Networks Fundamentals

Chapter 2

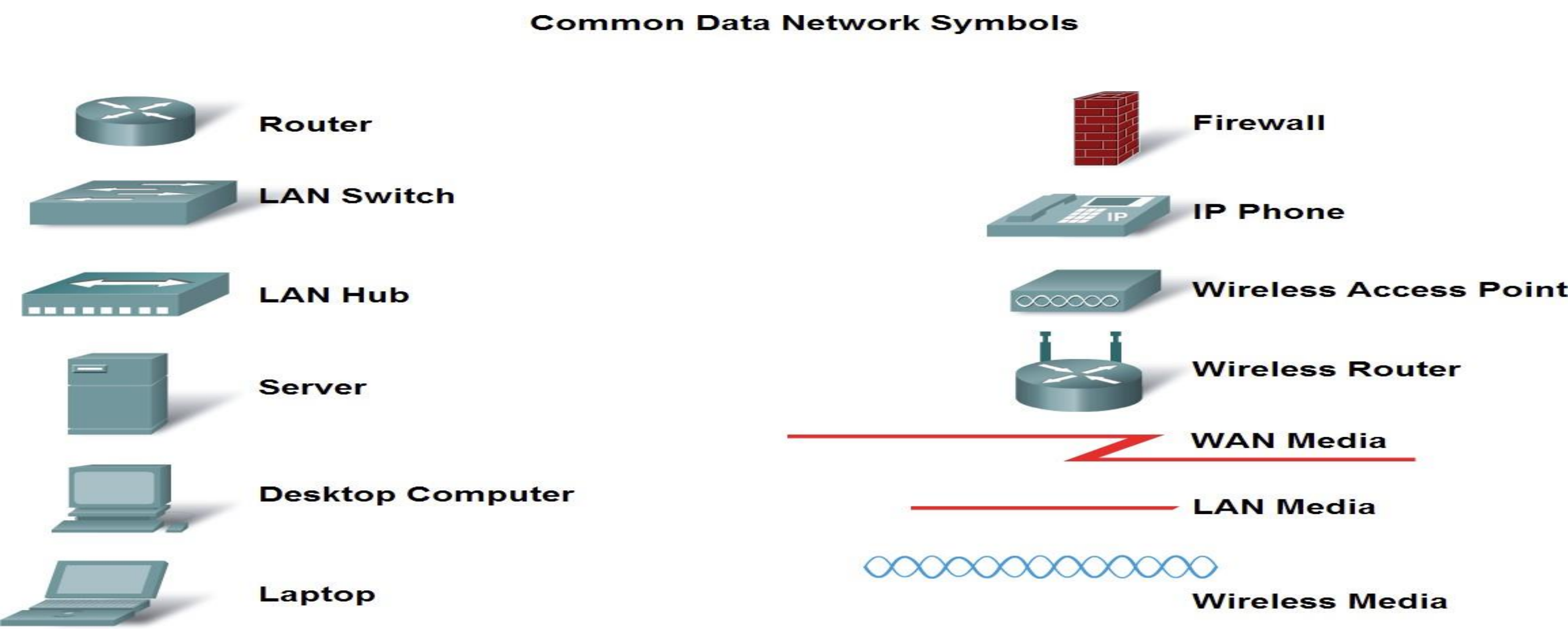
Network Fundamentals

Network Devices

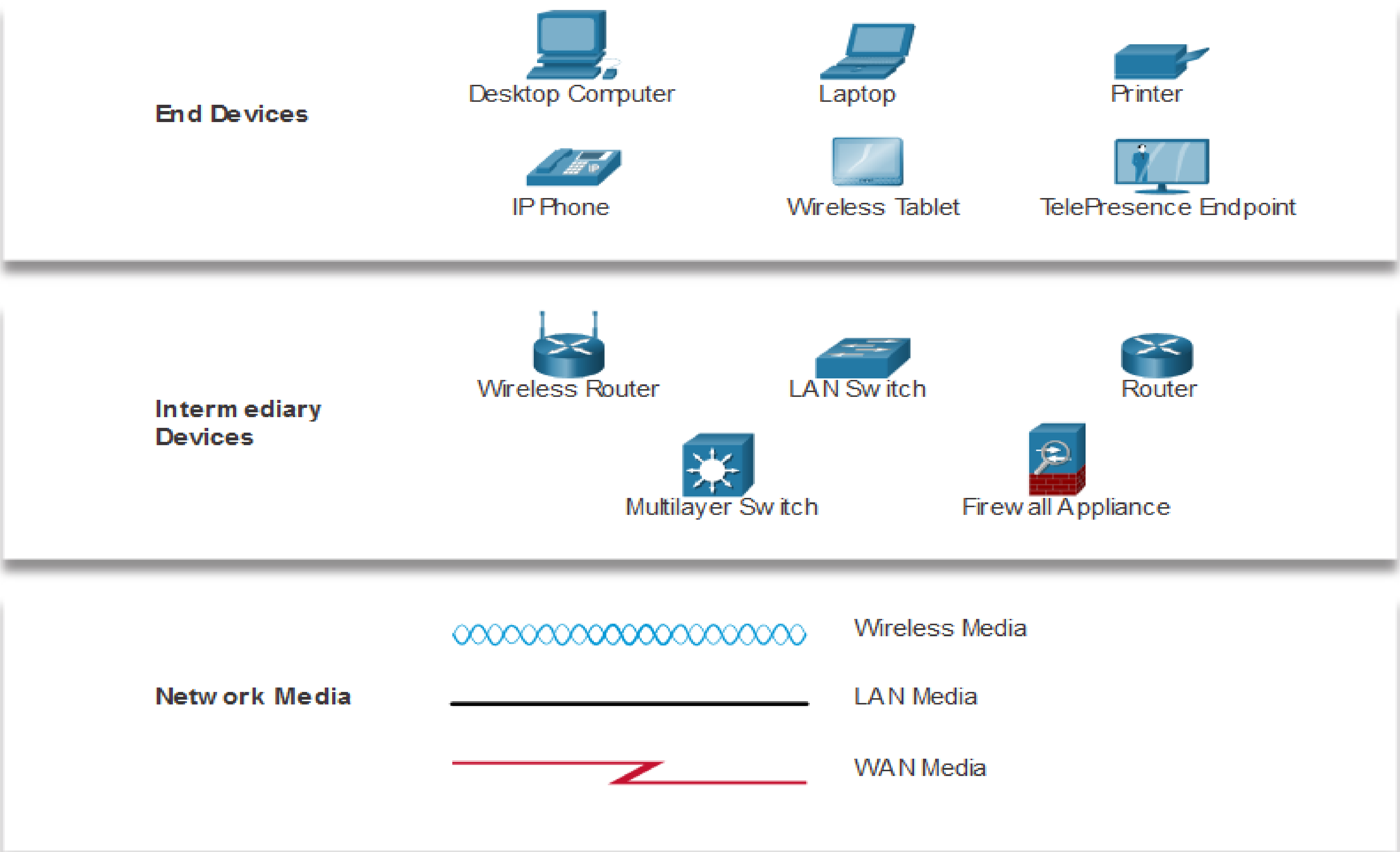
Network Devices

- Network Components or network infrastructure contains three categories of hardware components:

- End devices
- Intermediate devices
- Network media



Network Devices

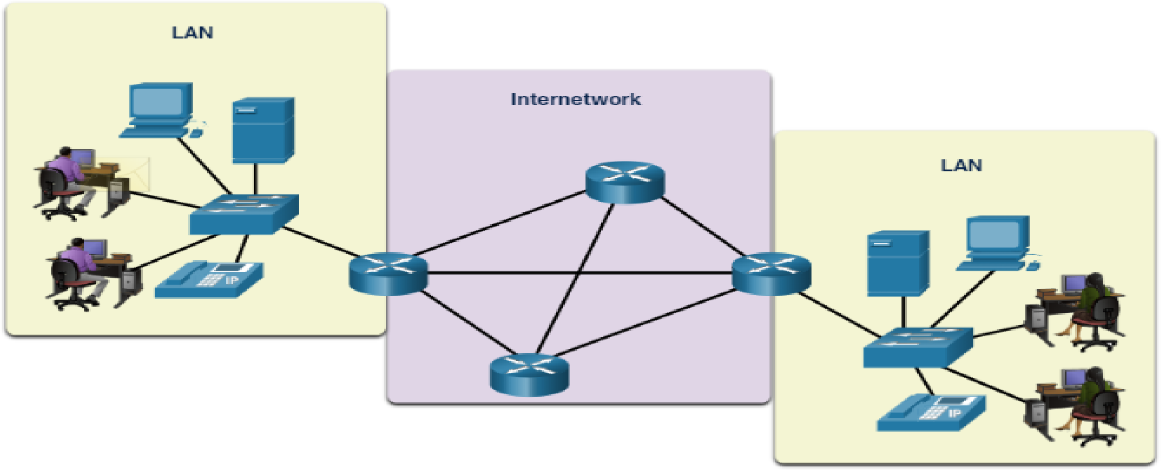


End Devices

- The network devices that people are most familiar with are called end devices, or hosts. These devices form the interface between users and the underlying communication network.

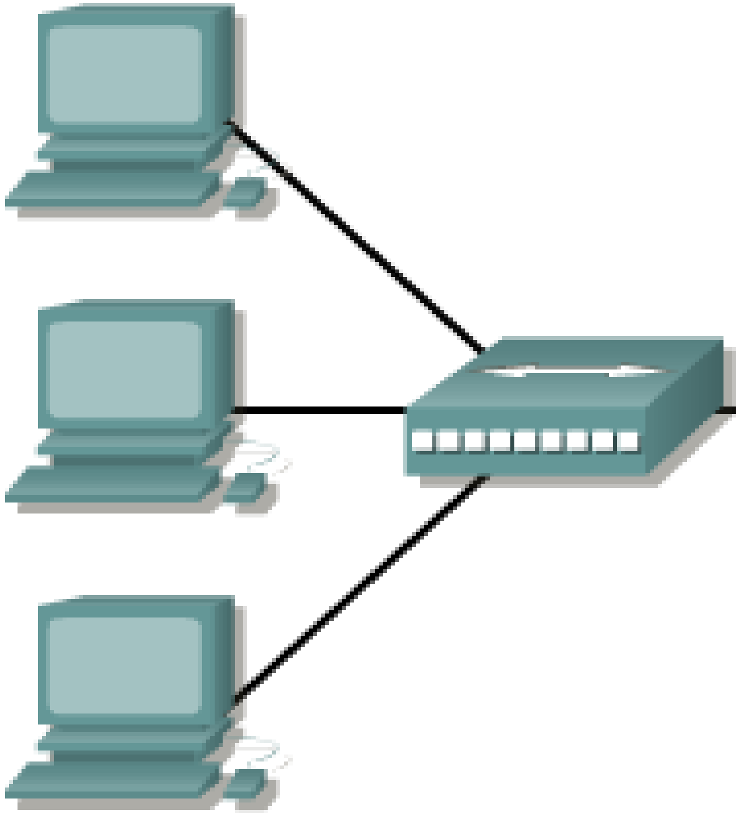
- Some examples of **end devices** are as follows:

- Computers (workstations, laptops, file servers, web servers)
- Network printers
- Telephones and teleconferencing equipment
- Security cameras
- Mobile devices (such as smart phones, tablets, PDAs, and wireless debit/credit card readers and barcode scanners)



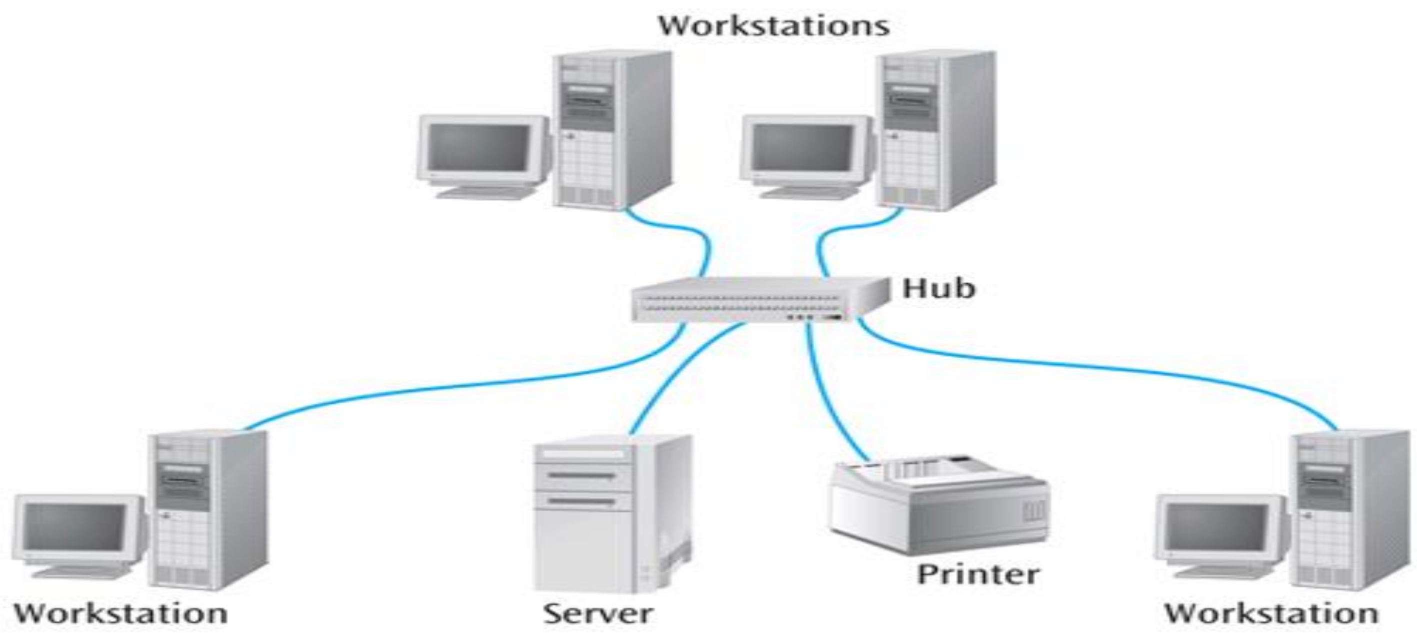
Network Devices – Hub

- The hub is a simple device that transmits an incoming frame out all the other ports on the hub.
- Connects a group of hosts (Multiple ports)
- Works at Layer 1 (Physical layer)
- **Half-Duplex :** connection transmits data in both directions but in only one direction at a time
- Amplifier
- Resends the data
- The hub is a (multi-port repeater).

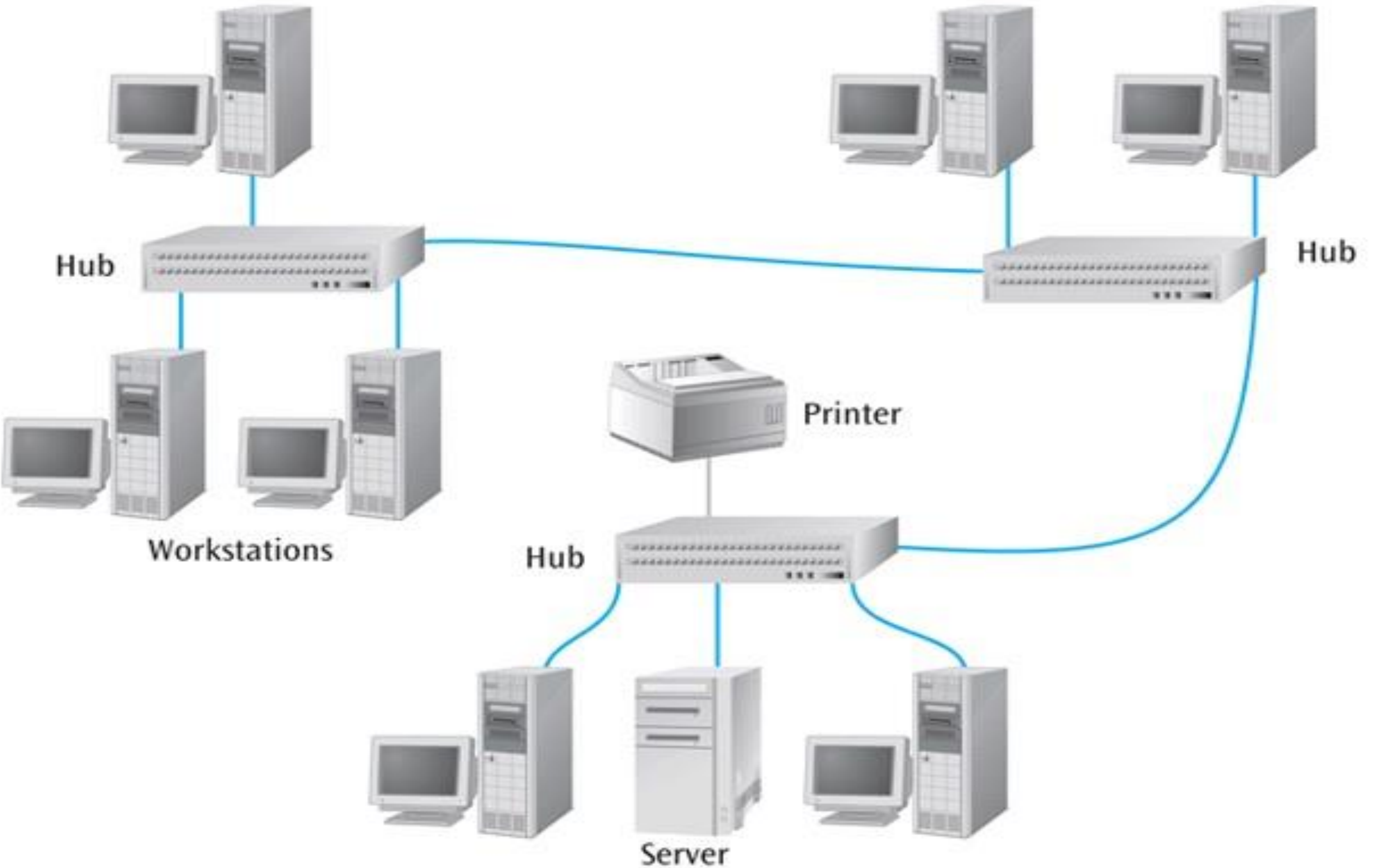


Network Devices – Hub

- All devices are in the same collision domain.
- All devices are in the same broadcast domain.
- Devices share the same bandwidth.
- More end stations means more collisions.
- Biggest disadvantage: when one station talks, everyone hears it

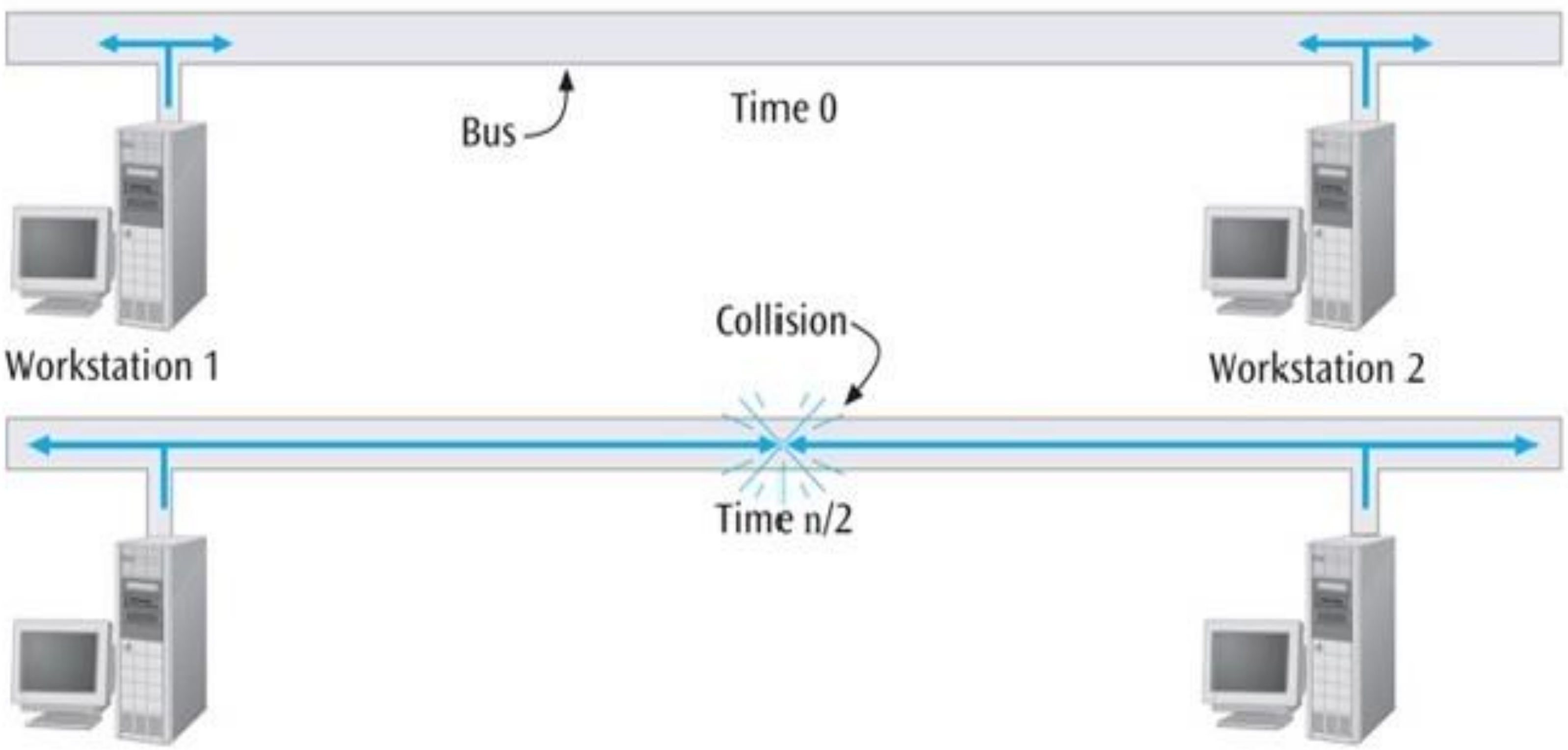


Network Devices – Hub



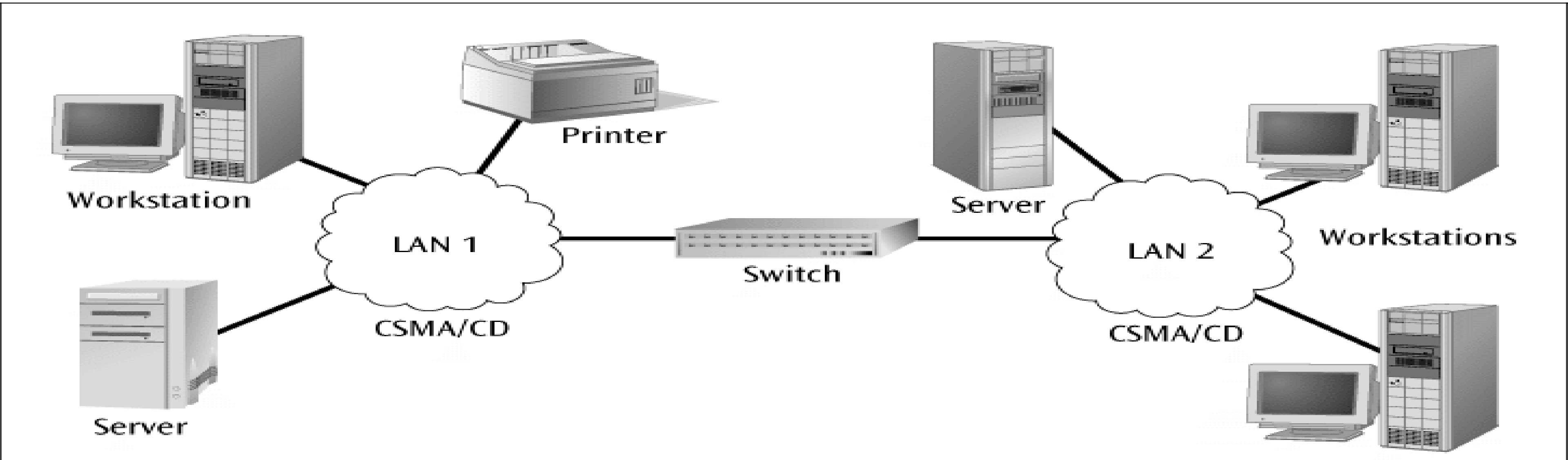
Network Collision

- If two workstations transmit at same time, collision occurs



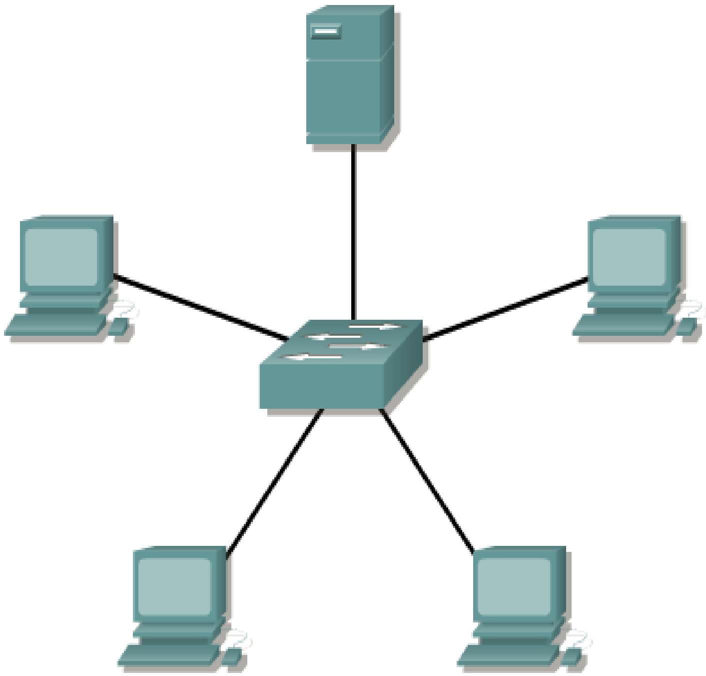
Network Devices – Switch

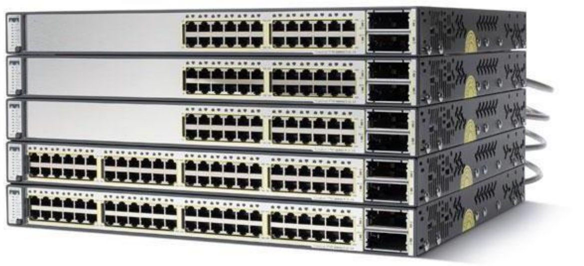
- The switch has intelligence and can filter out and forward frames based on their NIC address.
- A switch maintains internal port table(s) that keep track of which frames arrived on which ports.
- A switch observes each frame that arrives at a port, extracts the source address from the frame, and places that address in the port's routing table.



Network Devices – Switch

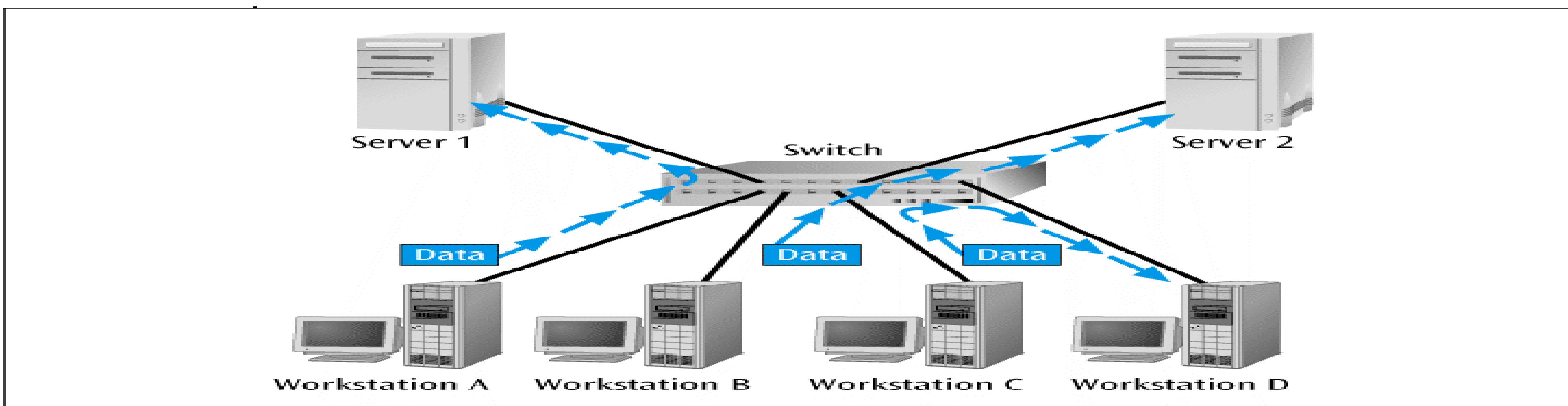
- Amplifier
- Resends the data
- Multiple ports
- **Full duplex :** connection transmits data in both directions and at the same time
- helps to eliminate collisions.
- Works at Layer 2 (Data Link layer).



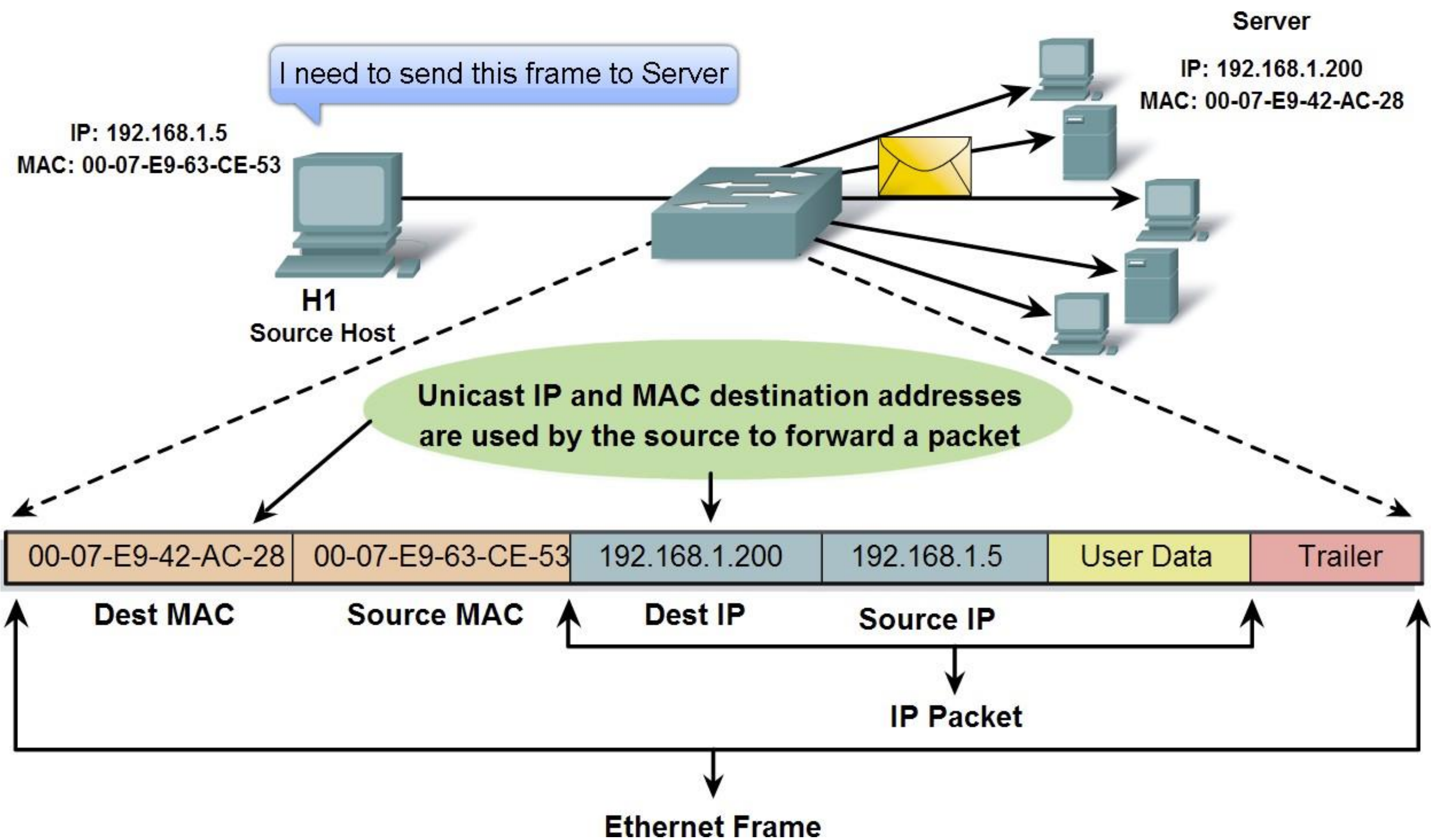


Network Devices – Switch

- Switch functions at layer 2:
  - **Address learning**: the switch learns the source MAC address of each frame received on an interface and enter it into a table called forward/filter table.
  - **Forward/filter decisions**: the switch looks at the destination MAC address for the frame received on an interface and finds the exit interface on the forward/filter table.
- Switches are used to connect end devices to a single LAN
- Switches can segment collision domains and provide enhanced

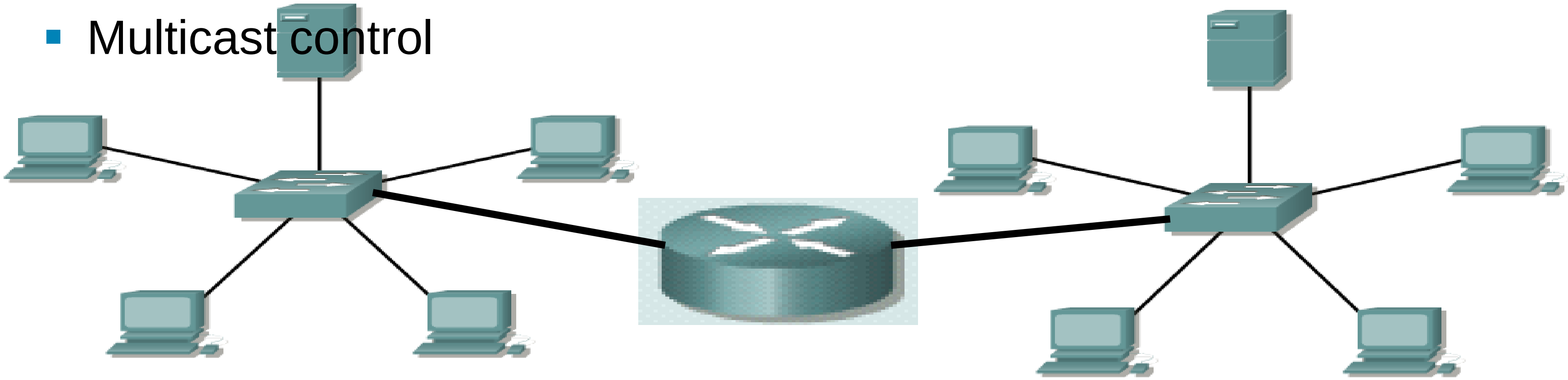


Network Devices – Switch



Network Devices – Router

- Works at Layer 3 (Network layer).
- Logical addressing
- Full duplex
- Routers are primarily devices used to interconnect networks – LANs, WANs, and WLANs.
- Route packets of data from one network to another → Path determination
- Routers, by default, break up a broadcast domain → Broadcast control
- Multicast control



Network Devices – Router

- Router is connected to two or more data lines from different networks (it has interfaces for different physical types of network connections (copper, fiber, wireless)
- Router checks the packet looking at the destination ip address
- It makes the decision based on the **routing table**
- Routing tables are populated with static and dynamic entries
- Routers exchange information about destination addresses using dynamic routing protocols

Network Devices – Router

- Router Interfaces
  - **Data Interfaces:**
    - Serial interface (WAN Interface) connects to another router.
    - Ethernet interface (LAN Interface) connects to a switch, bridge, hub, repeater.

Network Devices – WLC / AP

- **Access-points**
- can be considered as wireless bridges/switches
- They allow mobile users to connect to the network
- Two types: Autonomous and Lightweight APs

- **Wireless LAN controller (WLC)**
- The AP communicates using a special protocol called the Lightweight AP Protocol (LWAPP) to relay information to the WLC.
- LWAPP is encrypted

Network Devices – Security Appliances

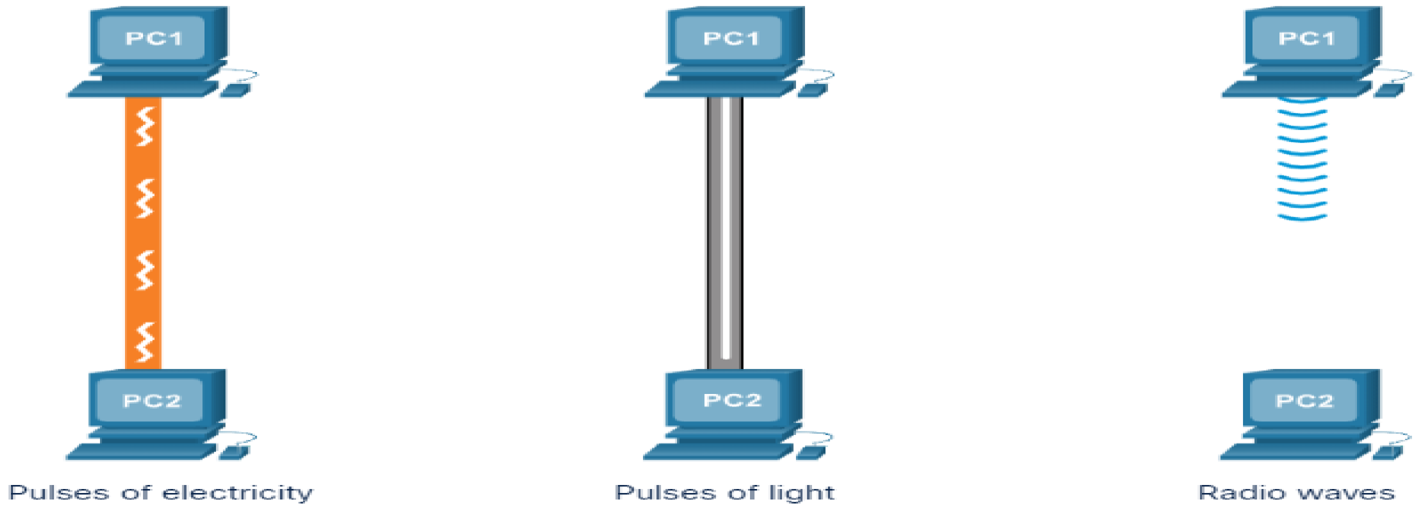
- **A firewall** is a system or group of systems that manages access between two or more networks.
- Controls incoming and outgoing traffic by analyzing the data packets.
- Software or Hardware
- Firewall allows or drops the traffic according to the configured rules
- Can filter the traffic from Layer 3 up to 7

Network Devices – Security

- IPS/IDS can prevent from known network attacks and worms, reconnaissance, spyware, Trojans, backdoors, bots – detection based on the signatures
- **Intrusion Detection Systems (IDS):** analyze and monitor network traffic for signs that indicate attackers are using a known cyberthreat to infiltrate or steal data from your network(Just alarm).
- **Intrusion Prevention Systems (IPS):** analyze and monitor network traffic as a firewall, between the outside world and the internal network.(take action)

Data Transmission

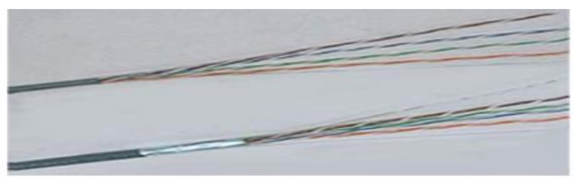
- There are three common methods of signal transmission used in networks:
  - **Electrical signals :** Transmission is achieved by representing data as electrical pulses
  - **Optical signals :**Transmission is achieved by converting the electrical signals into light pulses.
  - **Wireless signals :** Transmission is achieved by using infrared, microwave, or radio waves through the air.



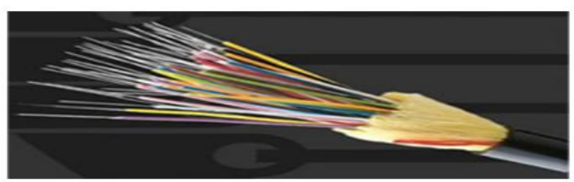
Network Media Types

- Communication transmits across a network on media.
- Modern networks primarily use three types of media to interconnect devices.
  - **Metal wires within cables -** Data is encoded into electrical impulses.
  - **Glass or plastic fibers within cables (fiber-optic cable)** - Data is encoded into pulses of light.
  - **Wireless transmission -** Data is encoded via modulation of specific frequencies of electromagnetic waves.

Copper



Fiber-optic

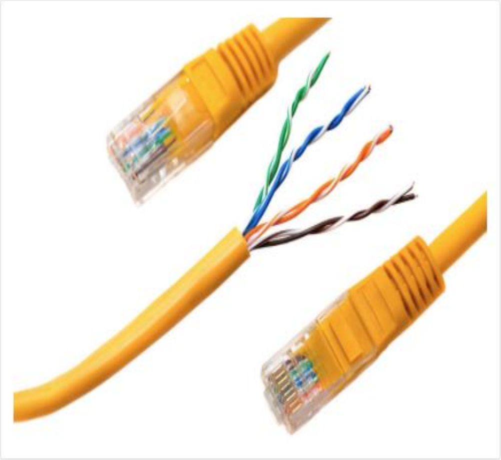


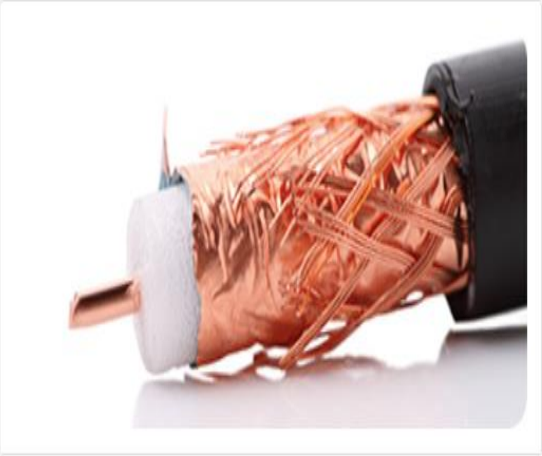
Wireless

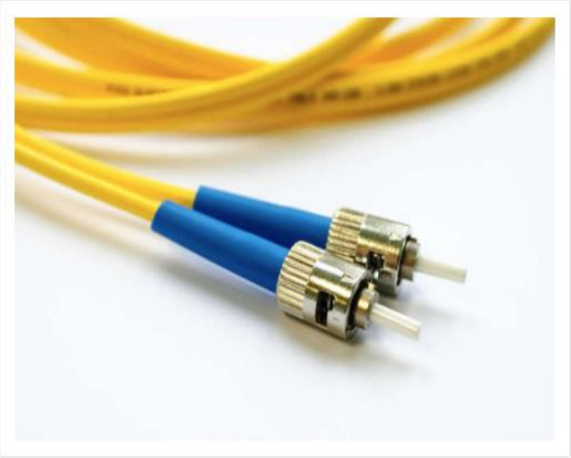
Network Media Types

- The three most common network cables are twisted-pair cable, coaxial cable, and fiber-optic cable.

Twisted-Pair Cable **Coaxial Cable** **Fiber-Optic Cable**







Twisted-Pair Cables

- Ethernet technology generally uses twisted-pair cables to interconnect devices.
- The networks in most homes and schools are wired with twisted-pair copper cable.
- Most common form of wire
- This type of cable is inexpensive and readily available.
- Twisted-pair cable uses pulses of electricity to transmit data.
- There are two commonly installed types of twisted-pair cable:
  - **Unshielded twisted-pair (UTP)**
  - **Shi**

Twisted-Pair Cables

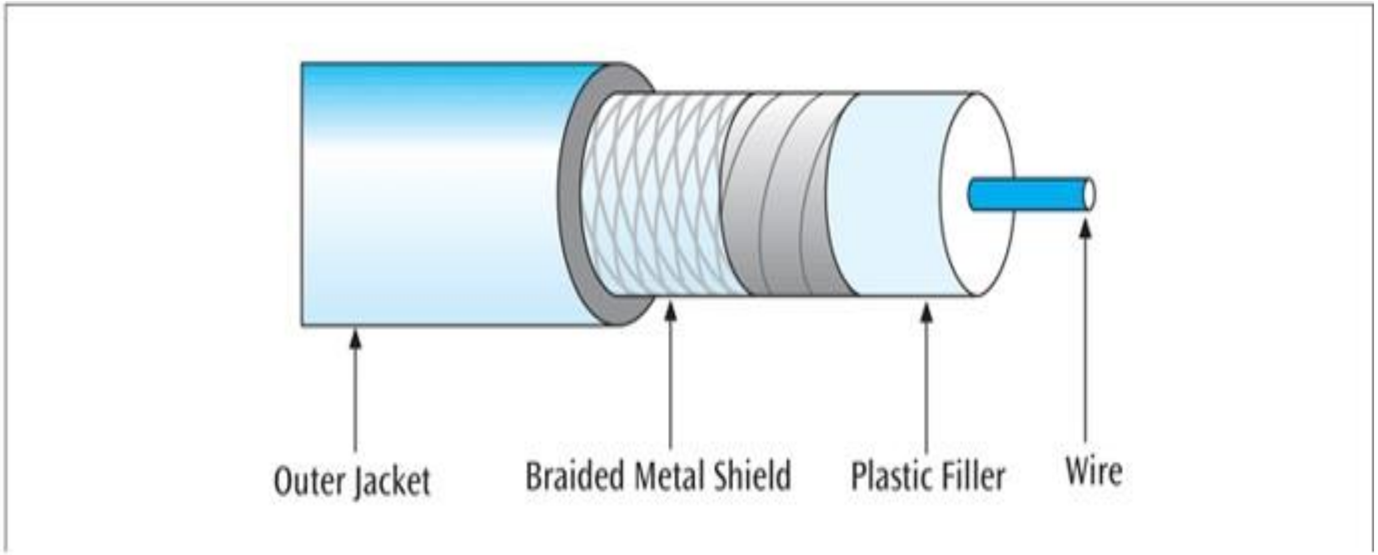
Table 3-1

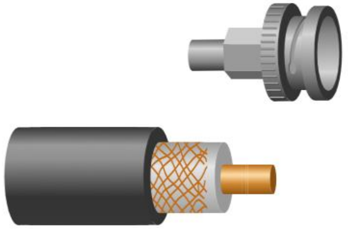
A summary of the characteristics of twisted pair wires

UTP Category	Typical Use	Maximum Data Transfer Rate	Maximum Transmission Range	Advantages	Disadvantages
Category 1	Telephone wire	<100 kbps	5–6 kilometers (3–4 miles)	Inexpensive, easy to install and interface	Security, noise, obsolete
Category 2	T-1, ISDN	<2 Mbps	5–6 kilometers (3–4 miles)	Same as Category 1	Security, noise, obsolete
Category 3	Telephone circuits	10 Mbps	100 m (328 ft)	Same as Category 1, with less noise	Security, noise
Category 4	LANs	20 Mbps	100 m (328 ft)	Same as Category 1, with less noise	Security, noise, obsolete
Category 5	LANs	100 Mbps (100 MHz)	100 m (328 ft)	Same as Category 1, with less noise	Security, noise
Category 5e	LANs	250 Mbps per pair (125 MHz)	100 m (328 ft)	Same as Category 5. Also includes specifications for connectors, patch cords, and other components	Security, noise
Category 6	LANs	250 Mbps per pair (250 MHz)	100 m (328 ft)	Higher rates than Category 5e, less noise	Security, noise, cost
Category 7	LANs	600 MHz	100 m (328 ft)	High data rates	Security, noise, cost

Coaxial Cable

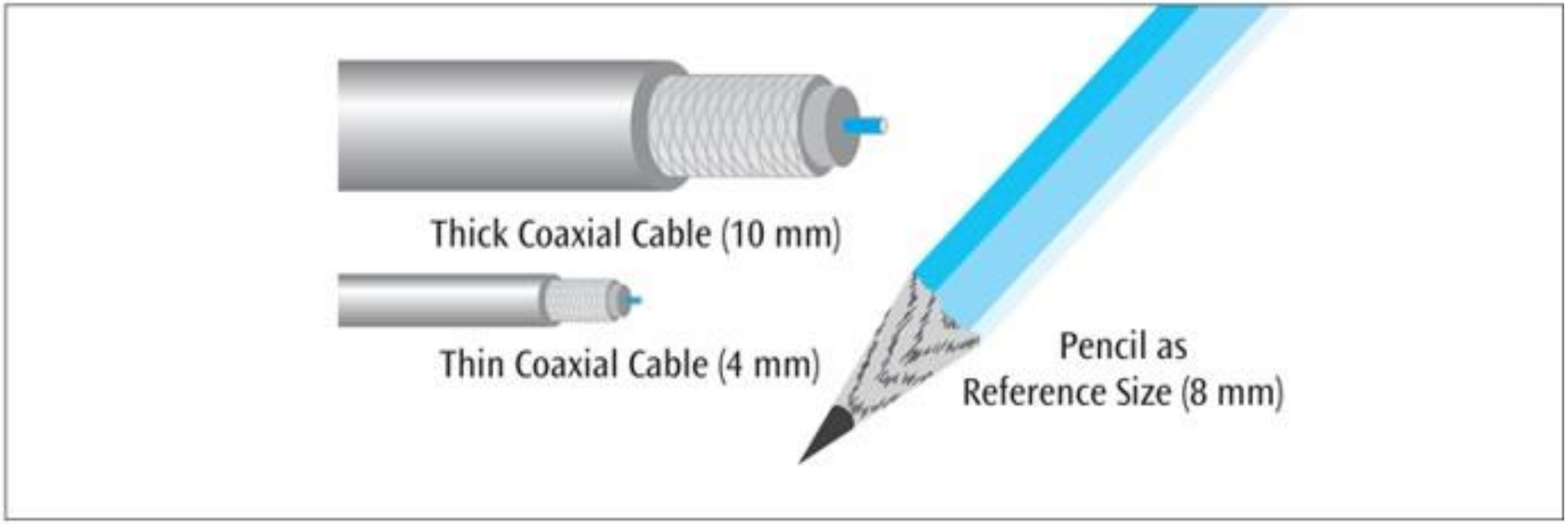
- A single wire wrapped in a foam insulation surrounded by a braided metal shield, then covered in a plastic jacket. Cable comes in various thicknesses.
- Cable TV and Satellite Cables
- It was one of the earliest network cabling types developed.
- Coaxial cable (or coax) carries data in the form of electrical signals.
- It provides improved shielding compared to UTP and can therefore carry more data.





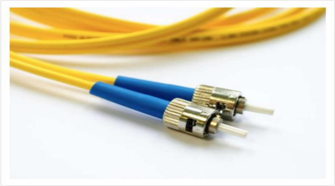
Coaxial Cable

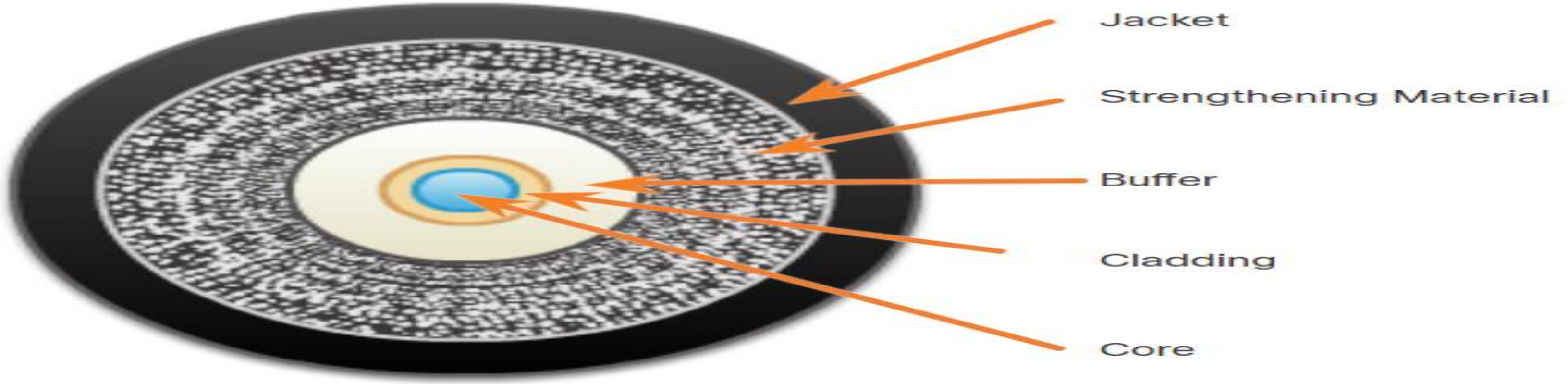
- It is used by cable television companies to provide service and for connecting the various components that make up satellite communication systems.
- It is used as a high-frequency transmission line to carry high-frequency or broadband signals.
- More expensive than twisted pair



Fiber-Optic Cables

- A thin glass cable approximately a little thicker than a human hair surrounded by a plastic coating and packaged into an insulated cable.
- Fiber optic cable can carry the highest data rate for the longest distances but more expensive.
- Fiber-optic cables transmit data using pulses of light.
- Fiber-optic cable is constructed of either glass or plastic.

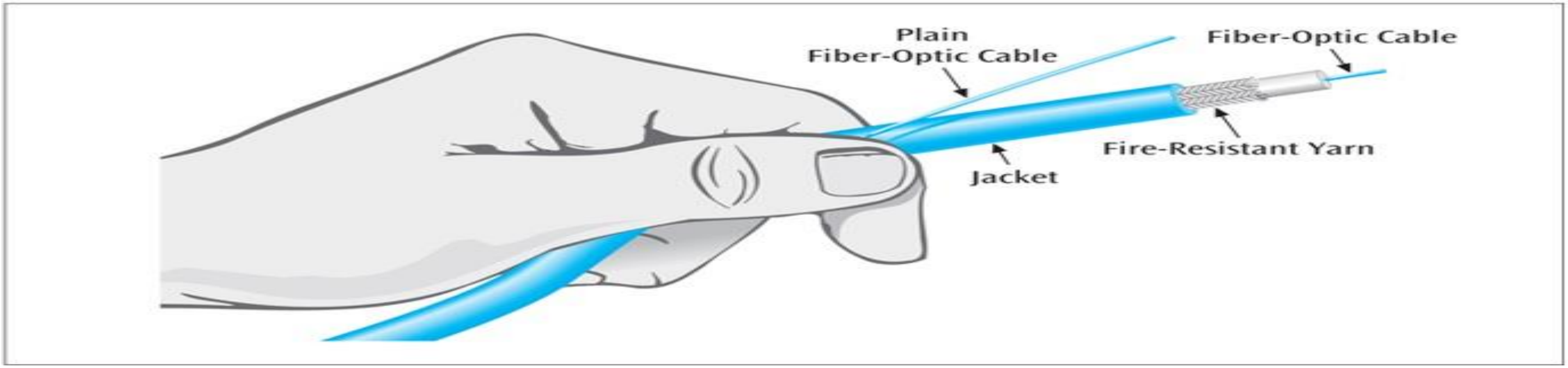




Fiber-Optic Cables

- Parts of a fiber-optical cable are:

- **Jacket** - protects the fiber against abrasion, moisture, and other contaminants.
- **Strengthening Material** - Surrounds the buffer, prevents the fiber cable from being stretched when it is being pulled
- **Buffer** - Used to help shield the core and cladding from damage.
- **Cladding** - Made from slightly different chemicals than those used to create the core. It tends to act like a mirror.
- **Core** - The light transmission element at the center of the optical fiber. Light pulses travel through the fiber core.

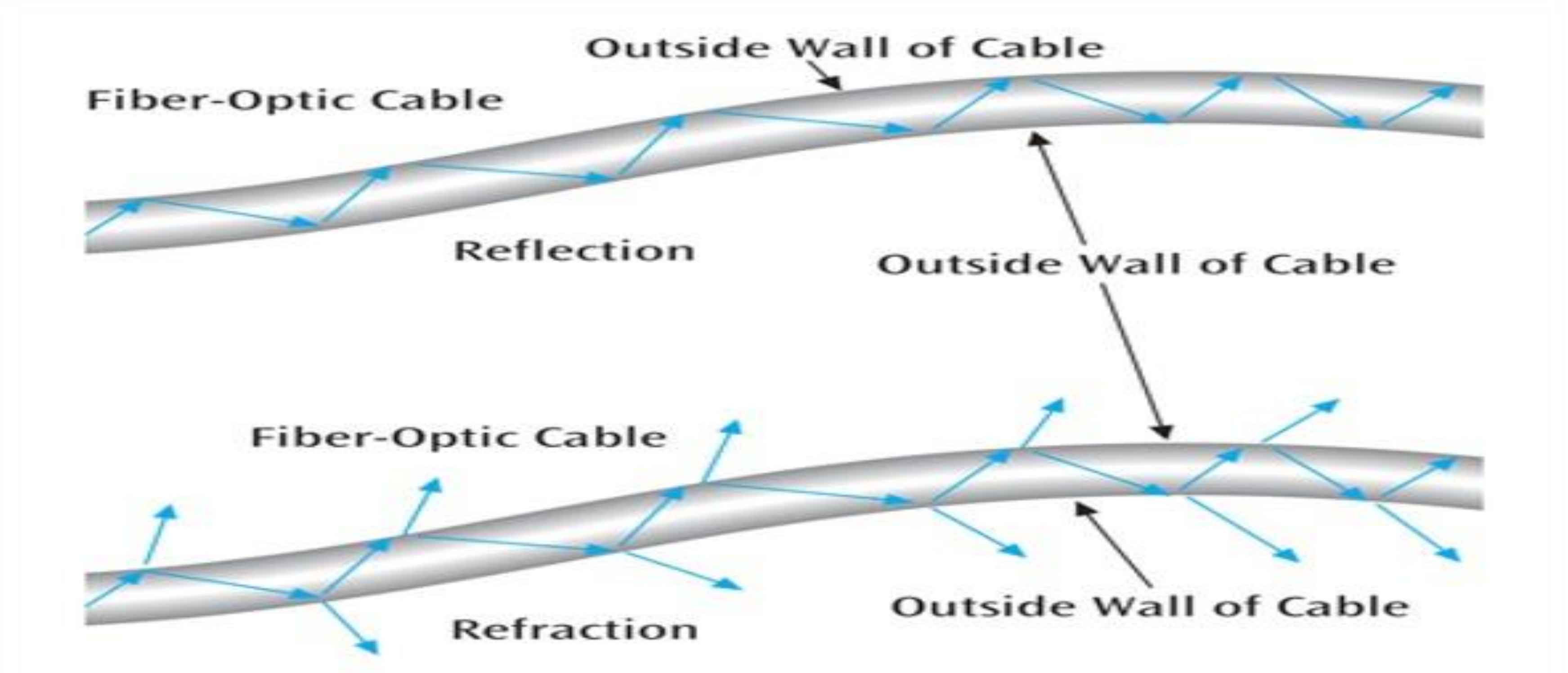


Fiber-Optic Cables

- Fiber-optic cable is capable of supporting millions of bits per second for 1000s of meters.
- **Thick cable** (62.5/125 microns) causes more ray collisions, so you have to transmit slower. This is step index multimode fiber. Typically use LED for light source, shorter distance transmissions.
- **Thin cable** (8.3/125 microns) – very little reflection, fast transmission, typically uses a laser, longer transmission distances; known as single mode fiber.

Fiber-Optic Cables

- Fiber-optic cable is susceptible to :
- **Reflection** (where the light source bounces around inside the cable)
- **Refraction** (where the light source passes out of the core and into the surrounding cladding)



Network Cables

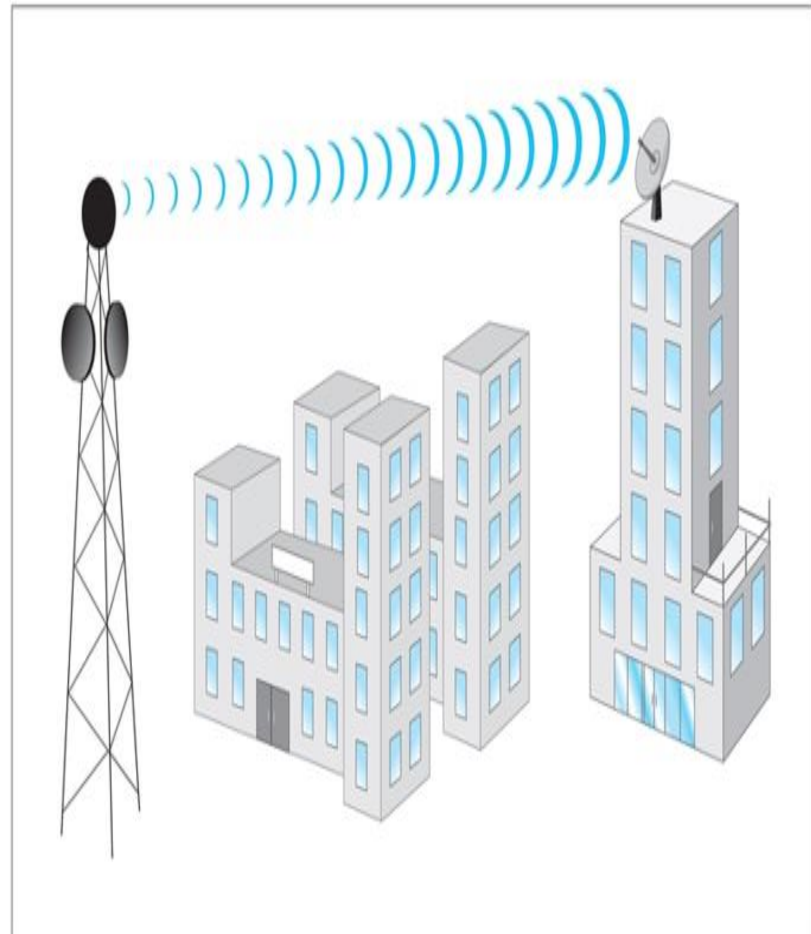
Table 3-3 A summary of the characteristics of conducted media

Type of Conducted Medium	Typical Use	Maximum Data Rate	Maximum Transmission Range	Advantages	Disadvantages
Twisted pair Category 1, 3	Telephone systems	<2 Mbps	5–6 kilometers (3–4 miles)	Inexpensive, common	Noise, security, obsolete
Twisted pair Category 5, 5e, 6, 7	LANs	100–1000 Mbps	100 m (328 feet)	Inexpensive, versatile	Noise, security
Thin Coaxial Cable (baseband single channel)	LANs	10 Mbps	100 m (328 feet)	Low noise	Security
Thick Coaxial Cable (broadband multichannel)	LANs, cable TV, long-distance telephone, short-run computer system links	10–100 Mbps	5–6 kilometers (3–4 miles) (at lower data rates)	Low noise, multiple channels	Security
LED Fiber-Optic	Data, video, audio, LANs	Gbps	300 meters (approx. 1000 feet)	Secure, high capacity, low noise	Interface expensive but decreasing in cost
Laser Fiber-Optic	Data, video, audio, WANs, MANs	100s Gbps	100 kilometers (approx. 60 miles)	Secure, high capacity, very low noise	Interface expensive

Wireless Media

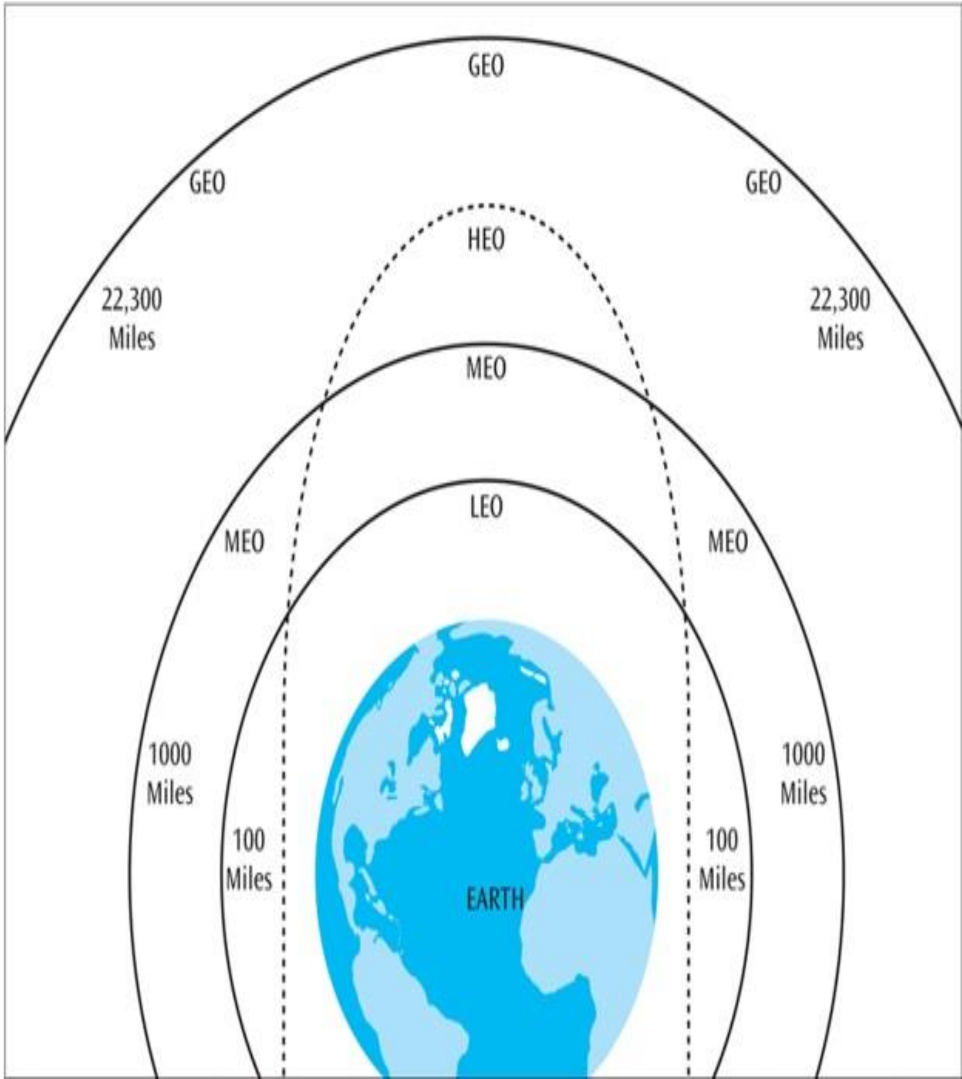
- Radio, satellite transmissions, and infrared light are all different forms of electromagnetic waves that are used to transmit data.

- **Terrestrial Microwave Transmission**
  - Land-based,line-of-sight transmission
  - Approximately 20-30 miles between towers
  - Transmits data at hundreds of millions of bits per second
  - Signals will not pass through solid objects
  - Popular with telephone companies and business to business transmissions



Wireless Media

- **Satellite Microwave Transmission**
  - Similar to terrestrial microwave except the signal travels from a ground station on earth to a satellite and back to another ground station.
  - Can also transmit signals from one satellite to another.
  - Satellites can be classified by how far out into orbit each one is (LEO, MEO, GEO, and HEO)



Wireless Media

- LEO (Low-Earth-Orbit) – 100 to 1000 miles out
  - Used for wireless e-mail, special mobile telephones, pagers, spying, videoconferencing
- MEO (Middle-Earth-Orbit) – 1000 to 22,300 miles
  - Used for GPS (global positioning systems) and government
- GEO (Geosynchronous-Earth-Orbit) – 22,300 miles
  - Always over the same position on earth (and always over the equator)
  - Used for weather, television, government operations
- HEO (Highly Elliptical Earth orbit) – satellite follows an elliptical orbit
  - Used by the military for spying and by scientific organizations for photographing celestial bodies

Q&A