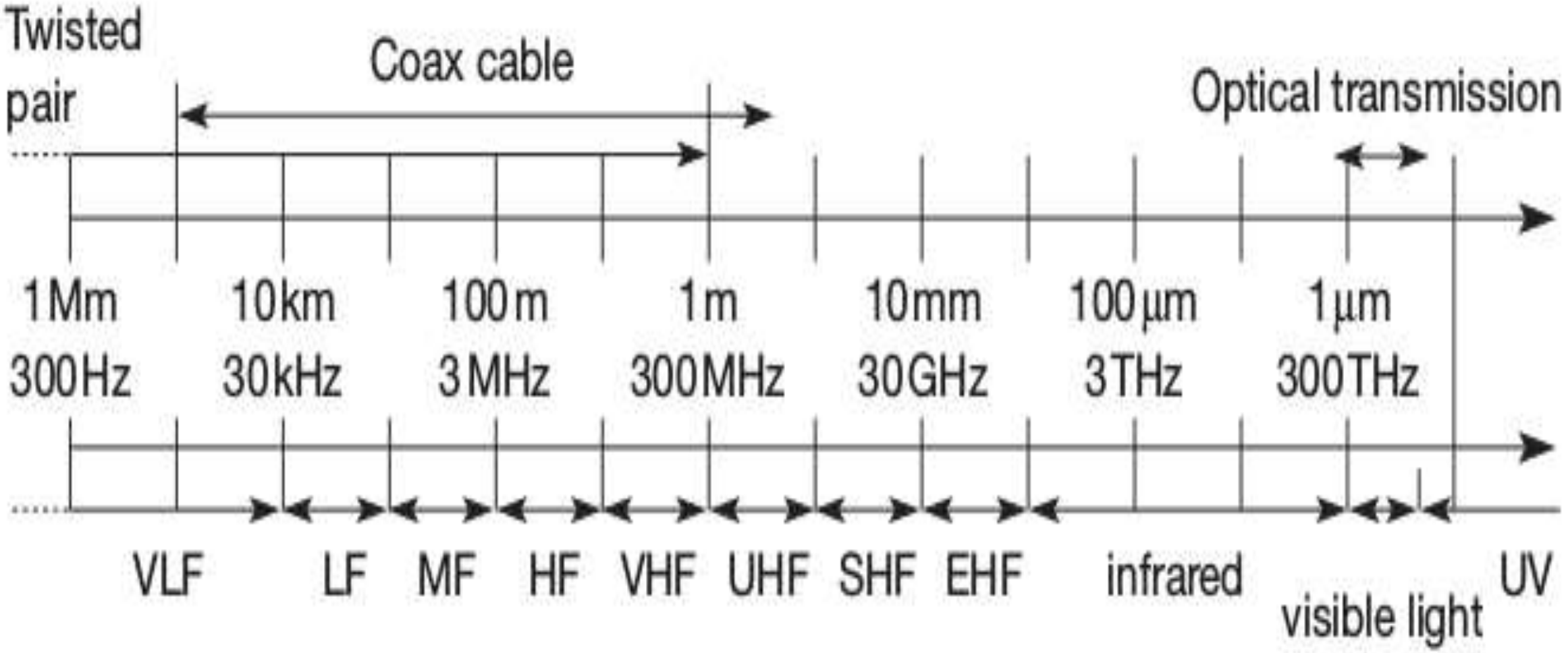
CHAPTER 2 : TRANSMISSION MEDIA

GUIDED AND UNGUIDED TRANSMISSION MEDIA

Introduction to Communication :

1. Oldest branch of Electronics Domain
2. Telecommunication : communicating at distance
3. Signals are the physical representation of data.
4. Users of a communication system can only exchange data through the transmission of signals
5. Communication system is the means of conveying information from one place to another.
6. components are :
    1. input transducer,
    2. transmitter,
    3. comm channel/medium,
    4. receiver,
    5. output transducer

Frequency Spectrum



$\lambda = c/f$

- where $c \cong 3 \times 10^8$ m/s (the speed of light in vacuum) and f the frequency.
- For traditional wired networks,
  - frequencies of up to several hundred kHz are used for distances up to some km with twisted pair copper wires.
  - frequencies of several hundred MHz are used with coaxial cable.
  - Fiber optics are used for frequency ranges of several hundred THz

At a Glance .....

- Introduction of Transmission Media
- Types of Transmission Media

a. Guided Transmission Media

1. TWISTED PAIR CABLE

i. UTP

ii. STP

2. CO AXIAL CABLE

3. FIBER OPTIC CABLE

b. Un Guided Transmission Media

1. Radio Waves

2. Microwave

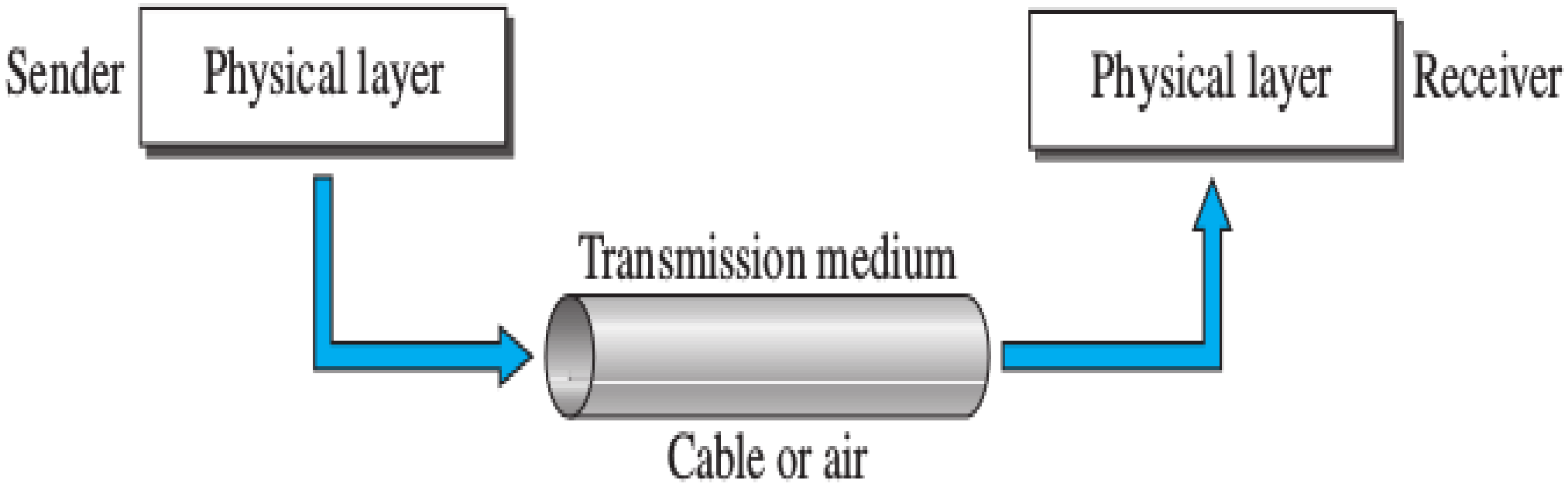
3. Infrared

INTRODUCTION

- Transmission media are actually located below the physical layer and are directly controlled by the physical layer.
- We could say that transmission media belong to layer zero.
- 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.*
- *The use of long-distance communication using electric signals started by Morse in the 19th century.*
- *Wireless communication started in 1895.*

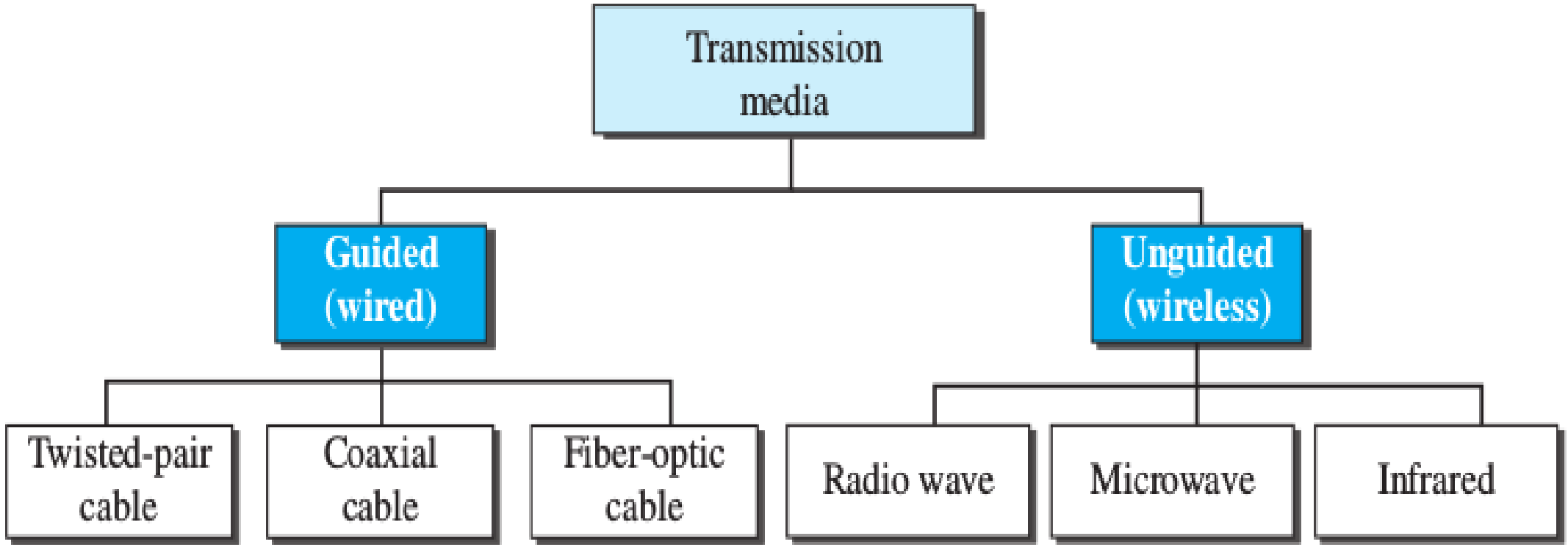
TRANSMISSION MEDIUM AND PHYSICAL LAYER

Figure 7.1 *Transmission medium and physical layer*



CLASSIFICATION OF TRANSMISSION MEDIA

Figure 7.2 *Classes of transmission media*



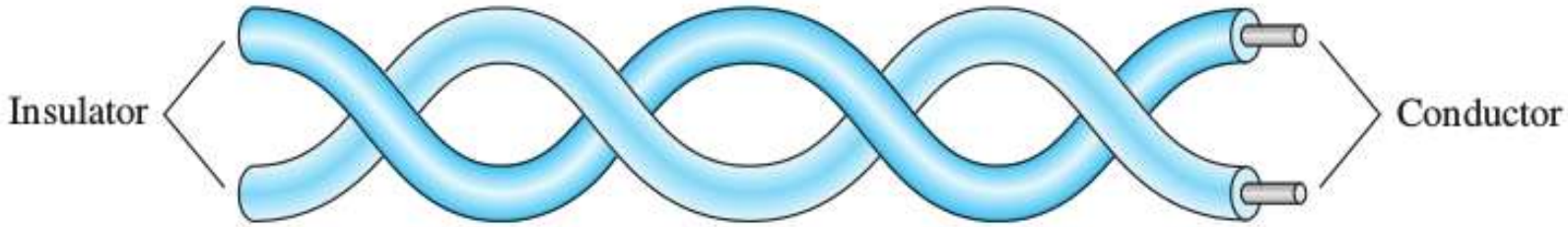
GUIDED MEDIA

- 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 and coaxial cable use metallic (copper) conductors that accept and transport signals in the form of *electric current*.
- Optical fiber is a cable that accepts and transports signals in the form of *light*.

Twisted-Pair Cable

- A twisted pair consists of two conductors (normally copper), each with its own plastic insulation, twisted together.
- One of the wires is used to carry signals to the receiver, and the other is used only as a ground reference.
- By twisting the pairs, a balance is maintained.
- The number of twists per unit of length (e.g., inch) has some effect on the quality of the cable.

Figure 7.3 *Twisted-pair cable*

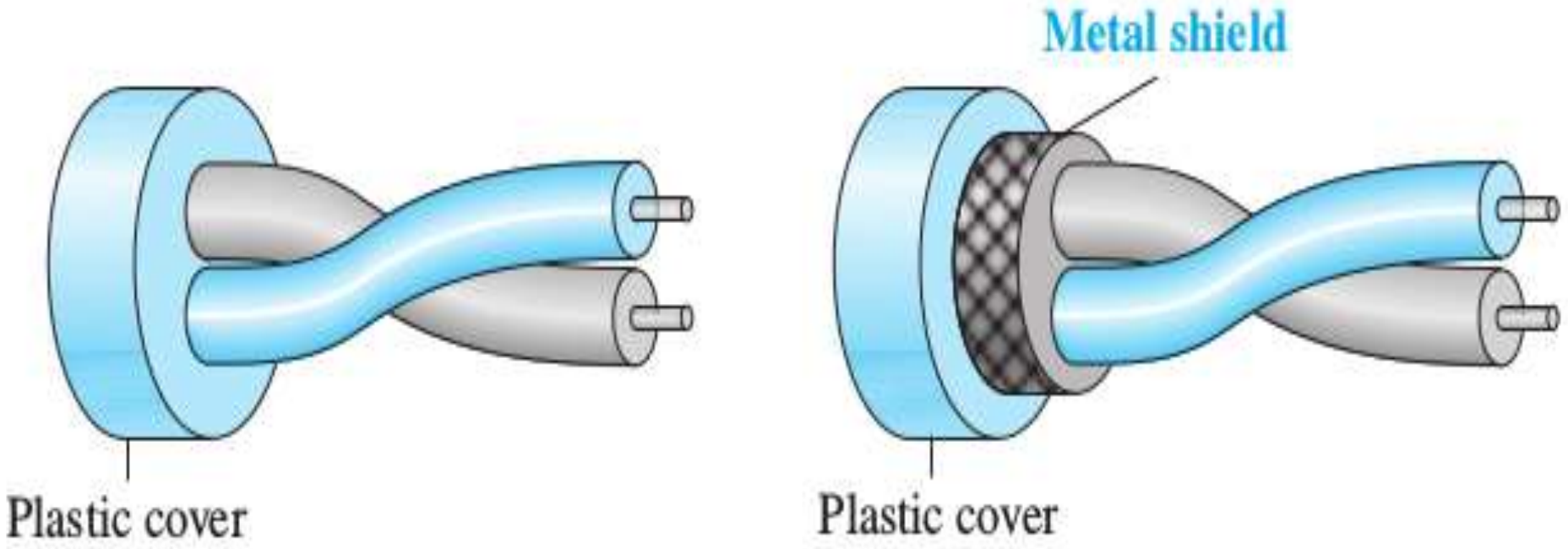


Unshielded Versus Shielded Twisted Pair Cable

- The most common twisted-pair cable used in communications is referred to as unshielded twisted-pair (UTP).
- IBM has also produced a version of twisted pair cable for its use, called shielded twisted pair (STP).
- STP cable has a metal foil or braided mesh covering that encases each pair of insulated conductors.
- Although metal casing improves the quality of cable by preventing the penetration of noise or crosstalk.
- it is bulkier and more expensive.

UTP AND STP

Figure 7.4 *UTP and STP cables*



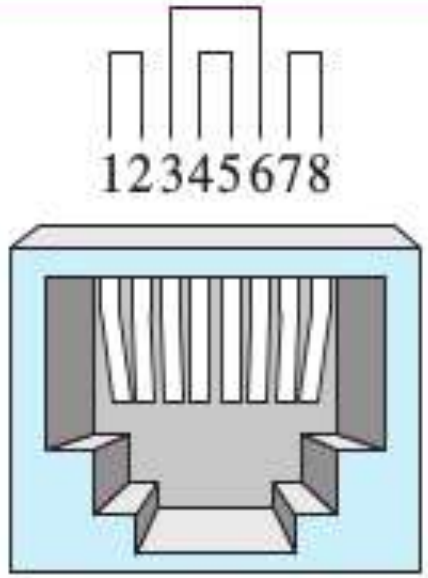
Categories of unshielded twisted pair cables

Category	*Specification*	*Data Rate (Mbps)*	*Use*
1	Unshielded twisted-pair used in telephone	< 0.1	Telephone
2	Unshielded twisted-pair originally used in T lines	2	T-1 lines
3	Improved CAT 2 used in LANs	10	LANs
4	Improved CAT 3 used in Token Ring networks	20	LANs
5	Cable wire is normally 24 AWG with a jacket and outside sheath	100	LANs
5E	An extension to category 5 that includes extra features to minimize the crosstalk and electromagnetic interference	125	LANs
6	A new category with matched components coming from the same manufacturer. The cable must be tested at a 200-Mbps data rate.	200	LANs
7	Sometimes called *SSTP (shielded screen twisted-pair)*. Each pair is individually wrapped in a helical metallic foil followed by a metallic foil shield in addition to the outside sheath. The shield decreases the effect of crosstalk and increases the data rate.	600	LANs

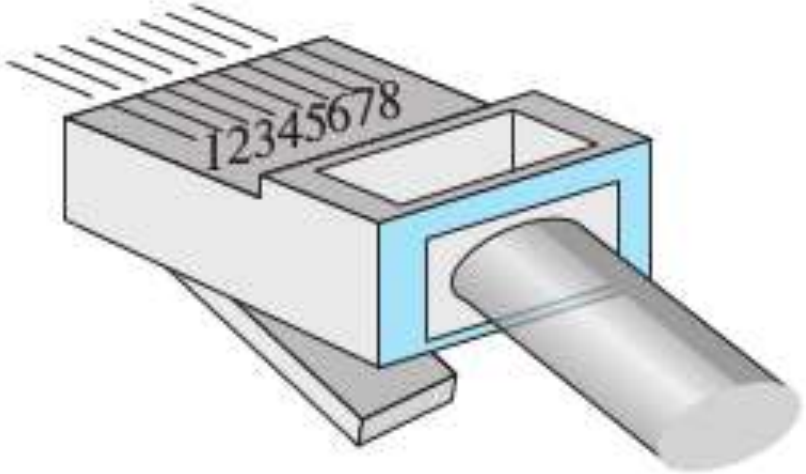
Connectors

- The most common UTP connector is RJ45 (RJ stands for registered jack), as shown in Figure

Figure 7.5 *UTP connector*



RJ-45 Female



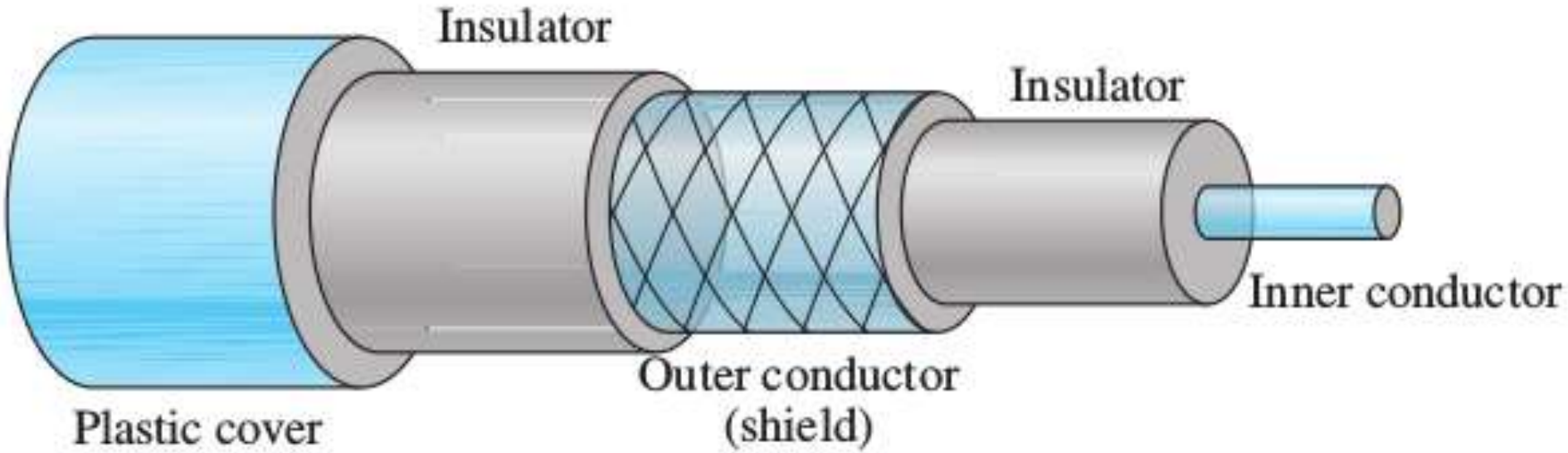
RJ-45 Male

Coaxial Cable

- Coaxial cable (or coax) carries signals of higher frequency ranges than those in twisted pair cable.
- Because the two media are constructed quite differently.
- Instead of having two wires, coax has a central core conductor of solid or stranded wire (usually copper)
- It is enclosed in an insulating sheath, which is, in turn, encased in an outer conductor of metal foil, braid, or a combination of the two.
- The outer metallic wrapping serves both as a shield against noise and as the second conductor, which completes the circuit.
- The whole cable is protected by a plastic cover.

Coaxial cable

Figure 7.7 *Coaxial cable*



Coaxial Cable Standards

- Coaxial cables are categorized by their Radio Government (RG) ratings.
- Each RG number denotes a unique set of physical specifications.

Table 7.2 *Categories of coaxial cables*

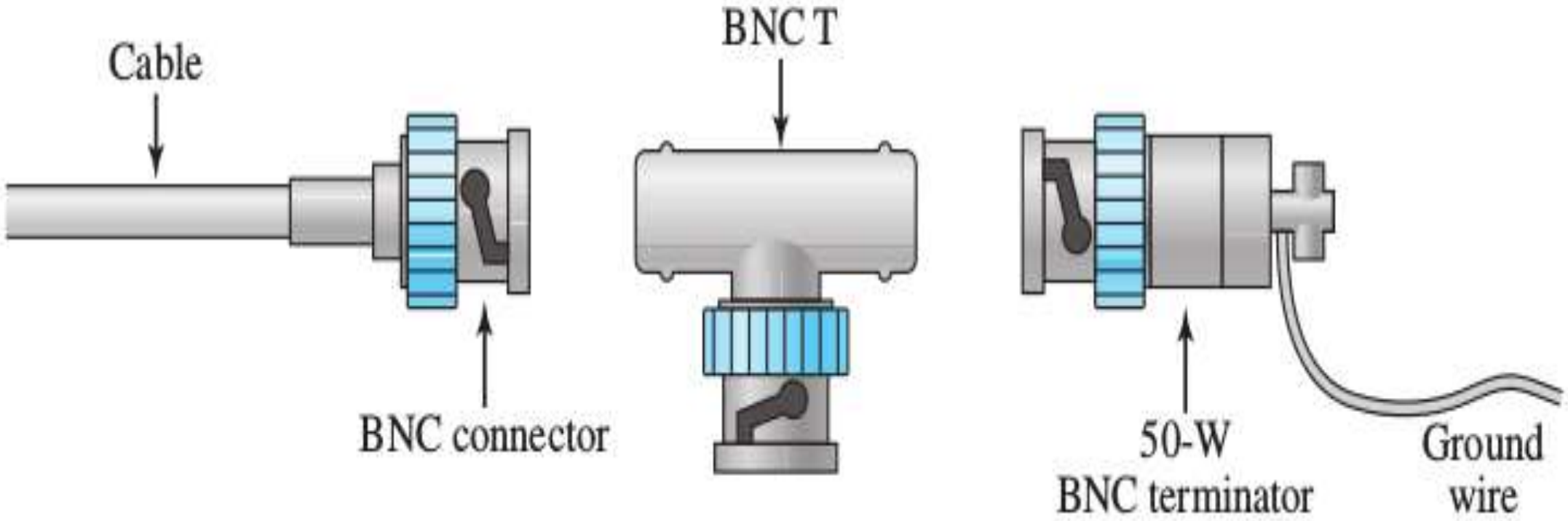
Category	*Impedance*	*Use*
RG-59	75 Ω	Cable TV
RG-58	50 Ω	Thin Ethernet
RG-11	50 Ω	Thick Ethernet

Coaxial Cable Connectors

- To connect coaxial cable to devices, we need coaxial connectors.
- The most common type of connector used today is the ***Bayonet Neill-Concelman (BNC)*** connector.
- The *BNC connector* is used to connect the end of the cable to a device, such as a TV set.
- The *BNC T connector* is used in Ethernet networks to branch out to a connection to a computer or other device.
- The *BNC terminator* is used at the end of the cable to prevent the reflection of the signal.

BNC Connectors

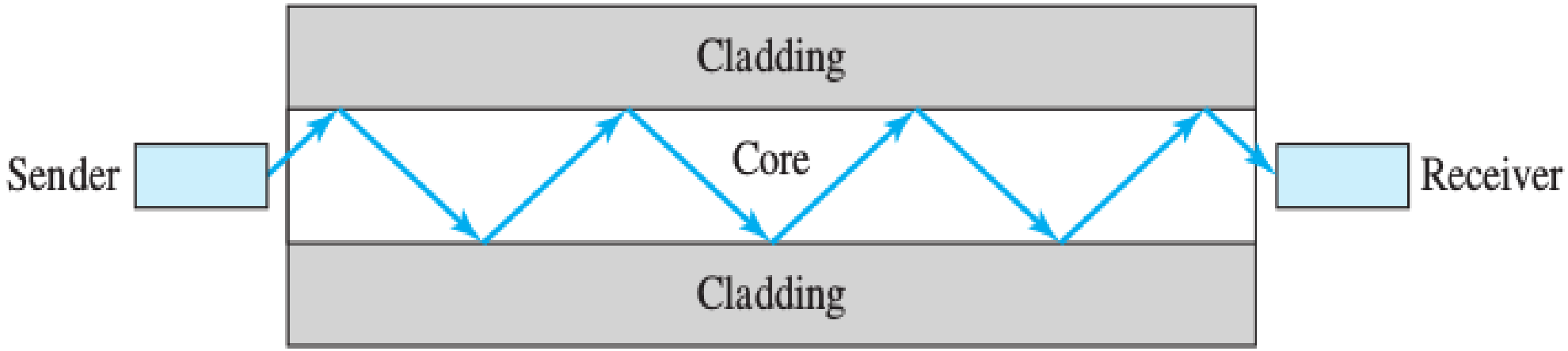
Figure 7.8 *BNC connectors*



Fiber Optic Cable

- A fiber-optic cable is made of glass or plastic and transmits signals in the form of light.

Figure 7.11 *Optical fiber*



Fiber Sizes

- Optical fibers are defined by the ratio of the diameter of their core to the diameter of their cladding, both expressed in micrometers.
- The common sizes are shown in Table

Table 7.3 *Fiber types*

Type	*Core (μm)*	*Cladding (μm)*	*Mode*
50/125	50.0	125	Multimode, graded index
62.5/125	62.5	125	Multimode, graded index
100/125	100.0	125	Multimode, graded index
7/125	7.0	125	Single mode

Propagation Modes

- Current technology supports two modes (multimode and single mode) for propagating light along optical channels.
- Each requiring fiber with different physical characteristics.
- Multimode can be implemented in two forms: step index or graded-index

Figure 7.12 *Propagation modes*

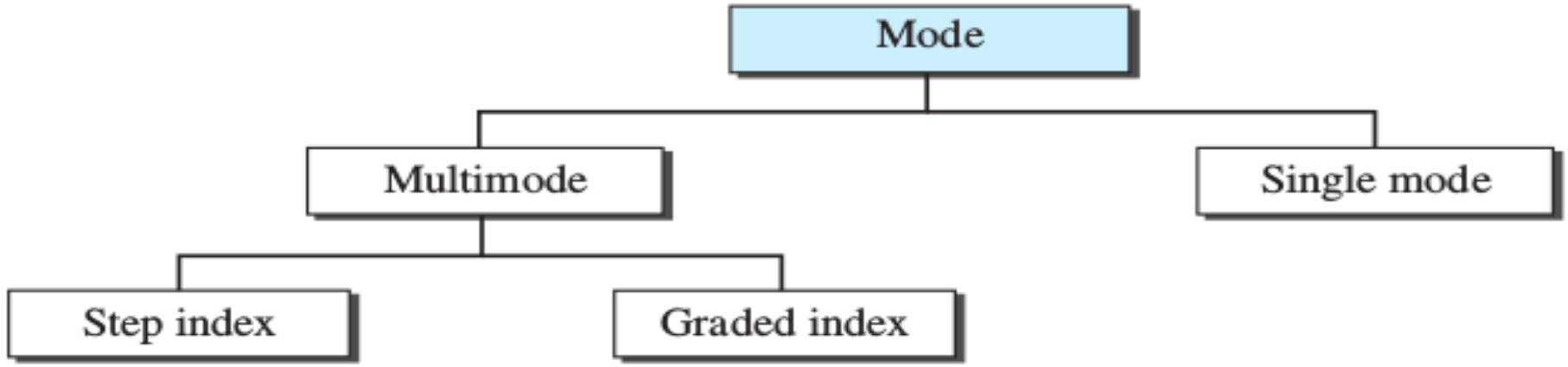
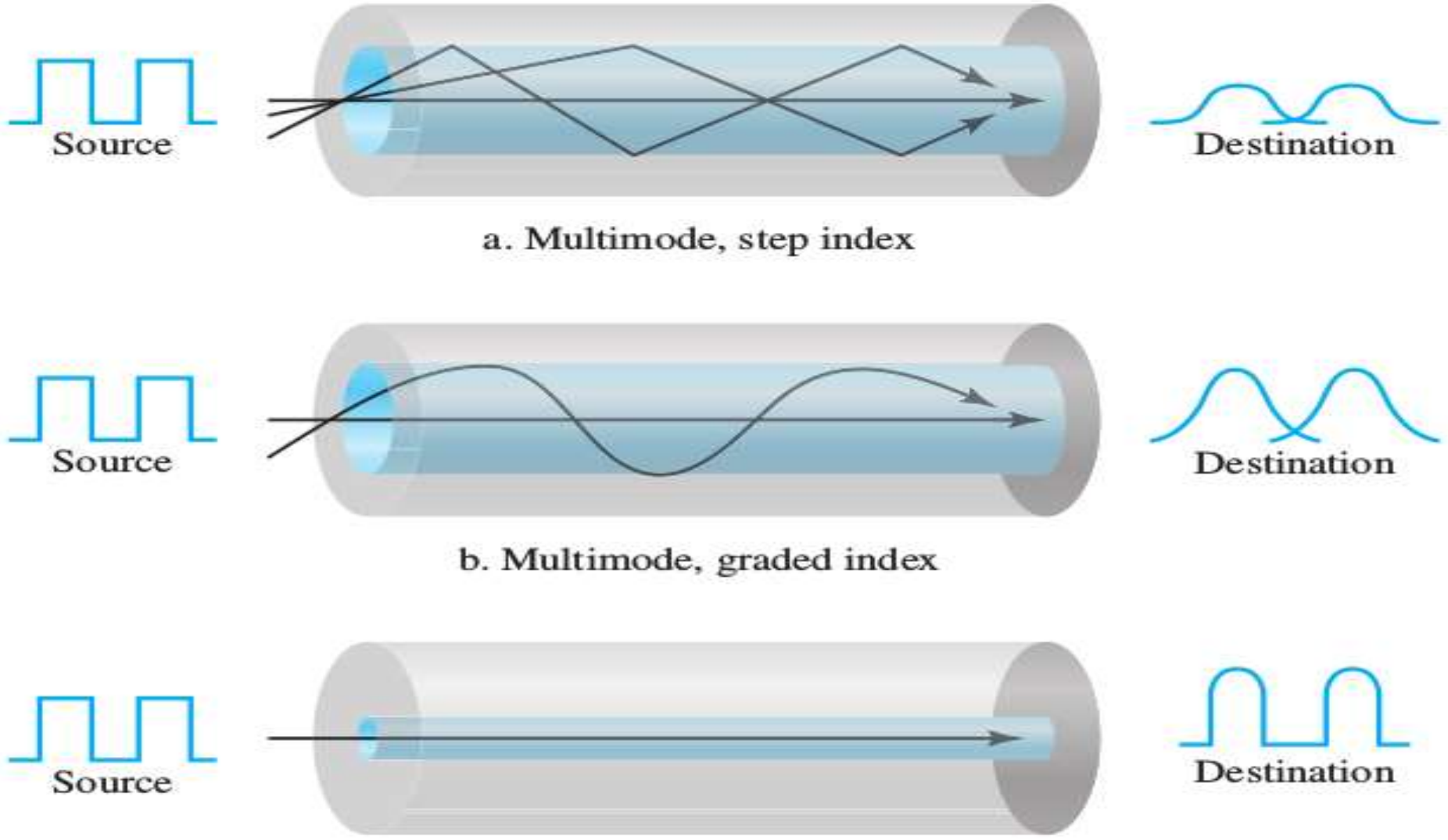


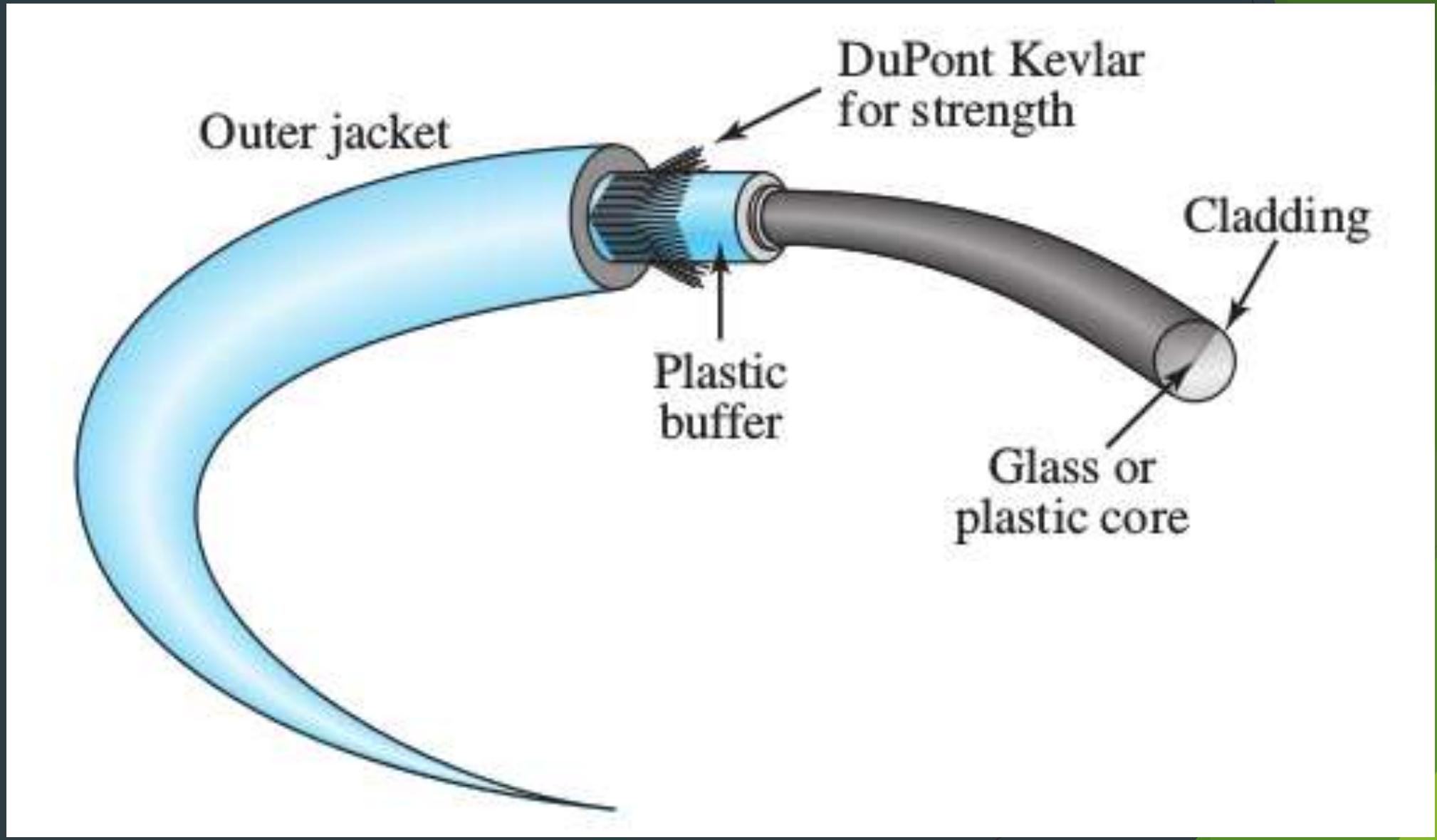
Figure 7.13 *Modes*



Cable Composition

- The outer jacket is made of either PVC or Teflon.
- Inside the jacket are Kevlar strands to strengthen the cable.
- Kevlar is a strong material used in the fabrication of bulletproof vests.
- Below the Kevlar is another plastic coating to cushion the fiber.
- The fiber is at the center of the cable, and it consists of cladding and core.

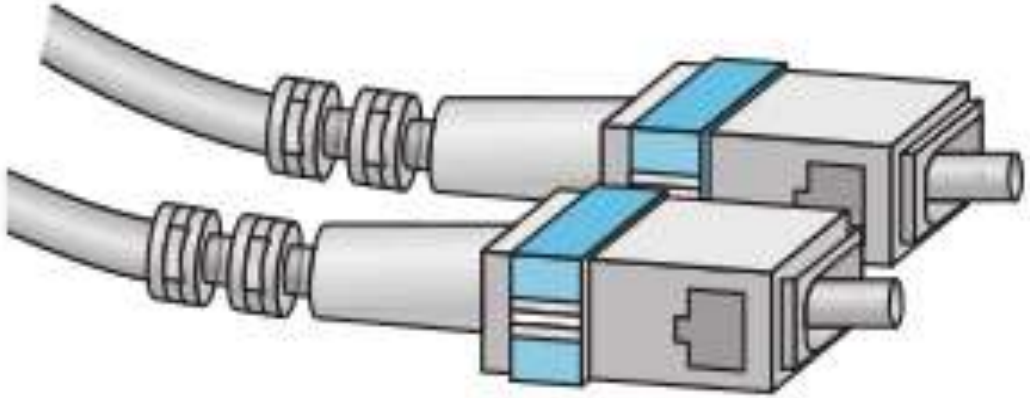
FIBER


DuPont Kevlar
for strength
Outer jacket
Cladding
Plastic
buffer
Glass or
plastic core

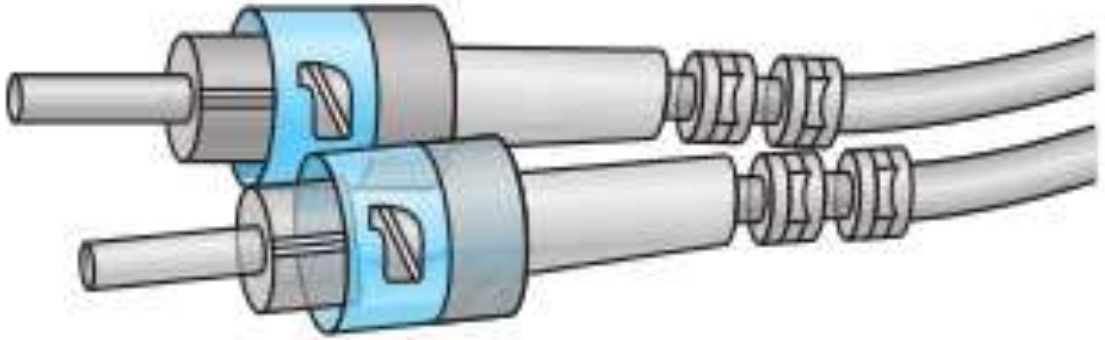
Fiber Optic Cable Connectors

- There are three types of connectors for fiber optic cables.
- The subscriber channel (SC) connector is used for cable TV. It uses a push/pull locking system.
- The straight tip (ST) connector is used for connecting cable to networking devices.
- It uses a bayonet locking system and is more reliable than SC.
- MTRJ is a connector that is the same size as RJ45.

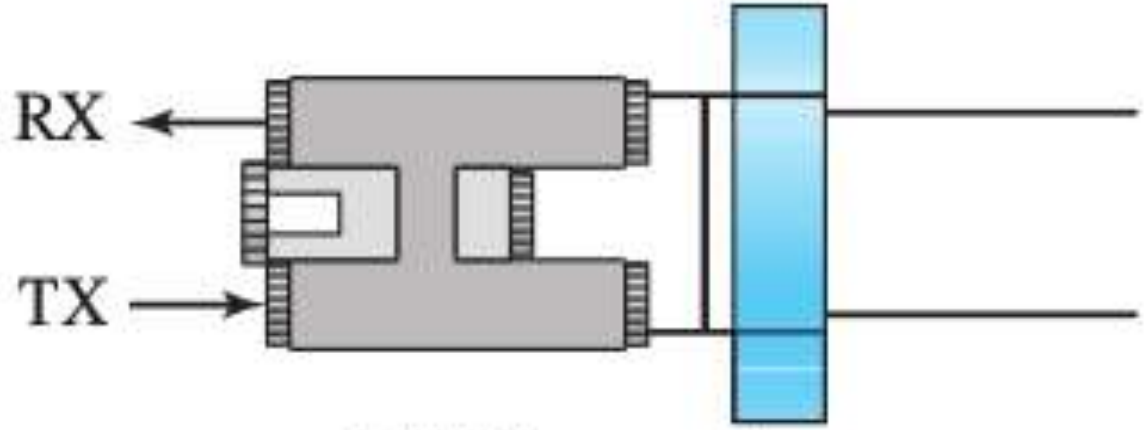
Connectors



SC connector



ST connector



MT-RJ connector

Advantages of Optical Fiber

- Higher bandwidth :
- Less signal attenuation :
- Immunity to electromagnetic interference :
- Resistance to corrosive materials :
- Light weight :
- Greater immunity to tapping :

Disdvantages of Optical Fiber

- Installation and maintenance :
- Unidirectional light propagation :
- Cost :

UNGUIDED MEDIA: WIRELESS

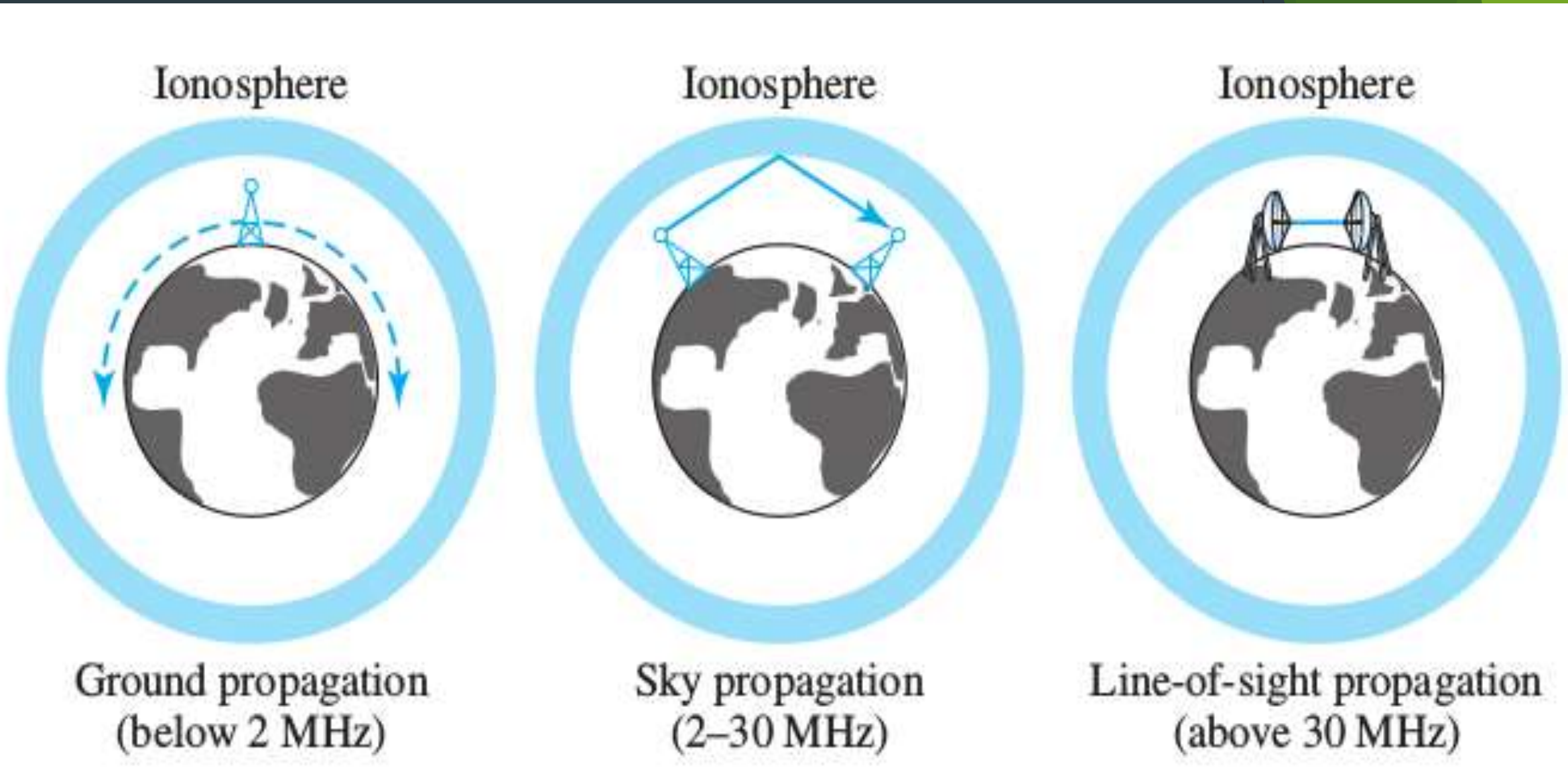
- Unguided medium transport electromagnetic waves without using a physical conductor.
- This type of communication is often referred to as wireless communication.
- Signals are normally broadcast through free space and thus are available to anyone who has a device capable of receiving them.
- Unguided signals can travel from the source to the destination in several ways:

Ground propagation,

Sky propagation,

Line of sight propagation.

Propagation Methods



GROUND PROPAGATION

- In ground propagation, radio waves travel through the lowest portion of the atmosphere, hugging the earth.
- These low frequency signals emanate in all directions from the transmitting antenna and follow the curvature of the planet.
- Distance depends on the amount of power in the signal: The greater the power, the greater the distance.

Sky propagation

- In sky propagation, higher frequency radio waves radiate upward into the ionosphere.
- ionosphere is the layer of atmosphere where particles exist as ions.
- Where they are reflected back to earth.

Line of Sight Propagation

- In line of sight propagation, very high frequency signals are transmitted in straight lines directly from antenna to antenna.
- Antennas must be directional, facing each other, and either tall enough or close enough together not to be affected by the curvature of the earth.
- Line of sight propagation is tricky because radio transmissions cannot be completely focused.

Radio Waves

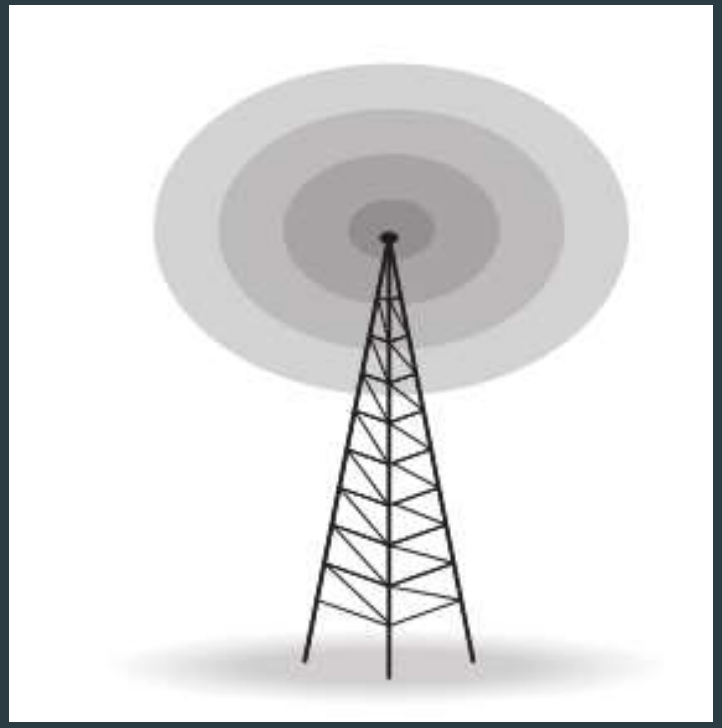
- Electromagnetic waves ranging in frequencies between 3 kHz and 1 GHz are normally called Radio waves.
- Radio waves, are Omnidirectional.
- When an antenna transmits radio waves, they are propagated in all directions.
- This means that the sending and receiving antennas do not have to be aligned.
- A sending antenna sends waves that can be received by any receiving antenna.
- The omnidirectional property has a disadvantage too : Interference

Radio Waves

- Radio waves, particularly those waves that propagate in the sky mode, can travel long distances.
- This makes radio waves a good candidate for long distance broadcasting.
- Radio waves, particularly those of low and medium frequencies, can penetrate walls.
- This characteristic can be both an advantage and a disadvantage.
- It is an advantage because it can receive signals inside a building.
- It is a disadvantage because we cannot isolate a communication to just inside or outside a building.

Radio Waves

- The radio wave band is relatively narrow, just under 1 GHz, compared to the microwave band.
- When this band is divided into subbands, the subbands are also narrow, leading to a low data rate for digital communications.



OMNIDIRECTIONAL ANTENNA

Applications

- The omnidirectional characteristics of radio waves make them useful for multicasting, in which there is one sender but many receivers.

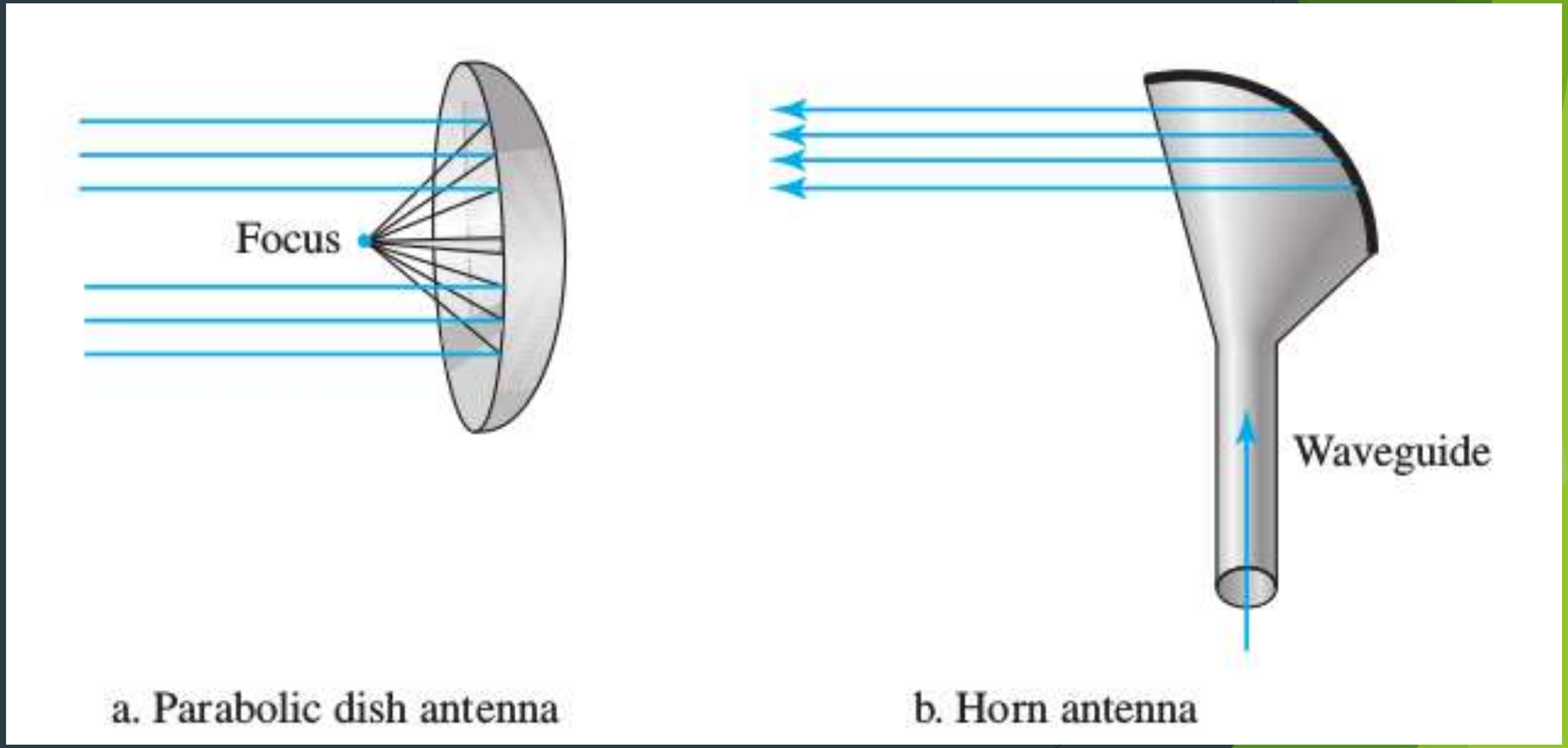
Microwaves

- Electromagnetic waves having frequencies between 1 and 300 GHz are called microwaves.
- Microwaves are unidirectional.
- When an antenna transmits microwaves, they can be narrowly focused.
- This means that the sending and receiving antennas need to be aligned.
- The unidirectional property has an obvious advantage. A pair of antennas can be aligned without interfering with another pair of aligned antennas.

Microwaves

- Microwave propagation is line of sight.
- Since the towers with the mounted antennas need to be in direct sight of each other, towers that are far apart need to be very tall.
- The curvature of the earth as well as other blocking obstacles do not allow two short towers to communicate by using microwaves.
- Repeaters are often needed for long distance communication.
- Very high frequency microwaves cannot penetrate walls.
- This characteristic can be a disadvantage if receivers are inside buildings.
- The microwave band is relatively wide, almost 299 GHz.
- Therefore wider subbands can be assigned, and a high data rate is possible.
- Use of certain portions of the band requires permission from authorities.

Unidirectional Antennas



Unidirectional Antenna

- Microwaves need unidirectional antennas that send out signals in one direction.
- Two types of antennas are used for microwave communications :

  Parabolic dish and

  Horn

- Applications : Microwaves, due to their unidirectional properties, are very useful when unicast (one to one) communication is needed between the sender and the receiver.
- They are used in cellular phones, satellite networks and wireless LANs.

Infrared

- Infrared waves, with frequencies from 300 GHz to 400 THz can be used for short range communication.
- Infrared waves, having high frequencies, cannot penetrate walls.
- This advantageous characteristic prevents interference between one system and another.
- e.g. TV Remote Control

- However, this same characteristic makes infrared signals useless for long range communication.
- In addition, we cannot use infrared waves outside a building because the sun's rays contain infrared waves that can interfere with the communication.
- The standard originally defined a data rate of 75 kbps for a distance up to 8 m.
- The recent standard defines a data rate of 4 Mbps.

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

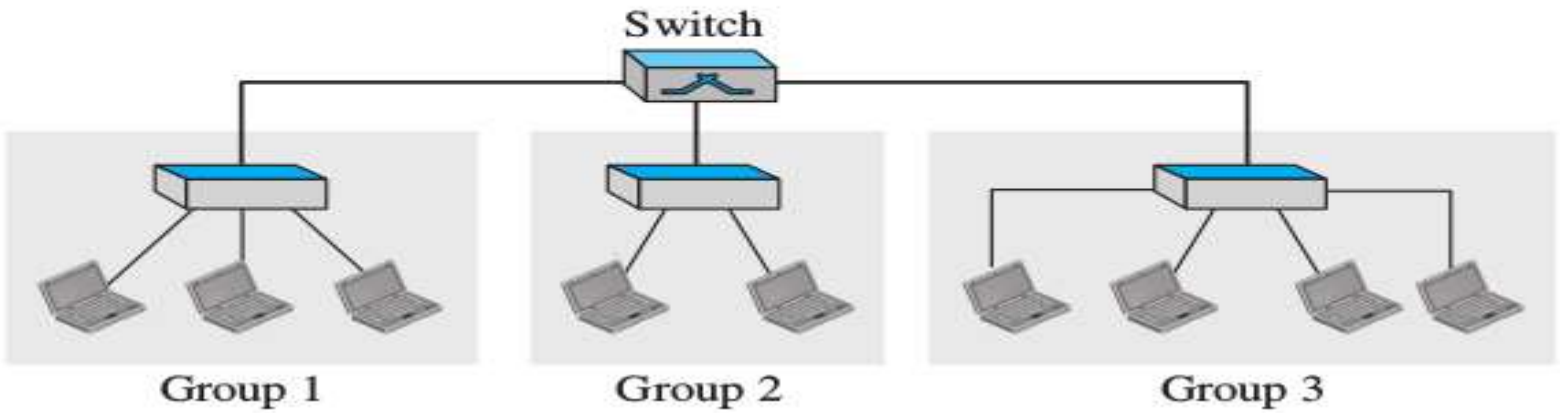
VIRTUAL LANS

- What happens if we need a virtual connection between two stations belonging to two different physical LANs?
- We can roughly define a virtual local area network (VLAN) as a local area network configured by software, not by physical wiring.

VIRTUAL LANS

- The first three engineers work together as the first group, the next two engineers work together as the second group, and the last four engineers work together as the third group.
- But what would happen if the administrators needed to move two engineers from the first group to the third group, to speed up the project being done by the third group?

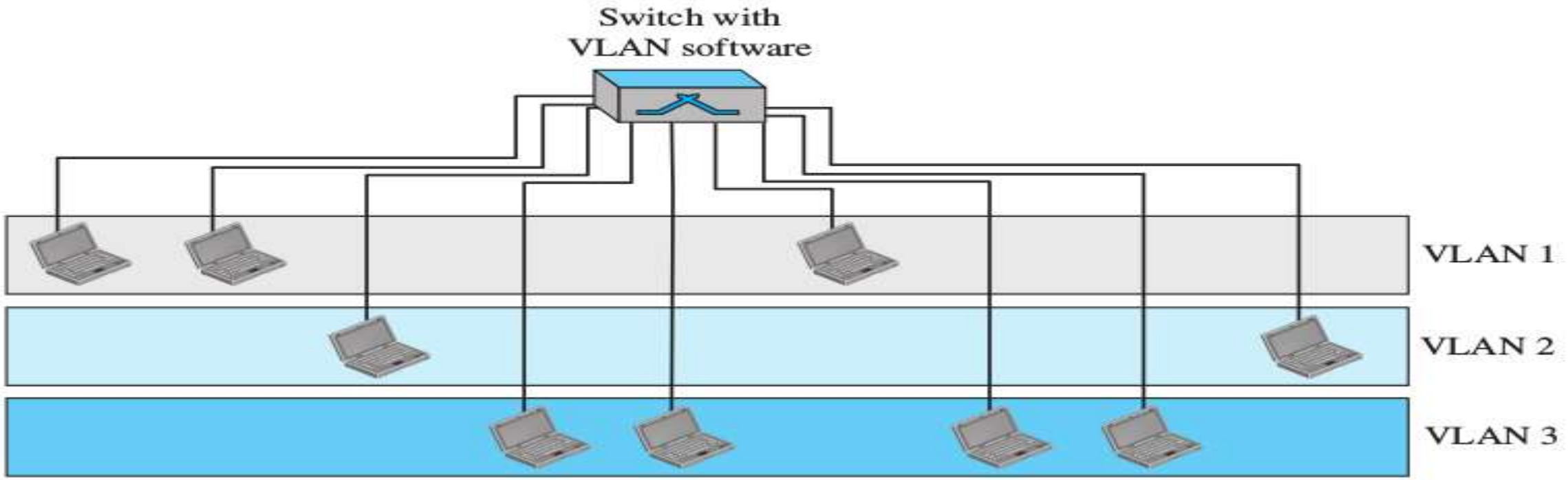
Figure 17.10 *A switch connecting three LANs*



VIRTUAL LANS

- The whole idea of VLAN technology is to divide a LAN into logical, instead of physical, segments.
- A LAN can be divided into several logical LANs, called VLANs.

Figure 17.11 *A switch using VLAN software*

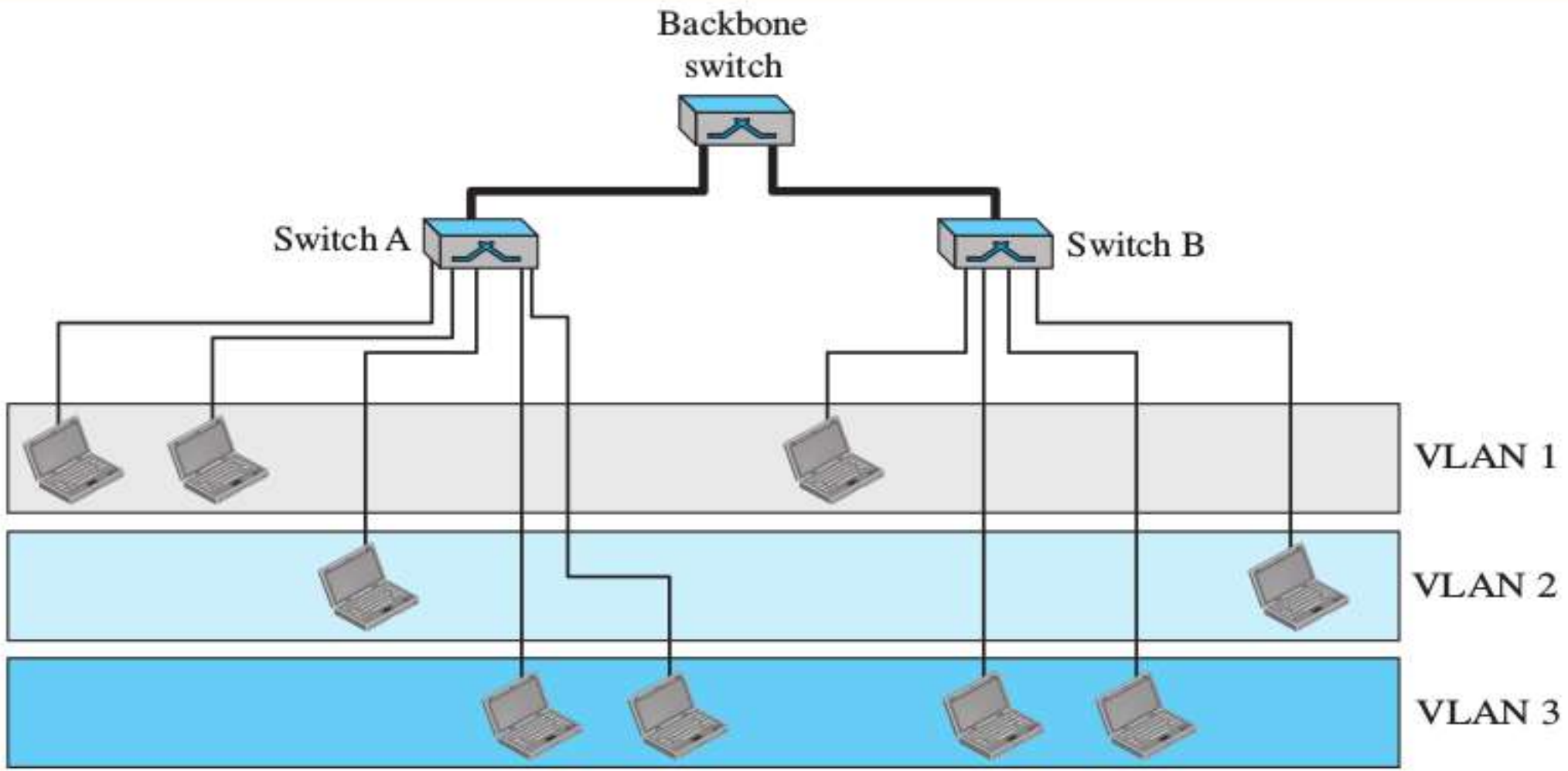


A switch connecting three LANs

- If a person moves from one group to another, there is no need to change the physical configuration.
- The group membership in VLANs is defined by software, not hardware.
- Any station can be logically moved to another VLAN.
- All members belonging to a VLAN can receive broadcast messages sent to that particular VLAN.

Two switches in a backbone using VLAN software

Figure 17.12 *Two switches in a backbone using VLAN software*



Two switches in a backbone using VLAN software

- VLAN technology even allows the grouping of stations connected to different switches in a VLAN.
- Figure shows a backbone local area network with two switches and three VLANs.
- Stations from switches A and B belong to each VLAN.
- This is a good configuration for a company with two separate buildings.
- Each building can have its own switched LAN connected by a backbone.
- People in the first building and people in the second building can be in the same work group even though they are connected to different physical LANs.

Advantages

- **Cost and Time Reduction :**

  VLANs can reduce the migration cost of stations going from one group to another.

  Physical reconfiguration takes time and is costly.

- **Creating Virtual Work Groups :**

  VLANs can be used to create virtual work groups. [study group, project group]

- **Security :**

  VLANs provide an extra measure of security.

  People communicates with the guaranteed assurance that users in other groups will not receive these messages.


Thank You