Transmission Media

Introduction

- Located below the physical layer
- Directly controlled by the physical layer.
- Layer 0
- anything that can carry information from a source to a destination
- free space,
- metallic cable i.e. telegraph
- fiber-optic cable.

Figure 1 Transmission medium and physical layer

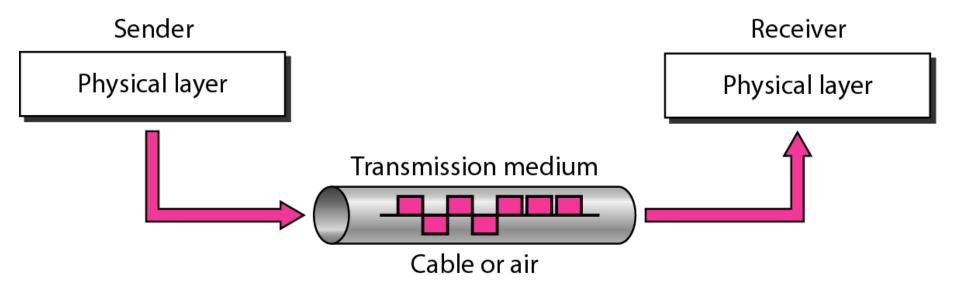
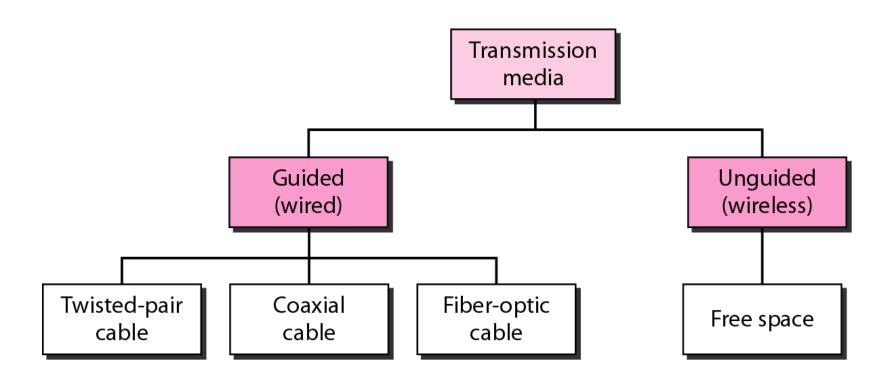


Figure 2 Classes of transmission media

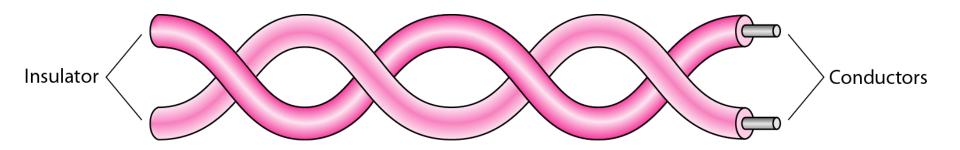


GUIDED MEDIA

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

directed and contained by the physical limits of the medium.

Figure 3 Twisted-pair cable



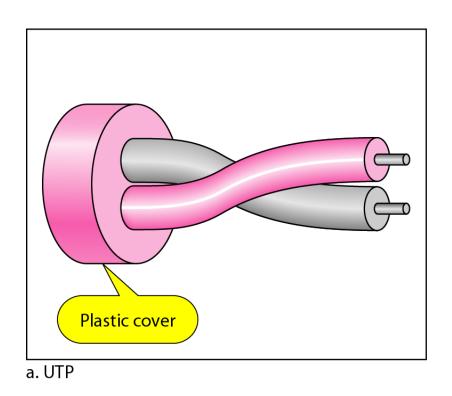
Twisted-pair cable

- Two conductors (normally copper)
- Each with its own plastic insulation
- One of the wires is used to carry signals to the receiver
- Other is used only as a ground reference.
- twisting the pairs, a balance is maintained

Unshielded Versus Shielded Twisted-Pair Cable

- STP cable has a metal foil or braided mesh covering that encases each pair of insulated conductors.
- bulkier and more expensive

Figure 4 UTP and STP cables



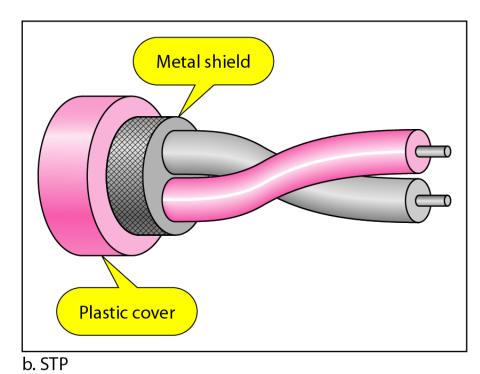
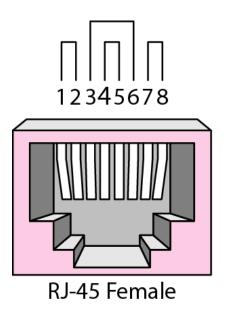
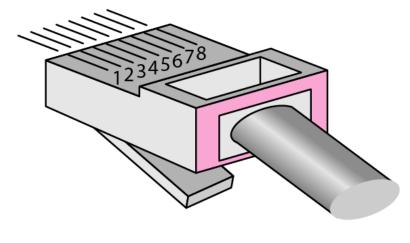


 Table 1
 Categories of unshielded twisted-pair cables

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

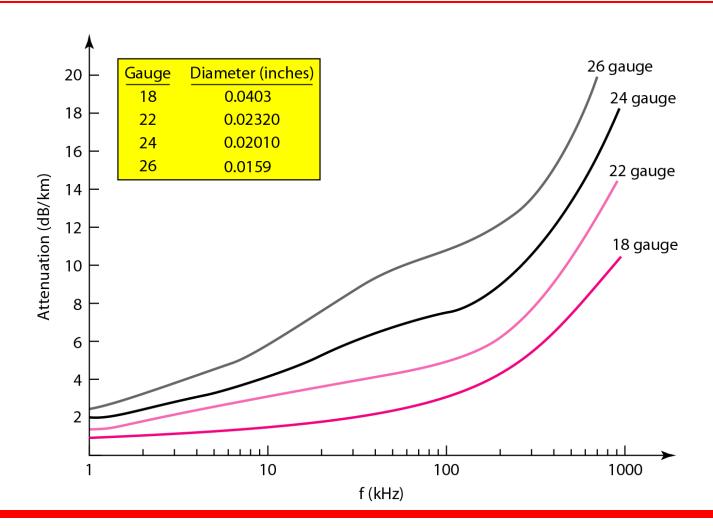
Figure 5 UTP connector





RJ-45 Male

Figure 6 UTP performance



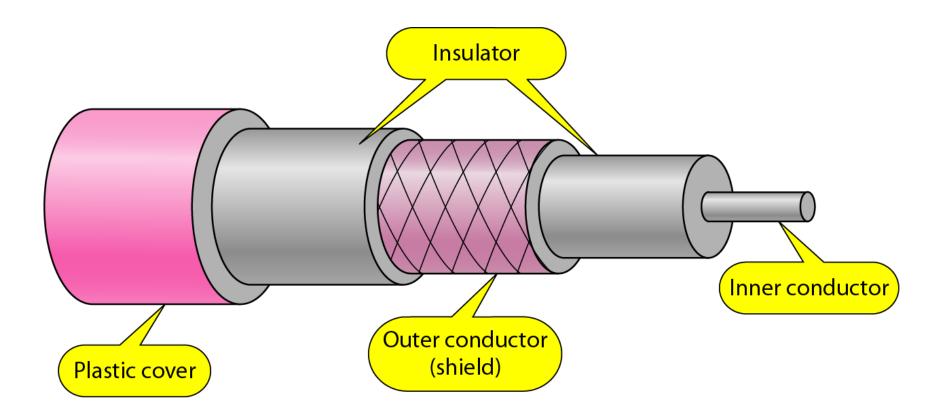
Application of Twisted-pair cable

- In telephone lines to provide voice and data channels
- local loop-the line that connects subscribers to the central telephone office
- Local-area networks, such as 10Base-T and 100Base-T,

Coaxial cable

- Carries signals of higher frequency ranges than those in twisted pair cable
- coax has a central core conductor of solid wire (usually copper)

Figure 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,
 - wire gauge of the inner conductor,
 - the thickness
 - type of the inner insulator,
 - the construction of the shield
 - size and type of the outer casing

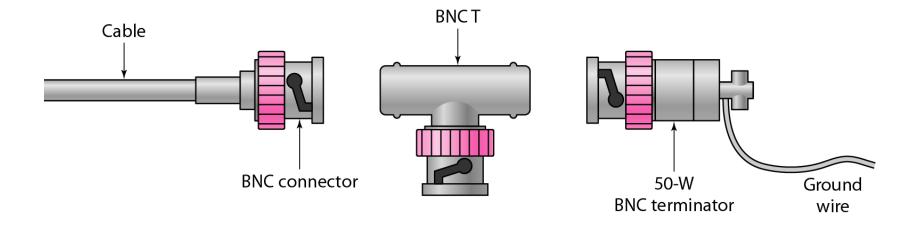
Table 2 Categories of coaxial cables

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

Coaxial cable Connectors

- 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.

Figure 8 BNC connectors



Application of coaxial cable

- In analog telephone networks where a single coaxial network could carry 10,000 voice signals.
- digital telephone networks where a single coaxial cable could carry digital data up to 600 Mbps
- Cable TV networks

Figure 9 Bending of light ray

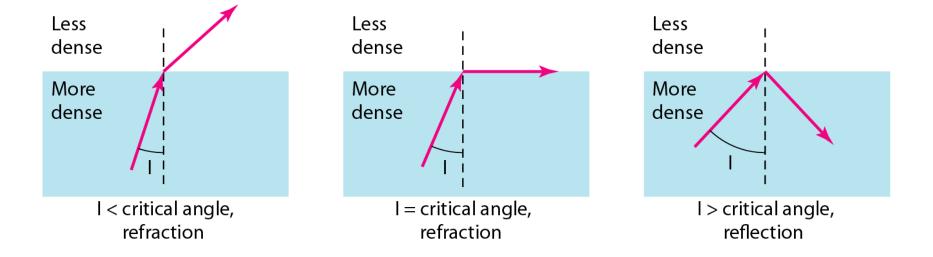


Figure 10 Optical fiber

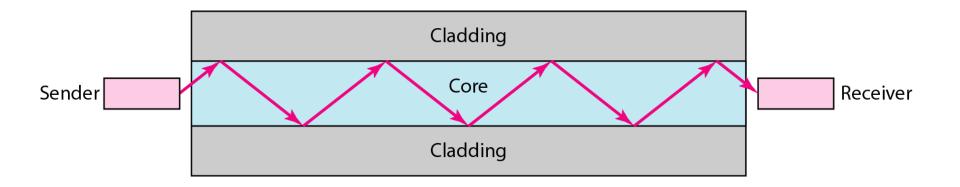


Figure 11 Propagation modes

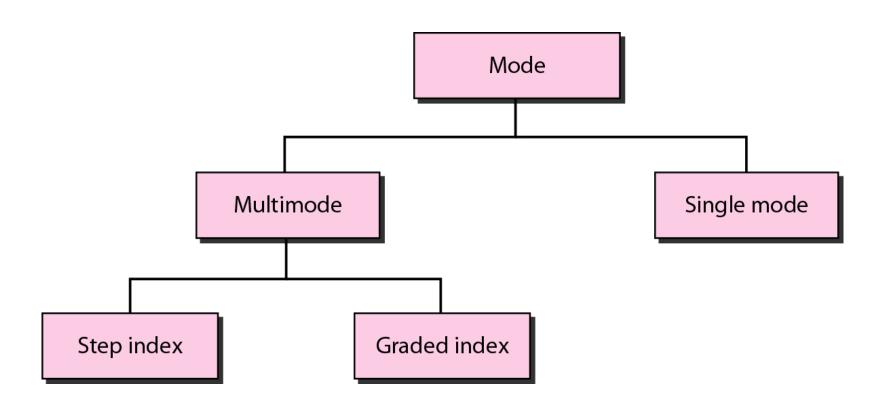
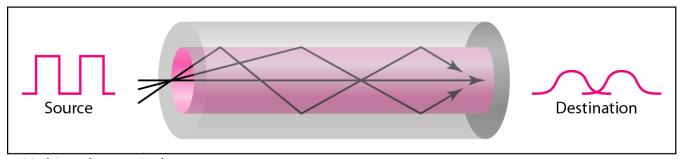
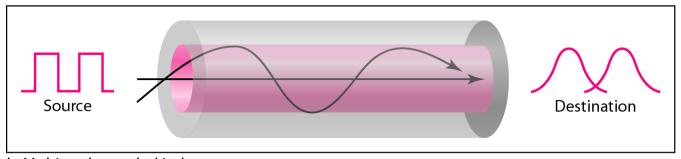


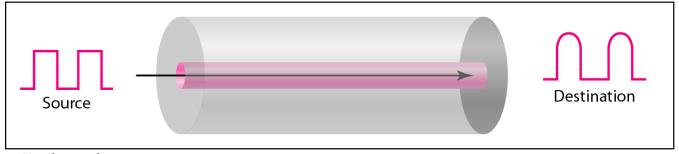
Figure 12 Modes



a. Multimode, step index



b. Multimode, graded index

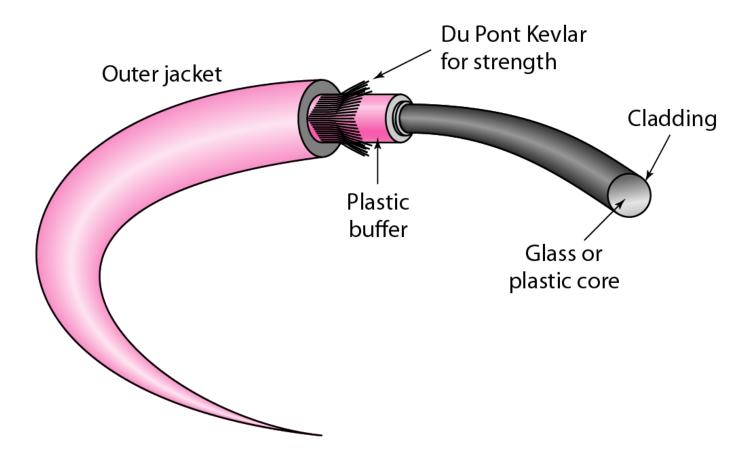


c. Single mode

Table 3 Fiber types

Туре	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

Figure 13 Fiber construction



Fiber-optic cable connectors

- 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.
- MT-RJ is a connector that is the same size as RJ45.

Figure 14 Fiber-optic cable connectors

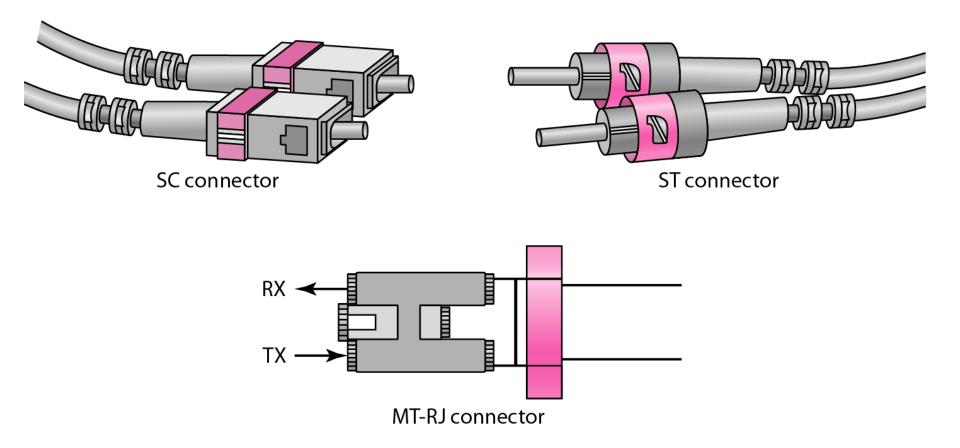
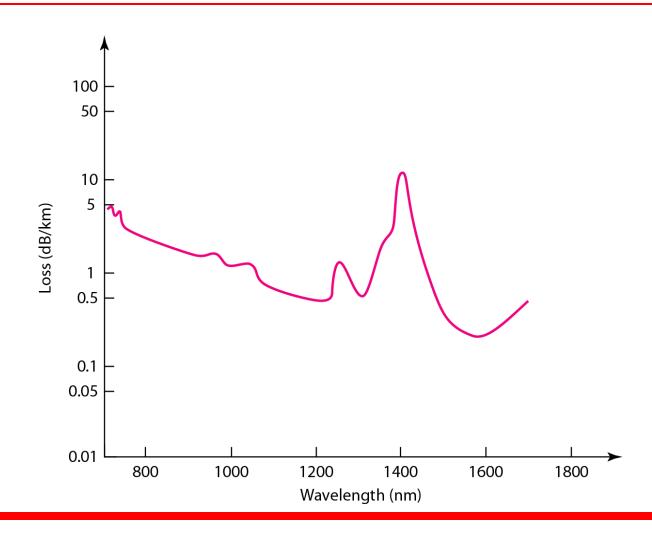


Figure 15 Optical fiber performance



Application of Fiber-optic cable

- backbone networks because its wide bandwidth is cost-effective.
- data at a rate of 1600 Gbps
- TV companies use a combination of optical fiber and coaxial cable

Advantage of Fiber-optic cable

- Higher bandwidth
- Less signal attenuation -> longer without regeneration
- Immunity to electromagnetic interference -> noise can't affect
- Resistance to corrosive materials
- Light Weight

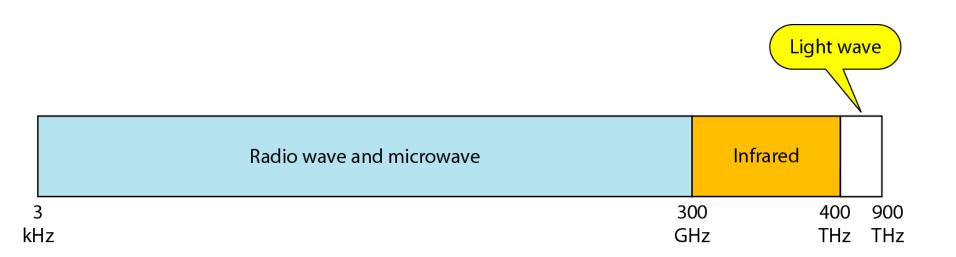
Disadvantage of Fiber-optic cable

- Installation and maintenance
- Unidirectional light propagation -> two fiber for bidirectional
- Cost

UNGUIDED MEDIA: WIRELESS

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

Figure 16 Electromagnetic spectrum for wireless communication



Ways of Signal propagation

- Ground propagation,
- Sky propagation
- Line-of-sight propagation,

Ground propagation

- radio waves travel through the lowest portion of the atmosphere, hugging the earth.
- low-frequency signals emanate in all directions
- follow the curvature of the planet
- Distance depends on the amount of power in the signal

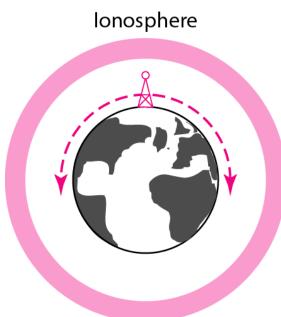
Sky propagation

- Higher-frequency radio waves radiate upward into the ionosphere (the layer of atmosphere where particles exist as ions)
- where they are reflected back to earth.
- greater distances with lower output power.

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.

Figure 17 Propagation methods



Ground propagation (below 2 MHz)

Ionosphere



Sky propagation (2-30 MHz)

Ionosphere

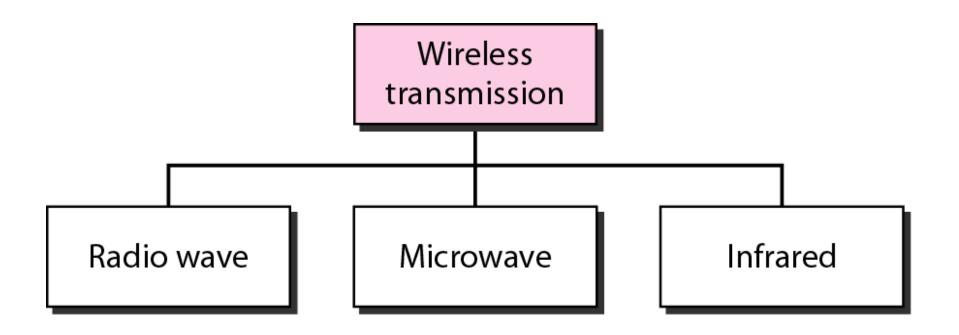


Line-of-sight propagation (above 30 MHz)

Table 4 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	UHFTV, 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

Figure 18 Wireless transmission waves



Radio Waves

- low and medium frequencies, can penetrate walls

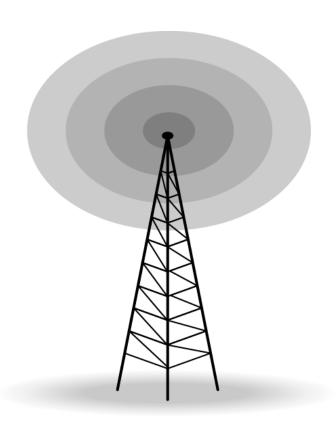
Micro Waves

- 1 to 300 GHz are called microwaves
- Unidirectional
- narrowly focused
 — means that the sending and receiving antennas need to be aligned.
- line-of-sight.
- Repeaters→for long distance communication.
- Very high-frequency → cannot penetrate walls

Infrared

- 300 GHz to 400 THz (wavelengths from 1 mm to 770 nm
- Used for short-range communication
- cannot penetrate walls
- TV Remote
- Infrared Data Association (IrDA), an association for sponsoring the use of infrared waves

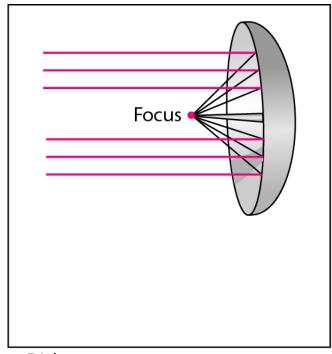
Figure 19 Omnidirectional antenna



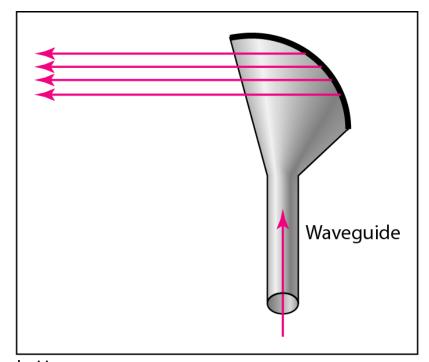
Note

Radio waves are used for multicast communications, such as radio and television, and paging systems.

Figure 20 Unidirectional antennas



a. Dish antenna



b. Horn antenna



Note

Microwaves are used for unicast communication such as cellular telephones, satellite networks, and wireless LANs.



Note

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