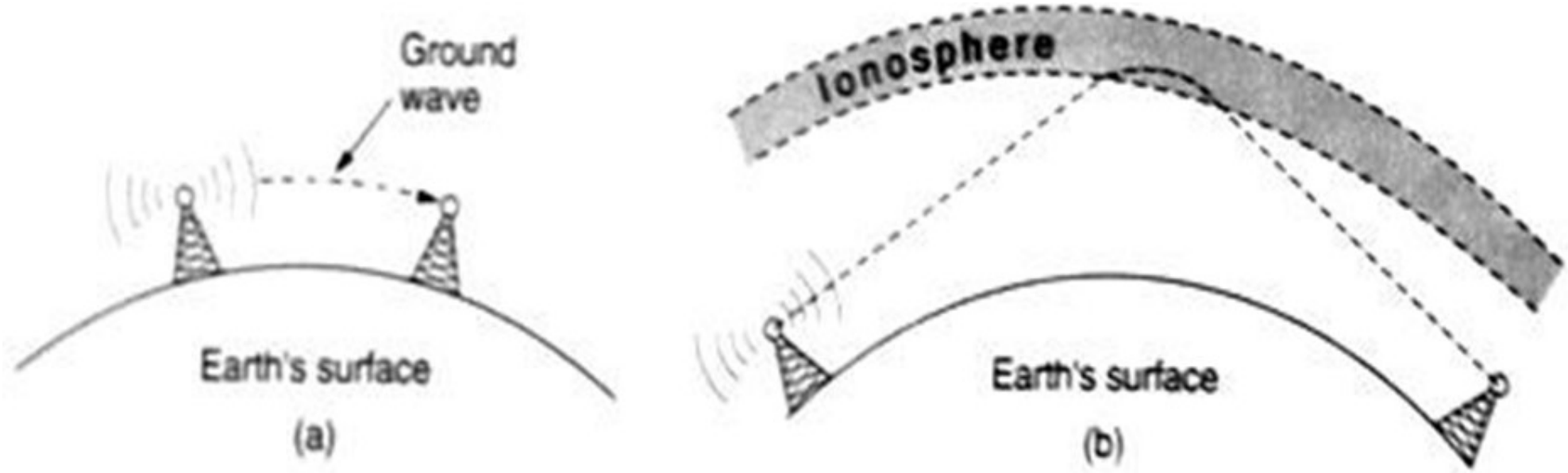
a. Dish antenna



b. Horn antenna

Types of Wireless Transmission

- Radio Transmission



- Microwave Transmission: widely used for long-distance telephone communication, television distribution
- Infrared: widely used for short-range communication (e.g., TV remote controller)
- Lightwave Transmission: use lightwave (e.g., laser beam) to communicate.

Communication Satellites

- Satellite likes a microwave repeater in the sky
- It listens and amplifies the incoming signal from somewhere on the earth, then rebroadcasts it at another frequency to another part on Earth