Internetworking

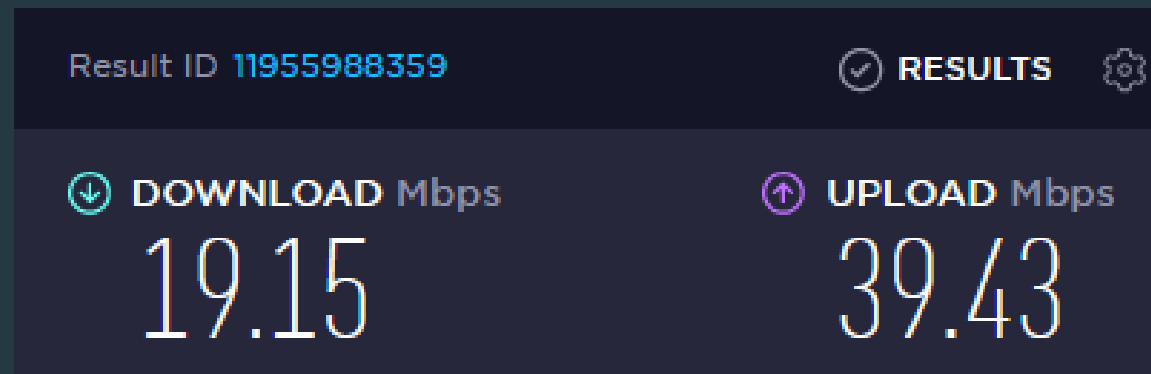# Computer Networks

- A computer network is simply two or more computers that are connected via software and hardware so they can communicate with each other.

- Each device connected to a network is referred to as a node. A node can be a computer, a peripheral such as a printer or a game console, or a network device such as a router

- Benefits:
  - Sharing an Internet connection:
  - Sharing printers and other peripherals:
  - Sharing files:
    Common communications

Network Performance

- **Data transfer rate** (also called **bandwidth**) is the maximum speed at which data can be transmitted between two nodes on a network.

- **Throughput** is the actual speed of data transfer that is achieved and is often less than bandwidth

- Bandwidth and throughput are usually measured in **bits per second (bps)**.

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⊙ **DOWNLOAD** Mbps ⊙ **UPLOAD** Mbps

19.15   39.43

Network Communication Mechanics

- A computer network functions similarly with a complex mail system

- Messages are transported as little packages of bits and bytes called packets

- Each node must have a unique address and must abide by a set of communication rules

- Packets travel from their source to destination using the network infrastructure

Network Components

- A network can be as simple as a single cable connecting two computers or as complex as a collection of networks that span the globe.

- A network contains two broad categories of physical components:
  - Transmission Media
  - Devices
   - Infrastructure devices
    - End devices
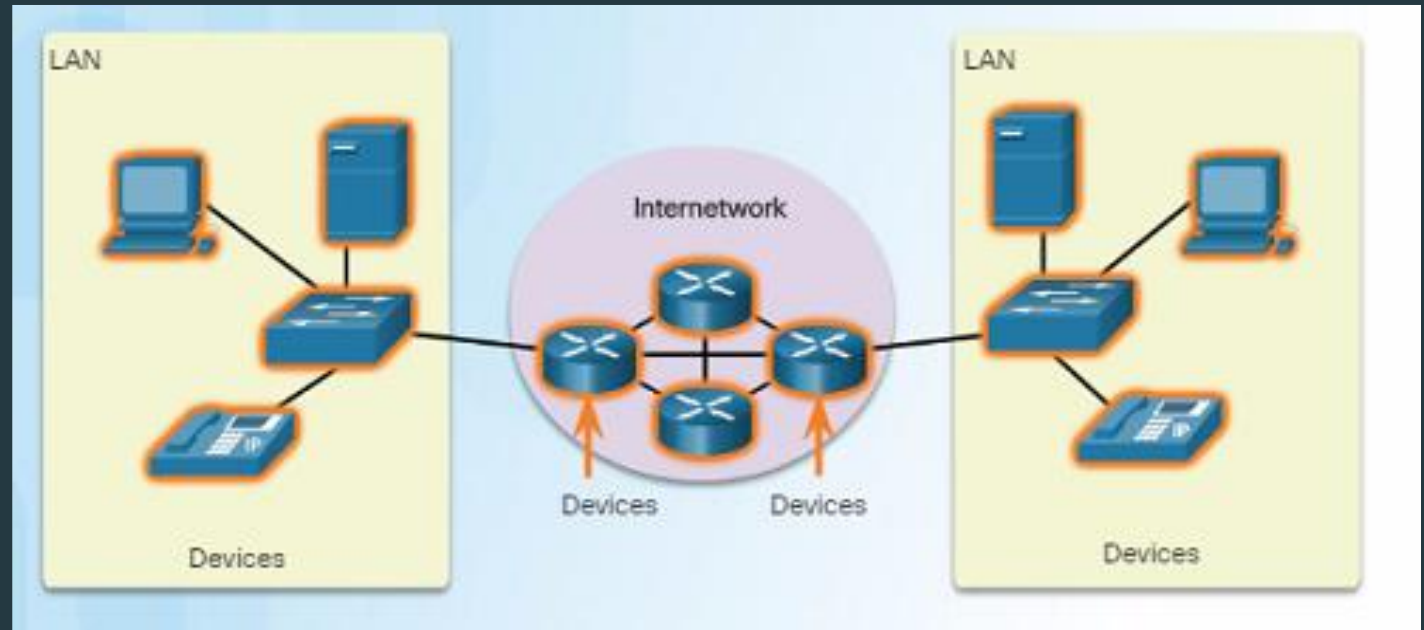
Transmission Media

- Communication across a network is carried through a medium which allows a message to travel from source to destination.

- Networks typically use three types of media:
  - Metallic wires within cables, such as copper
  - Glass, such as fiber optic cables
  - Wireless transmission

Network Media

Copper

Fiber-optic

Wireless
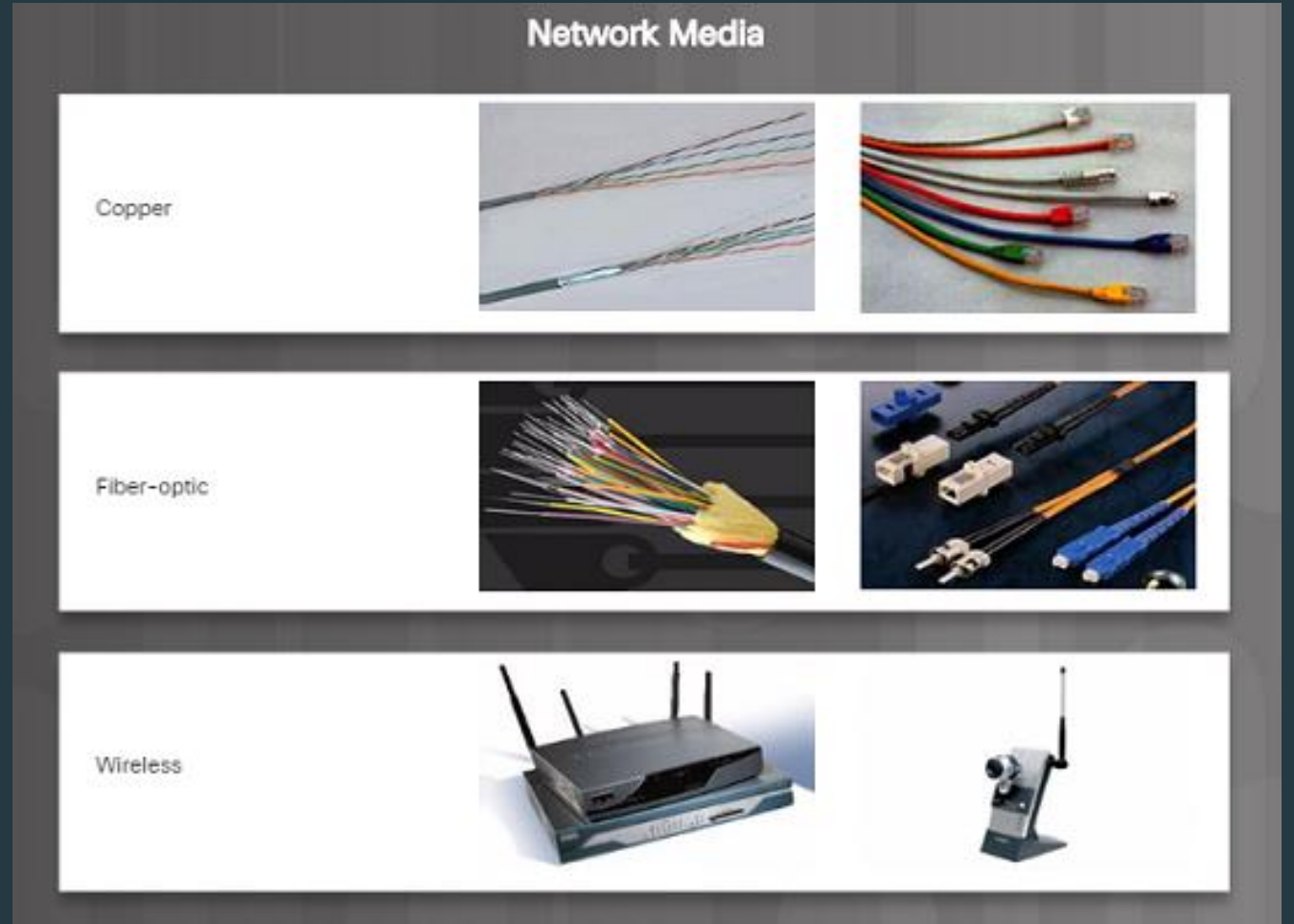
Electrical Media

- Most common and least expensive
- Types used in networking
  - Twisted Pair
    - made up of copper wires that are twisted around each other and surrounded by a plastic jacket.
    - Several grades available: Cat5e (up to 1 Gbps), Cat 6 and Cat 6a Up to 10 Gbps)
  - Coaxial Cable
    - Consists of a single copper wire surrounded by layers of plastic.
    - Commonly found on TVs, cable broadband connections and older networks
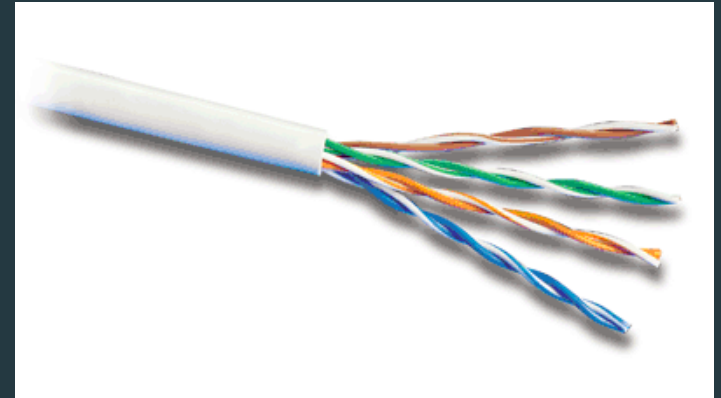
Optical Fiber

- Contains strands of light-conducting filaments made of plastic or glass with a tough plastic coating for protection from physical damage.

- Expensive, fragile, and difficult to install

- Very high bandwidth and can transmit over long distances

Wireless Media

- Conveys signals using radio frequency with the use of an antenna

- Lower bandwidth than wired connections but greater mobility compared to wired media
  - Easily affected by interference from other wireless and radio devices
  - Throughput is affected by distance and physical barriers

End Devices

- Every computer connected to a network is called a host or end device
- An end device is where a message originates from or where it is received.
  - Servers provide services and information to end devices on the network. For example, email servers, web servers, or file server
  - Clients send requests to the servers to retrieve information such as a web page from a web server or to ask for a task to be performed such as sending an email
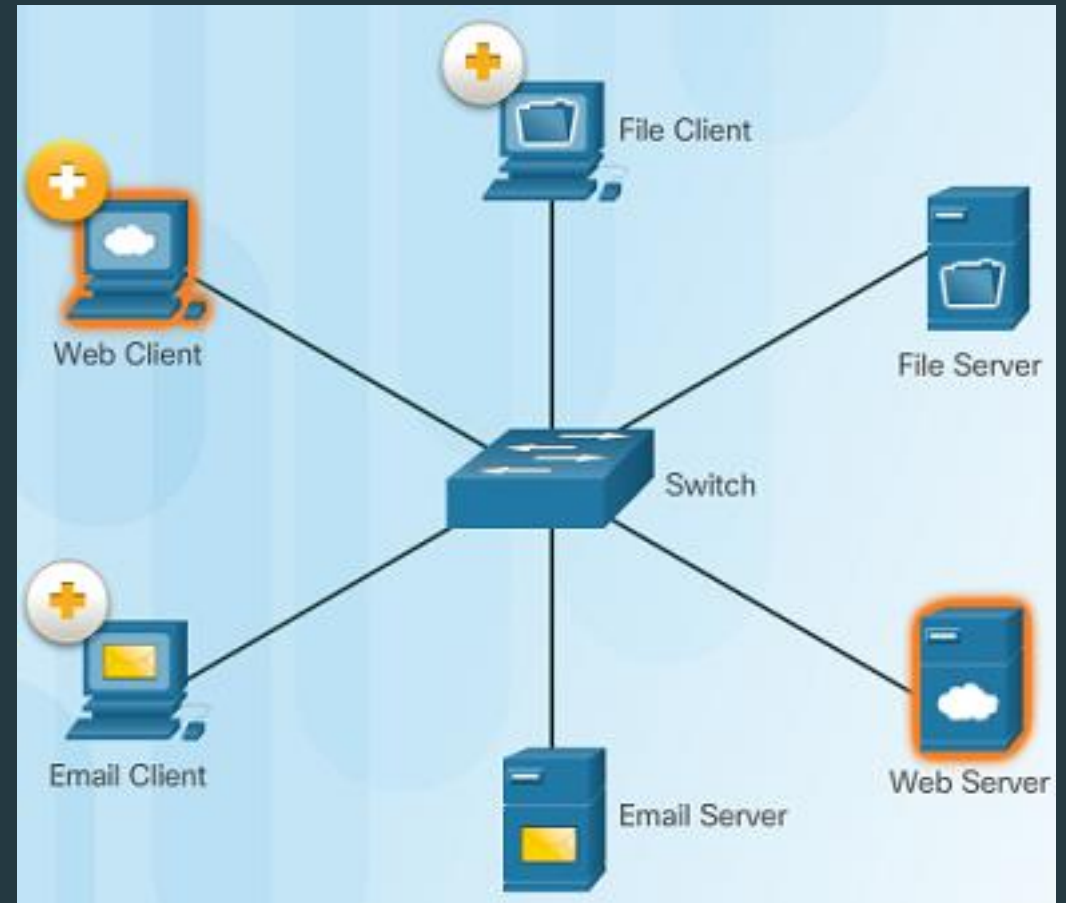
End Devices

- Other end devices that perform as servers with specialized functions include:
    - Network Printers provide centralized printing that can be access by different networked users
    - Network Attached Storage (NAS) provides centralized and dedicated file storage on the network
- A network interface card (NIC) or network port enables an end device to connect to a network

Network Infrastructure Devices

- An **infrastructure** device interconnects end devices in a network.

- The management of data as it flows through a network is also the role of an infrastructure device including:

  - Regenerate and retransmit data signals.

  - Maintain information about what pathways exist through the network and internetwork.

  - Notify other devices of errors and communication failures.
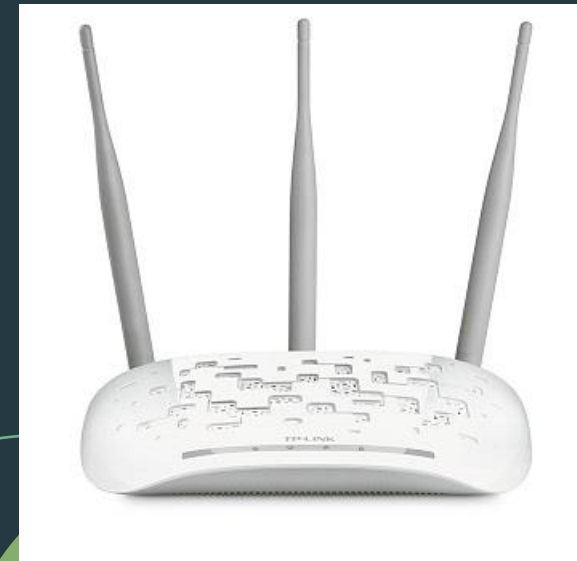
Network Infrastructure Devices

- Switches connect devices together using cables to form a network

    Symbol:

- Wireless Access Points connect wireless devices together to form a network

    Symbol:

Network Infrastructure Devices

- **Routers** connect networks together and calculate the best paths to move (route) data between them

  Symbol:

- **Firewalls** perform filtering in a network to block unwanted data

  Symbol:

Communication Rules

- Humans follow rules when communicating with each other- e.g. an identified sender and receiver; using a common language; method of communication – mail, face to face, messaging;

- To communicate over a network, devices similarly abide by a set of standards and protocols to ensure compatibility between communicating parties and orderly communications. These dictate rules such as:
  - How messages should be packaged
  - How addresses should be formatted
  - How fast messages can be sent

- Some popular standards are Ethernet (for wired devices), 802.11 Wireless Ethernet (for wireless devices) and the Internet Protocol (IP)

Addressing

- Addresses allow a device to be properly identified to receive packets.

- In modern networks, devices commonly have 2 types of addresses.
  - A MAC address is a permanent address that uniquely identifies a device whichever network it may join (similar to your name)
  - An IP address is a temporary address that uniquely identifies a device within a network (similar to your student ID). It is paired with a subnet mask to differentiate the network number and its host number within the network

Ex:

						Host number
IP Address	**192** .	**168** .	**50** .			**93**
Subnet Mask	**255** .	**255** .	**255** .			**0**
	Network Number					Host number

Addressing

- To communicate on a network, a device must the same network number as the network it is connected to, and must have a unique host number within that network

- To communicate with destinations outside its network, a device must additionally be set with a default gateway

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Wireless LAN adapter Wi-Fi:

   Connection-specific DNS Suffix  . :
   Link-local IPv6 Address . . . . . : fe80::64fe:92b2:4f8b:7cb2%7
   IPv4 Address. . . . . . . . . . . : 192.168.50.93
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 192.168.50.1
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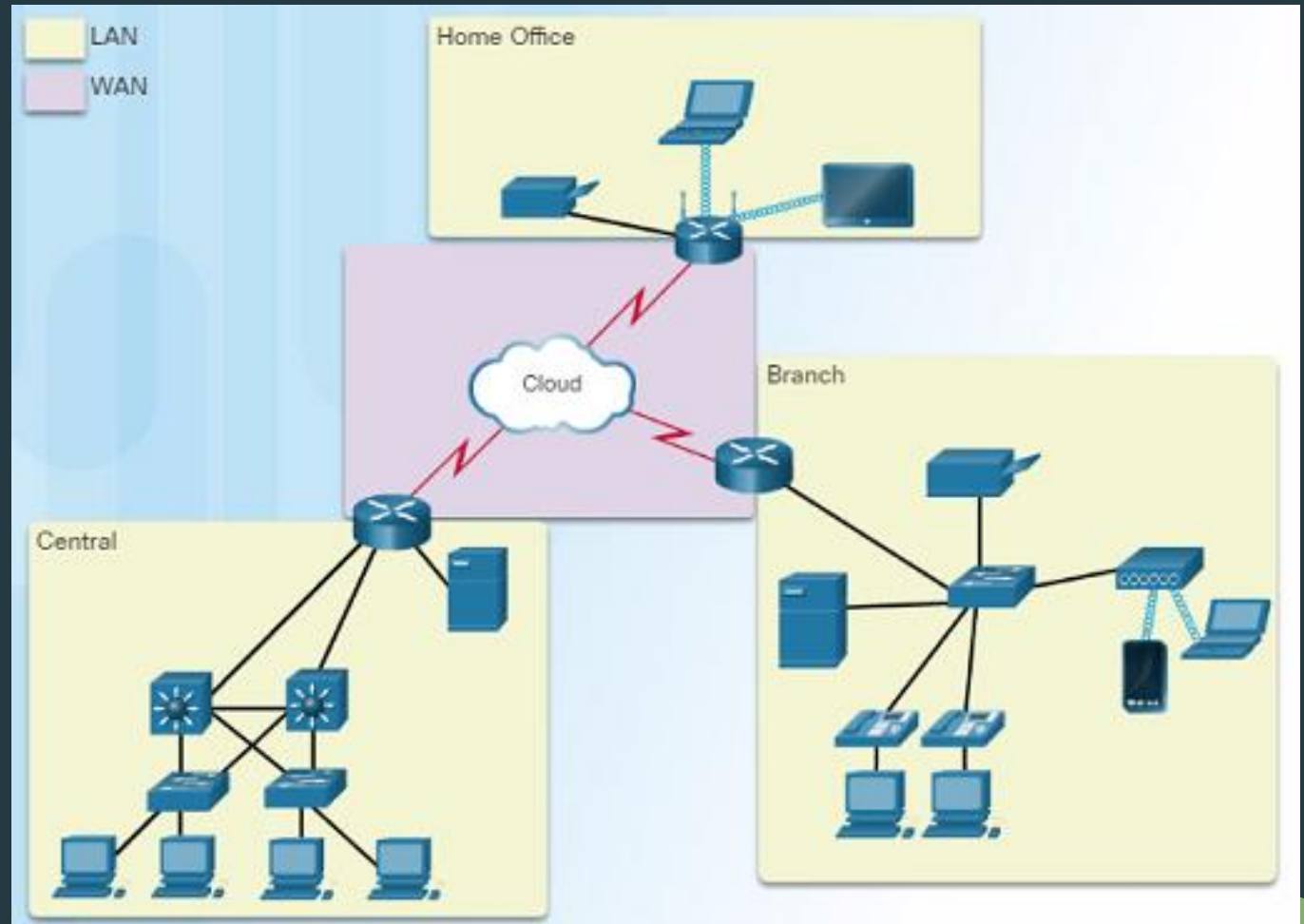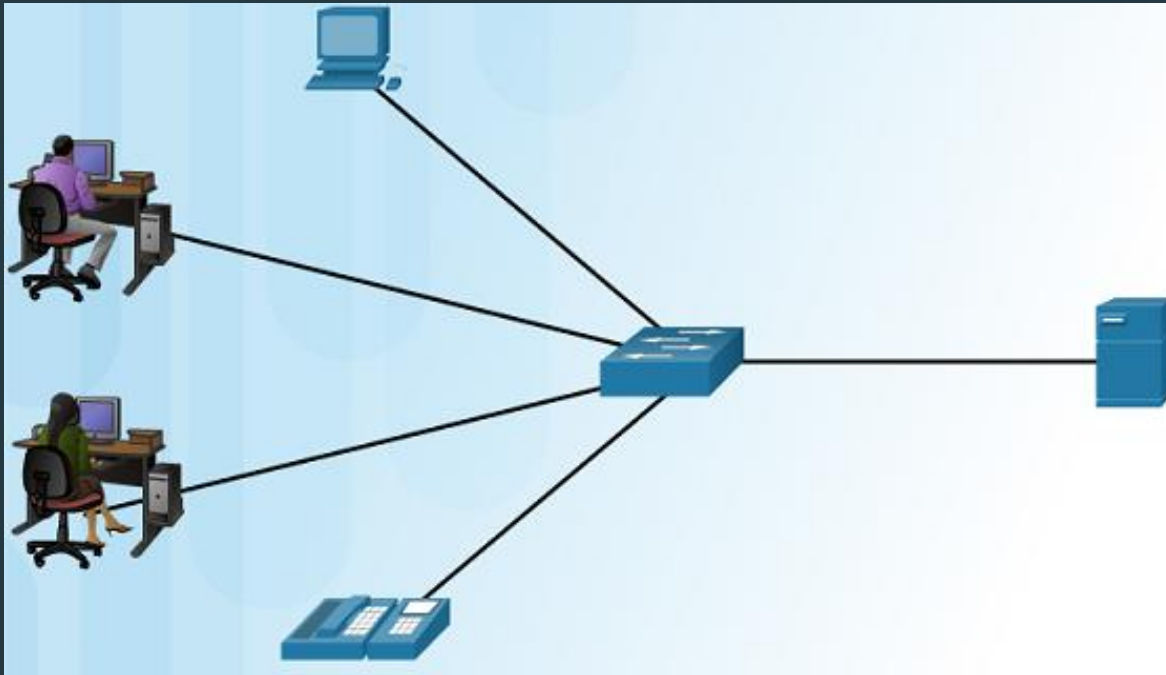
Types of Networks

Common types of networks:

- Local Area Network (LAN)

- Wireless LAN (WLAN)
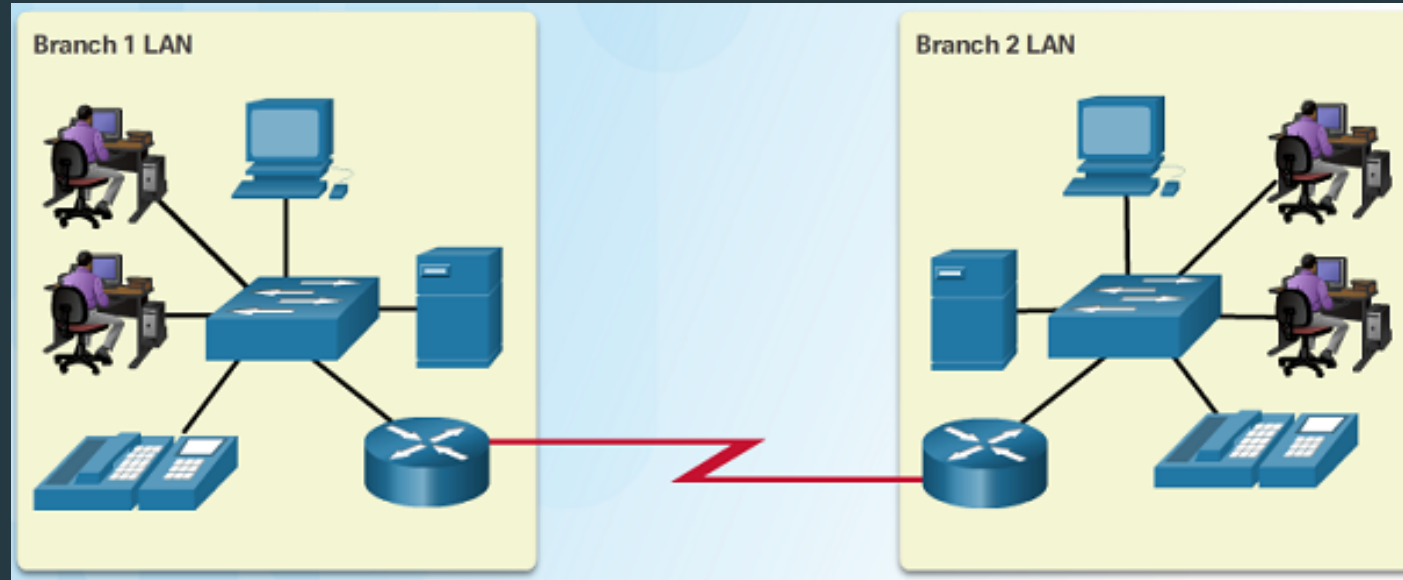
- Wide Area Network (WAN)

Local Area Networks

- LANs and WLANs span a small geographic area such as a home, school, office building, or campus.

- Usually owned or managed by a single organization or individual.

- Provides high speed bandwidth to end devices and infrastructure devices within the network.

Wide Area Networks

- WANs interconnect LANs over wide geographical areas such as between cities, provinces, or countries.
- Usually owned and managed by multiple service providers.
- WANs typically provide slower speed links between LANs.

The Internet

- The Internet is a worldwide collection of interconnected LANs and WANs.

- LANs are connected to each other using WANs.

- WANs are then connected to each other using copper wires, fiber optic cables, and wireless transmissions.

- The Internet is not owned by any individual or group, however, global organizations and consortiums help maintain its structure
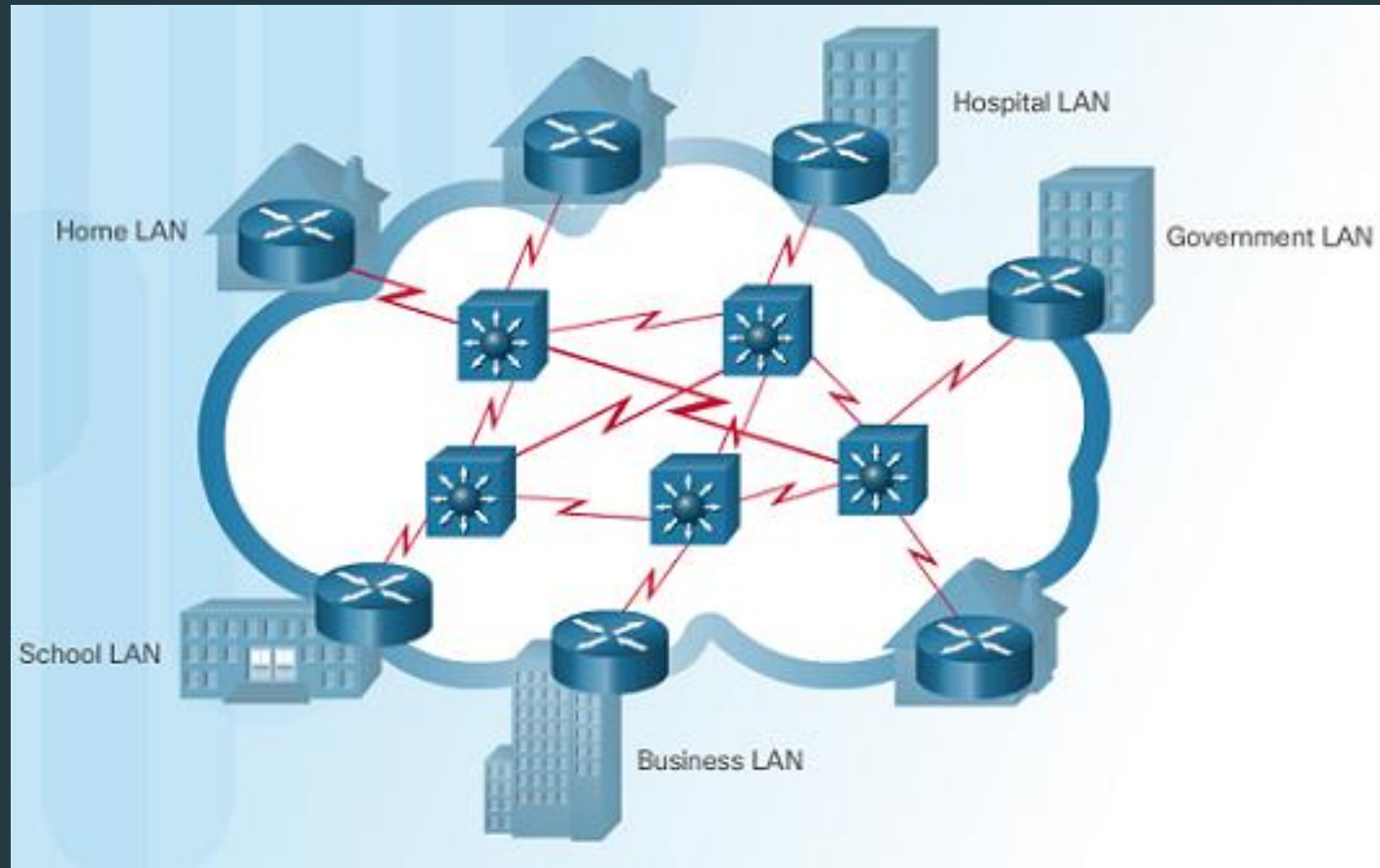
Connecting to the Internet

- Some businesses and large organizations have a dedicated connection to the Internet, but other businesses and home users purchase Internet access from Internet service providers (ISPs).

- ISPs offer broadband Internet connection services to their customers. Common options are:

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Broadband Type	Transmission Medium	Characteristics	Speeds
Cable	Coaxial cable, similar to cable TV wire	Cable connections are shared, so speed can drop during high-usage periods	Ave 10 Mbps, max of 30 Mbps
DSL	Copper wire phone line	Speed drops as distance from the main signal source increases	Ave 3.7 Mbps, max of 35 Mbps
Fiber	Optical fiber	Transmits data via light signals, which do not degrade over long distances	Ave 50 Mbps, max of 500 Mbps
Mobile (3G/4G/5G)	Radio frequency – uses same cellular network that cell phones use	Speed drops as users and distance from cell towers increase. Also affected by physical obstacles	3G: Ave 3 Mbps 4G: Ave 20 Mbps 5G: Ave 140 Mbps

Summary

- A computer network consists of two or more computers connected via software and hardware so they can communicate with each other.

- Network performance is measured by bandwidth and throughput

- The physical components of a network include transmission media, infrastructure devices and end devices
    - Media provide the physical connection and can be in the form of copper cables (twisted pair and coax), fiber optic cables or radio signals
    - End devices are originators and final destinations of messages. Examples include personal devices, servers, network printers and NAS
    - Infrastructure devices manage the flow of data through the network. Examples include switches, wireless access points, routers and firewalls

Summary

- Network devices conform to protocols and standards to successfully communicate with each other on a network

- A device has a permanent MAC address, and a temporary IP address to identify it on a network. Other needed settings are the subnet mask and default gateway.

- LANs are networks covering a limited geographic area; while WANs connect LANs over long distances. Multiple interconnected LANs and WANs form the Internet

- To access the Internet, users subscribe for a broadband connection from an Internet Service Provider and may choose a cable, DSL, fiber or mobile broadband service