NETWORKING 1, FUNDAMENTALS (IT-NET01)

1st SEMESTER A.Y. 2023 – 2024

Prepared by: Mhelveen G. Serrano

NETWORK FUNDAMENTALS

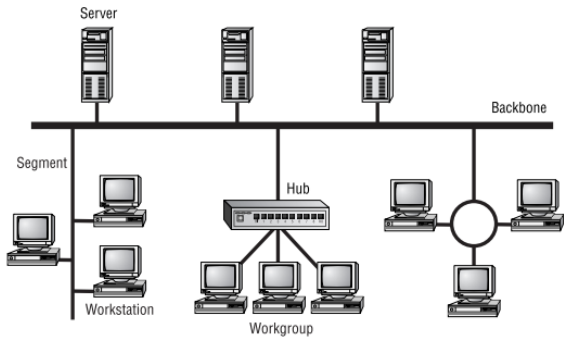
Network Elements

In the computer world, the term network describes two or more connected computers that can share resources such as data, a printer, an Internet connection, applications, or a combination of these. In the following sections, we'll discuss each type of network and describe the situation that is most appropriate for its use.

Local Area Network (LAN):

- Limited to a specific area, like an office or a building.
- Originally limited to 185 meters and 30 computers.
- Today's technology allows for larger LANs.
- LANs often divided into workgroups for practical administration.
- Workgroup: A collection of individuals sharing files and databases on the LAN.

FIGURE 1.1 A small LAN



Wide Area Network (WAN):

- Spans metropolitan, regional, or national boundaries.
- Uses routers and public network links.
- Can be centralized or distributed.
- Can use public or private network transports.
- Can operate in full-duplex or half-duplex communication modes.

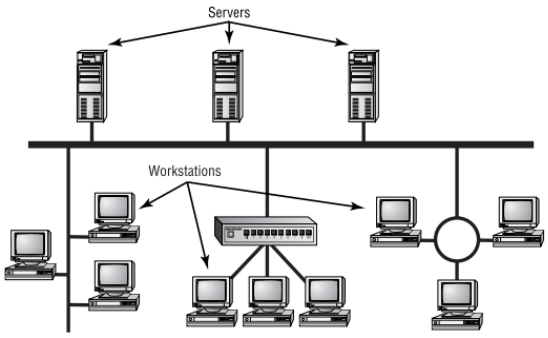
WANs differ from LANs in the following ways:

- **WANs** cover greater distances.
- **WAN** speeds are slower.
- **WANs** can be connected on demand or permanently connected; LANs have permanent connections between stations.
- **WANs** can use public or private network transports; **LANs** primarily use private network transports.
- **WANs** can use either full- or half-duplex communications. **LANs** have typically used half duplex communications, although many local area networks today use full-duplex communications (see the sidebar "Full-Duplex vs. Half-Duplex Communications").

Network Elements (Host, Workstation, and Server):

- Host: Any network device with an IP address.
- Workstation: A computer connected to the network for individual work.
- Server: Provides resources to clients and runs network operating system.
- Servers can be specialized for various purposes, like file servers, print servers, mail servers, etc.
- Common characteristics of servers include hardware/software for data integrity and support for a large number of clients.

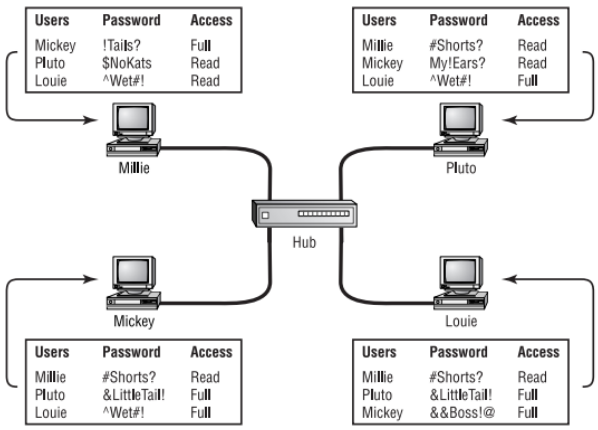
FIGURE 1.2 A sample network including servers and workstations



Peer-to-Peer (P2P) Network Review:

- In a P2P network, connected computers have no centralized authority, and all computers are considered equal or "peers."
- Users on one computer can request access to resources on another computer, and the security check for access rights is the responsibility of the computer holding the resource.
- P2P networks are suitable for small, informal setups, such as a home network or a small office where simplicity and cost-effectiveness are prioritized over advanced network management and security.

FIGURE 1.3 A peer-to-peer network



Characteristics:

- Each computer in a P2P network can act as both a client and a server, meaning they can request and provide resources.
- Typically used in smaller networks with minimal security requirements.
- Often seen in workgroups or smaller organizations.
- Commonly found in networks running Windows 95/98 or Windows NT, 2000, or XP in a workgroup setting.

Pros of P2P Networks:

- Simple to install.
- Relatively inexpensive.
- Uses less cable compared to some other topologies.
- Each computer can share resources with others easily.

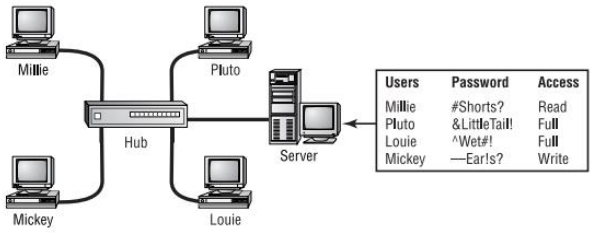
Cons of P2P Networks:

- Difficult to manage in larger environments.
- Limited fault tolerance: a single fault can disrupt the entire network.
- Security is not centralized, and user credentials must be maintained separately on each machine.

Client/Server Network

- In contrast to a peer-to-peer network, a client/server network uses a network operating system designed to manage the entire network from a centralized point, which is the server. Clients make requests of the server, and the server responds with the information or access to a resource.

FIGURE 1.4 A client/server network



Physical Topologies:

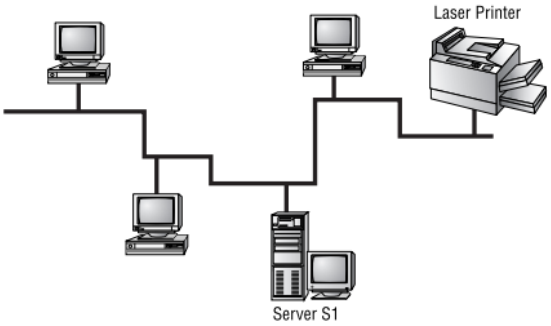
- The layout of cables, workstations, and network components.
- Different from logical topologies that describe how data flows.
- Important to choose a configuration that suits your needs.

Common Physical Topologies:

1. Bus Topology:

- All computers connected to a single continuous cable.
- Simple installation, inexpensive, and uses less cable.
- Difficult to reconfigure and has little fault tolerance.

FIGURE 1.5 An example of a physical bus topology

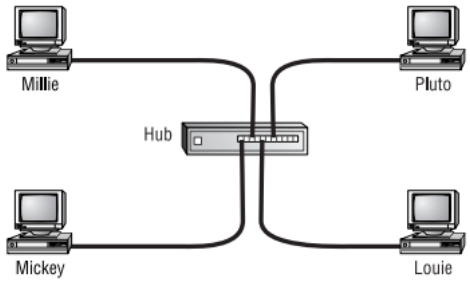


2. Star Topology:

- Each computer connected to a central point (hub or switch) individually.
- New stations can be added easily, not affected by single cable failure.

- Relatively easy to troubleshoot, but installation cost can be higher.

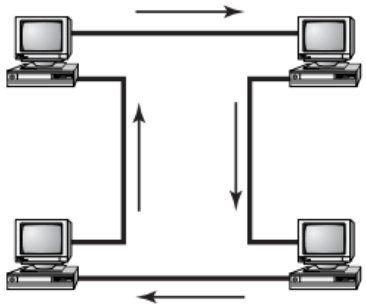
FIGURE 1.6 A typical star topology with a hub



3. **Ring Topology:**

- Each computer connected to two others forming a one-way path.
- Cable design is simple, but a single cable fault can disrupt the network.
- Difficult to reconfigure and not fault tolerant.

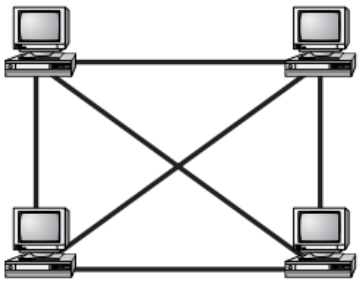
FIGURE 1.7 A typical ring topology



4. **Mesh Topology:**

- Path exists between each station and every other station.
- Offers fault tolerance in case of cable or node failure.
- Complex and expensive, primarily used in WANs.

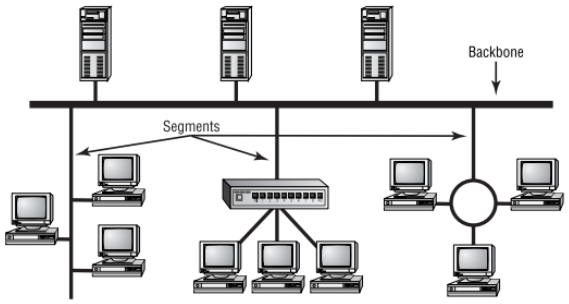
FIGURE 1.8 A typical mesh topology



Backbones and Segments:

- Backbones connect all segments and servers, providing the main structure of the network.
- High-speed technology used in backbones (e.g., FDDI, Ethernet).
- Segments are short network sections that connect workstations to the backbone.

FIGURE 1.9 Backbone and segments on a sample network



Selecting the Right Topology:

- Consider factors like cost, ease of installation, ease of maintenance, and cable fault tolerance.
- Choose the topology that fits your network's specific requirements.

You should balance the following considerations when choosing a physical topology for your network:

- Cost
- Ease of installation
- Ease of maintenance
- Cable fault tolerance

Physical Media

- Although it is possible to use several forms of wireless networking, such as radio frequency and infrared, the majority of installed LANs today communicate via some sort of cable.

THREE TYPES OF CABLES:

- Coaxial
- Twisted pair
- Fiber optic

1. **Coaxial Cable:**

- Structure: Contains a copper center conductor, surrounded by a plastic jacket and a braided shield.

- Plenum Rating: Teflon-type plenum-rated coating used for safety in air plenums.
- BNC Connectors: Used to attach stations to the network. Connector can be crimped or screwed on.
- T-Connector: Passive device to connect backbone cable to each station. Requires termination with male BNC connectors.
- Limitations: No drop cables allowed at the device end, and many interconnections can introduce noise and failure points.

TABLE 1.1 Coaxial Cable Specifications

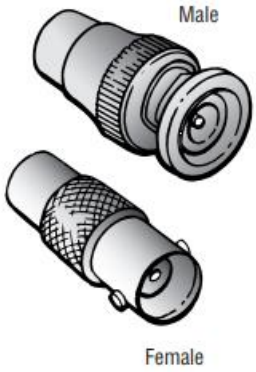
RG Rating	Popular Name	Ethernet Implementation	Type of Cable
RG-58 U	N/A	None	Solid copper
RG-58 A/U	Thinnet	10Base2	Stranded copper
RG-8	Thicknet	10Base5	Solid copper
RG-62	ARCnet	N/A	Solid/stranded

Thin Ethernet (Thinnet or 10Base-2):

- Thin Ethernet, also known as Thinnet or 10Base-2, is a type of coaxial cable with a smaller diameter (about 1/4 inch) compared to thick coaxial cables.
- The specific type of coaxial cable used for Thin Ethernet is RG-58.
- BNC connectors are used to attach stations to the Thin Ethernet network, and they securely lock with a quarter-twist motion.
- The exact meaning of the abbreviation BNC (BayoNet Connector, Bayonet Nut Connector, or British Navel Connector) is a subject of debate, but it's commonly referred to as the Bayonet Neill-Concelman connector.

FIGURE 1.10 A stripped-back Thinnet

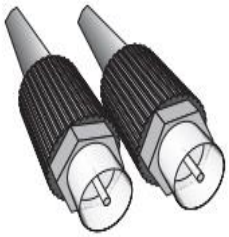
FIGURE 1.11 A male and female BNC connector



F-Type Connectors:

- Threaded, screw-on connectors used for device attachment.
- Commonly found with 75-ohm coaxial media.
- Connects the center conductor of the coaxial cable to the metal body of the connector.
- Increasingly used in mainstream data networking, especially due to cable modems.

FIGURE 1.12 An example of an F-Type coaxial cable connector



2. **Twisted-Pair Cable:**

- Structure: Multiple individually insulated wires twisted together in pairs.
- Shielding: Can be shielded (STP) or unshielded (UTP).
- Significance of Twisting: Reduces electromagnetic interference (crosstalk) and protects against external interference.
- Commonly used in Ethernet, including 10Base-T and 100Base-TX networks.

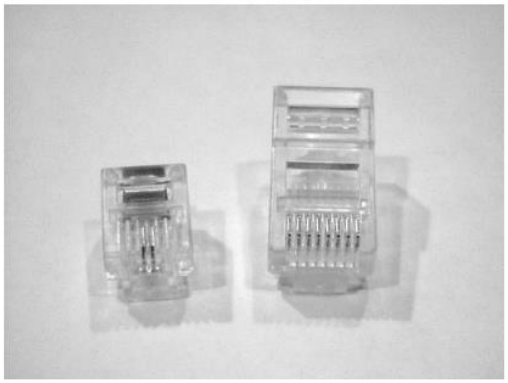
UTP Cable Categories:

- ➔ **Category 1:** Voice-grade, not rated for data communications, used for POTS.
- ➔ **Category 2:** Suitable for up to 4Mbps, with a frequency limitation of 10MHz.
- ➔ **Category 3:** Acceptable for transmissions up to 16MHz, popular in telecommunications.
- ➔ **Category 4:** Rated for 20MHz.
- ➔ **Category 5:** Rated for 100MHz.
- ➔ **Category 5e:** Rated for 100MHz, capable of handling Gigabit Ethernet.
- ➔ **Category 6:** Rated for 250MHz, became a standard in June 2002.

RJ Connectors:

- RJ-45 connector is commonly used with UTP cable.
- RJ-11 is used for telephones.
- Crimper tools used to attach RJ connectors to cables.

FIGURE 1.13 RJ-11 and RJ-45 connectors



Signaling Methods:

- Baseband: Entire cable bandwidth used for each signal, typically with digital signaling.
- Broadband: Available bandwidth divided into discrete bands, allowing multiple signals transmission.
- Broadband vs. narrowband: Broadband refers to speeds exceeding T1/E1 rates, such as Broadband-ISDN (B-ISDN).

Ethernet Cable

Ethernet cable types are designated using a code format N-X, where N represents the signaling rate in megabits per second, and X serves as a unique identifier for a specific Ethernet cabling scheme. For example:

- 10BaseX signifies a 10Mbps transmission speed.
- 10Base5 indicates a maximum signal transmission distance of 500 meters.
- 10Base2, while labeled as such, has a more accurate limit of 185 meters.
- 10Base-T (twisted-pair) is used for 10-Megabit Ethernet over two pairs (four wires) of Category 4, 5e, or 6 Unshielded Twisted Pair (UTP) cables.
- 10Base-FL (fiber link) is the standard for running 10-Megabit Ethernet over fiber-optic cables to the desktop.

This N-X format simplifies the description and classification of various Ethernet standards, allowing for easy understanding of their speed and medium specifications.

ETHERNET CABLE TYPES:

1. **10BaseX:**
   - The 10 indicates a 10Mbps transmission speed.
   - X represents a unique identifier for specific cabling schemes.
   - Examples include 10Base2 (limited to 185 meters), 10Base5 (limited to 500 meters), 10Base-T (twisted-pair), and 10Base-FL (fiber link).
2. **100Base-TX (Fast Ethernet):**
   - A standard for Ethernet transmission at 100Mbps.
   - Uses two UTP pairs (four wires) in at least Category 5 UTP cable.

3. **1000Base-TX (Gigabit Ethernet):**

- Allows 1000Mbps throughput on standard twisted-pair copper cable (Category 5e or higher).

4. **1000Base-SX:**

- Gigabit Ethernet over multimode fiber-optic cable, using short wavelength lasers.

5. **1000Base-LX:**

- Gigabit Ethernet over single-mode and multimode fiber, using long wavelength lasers.

6. **1000Base-CX:**

- Gigabit Ethernet over balanced, 150-ohm copper cabling with the High-Speed Serial Data Connector (HSSDC).

7. **10GBase-SR:**

- 10 Gigabit Ethernet using short wavelength lasers at 850 nm over multimode fiber.
- Maximum transmission distance varies (2-300 meters) depending on fiber size and quality.

8. **10GBase-LR:**

- 10 Gigabit Ethernet using long wavelength lasers at 1310 nm over single-mode fiber.
- Maximum transmission distance varies (2 meters to 10 kilometers) depending on fiber size and quality.

9. **10GBase-ER:**

- 10 Gigabit Ethernet using extra long wavelength lasers at 1550 nm over single-mode fiber.
- Maximum transmission distance varies (2 meters to 40 kilometers) depending on fiber size and quality.

IEEE Standard 1394 (FireWire):

- IEEE standard 1394, known as FireWire, developed by Apple Computer.
- Speeds of 100, 200, 400Mbps (800Mbps in 1394b standard).
- Cable length limitation of 15 feet (4.5 meters) in standard mode.
- Uses 6-pin and 4-pin connectors:
  - 6-pin connectors provide power and data transfer.
  - 4-pin connectors are for data transfer only.

FIGURE 1.14 Six-pin FireWire connector (male)

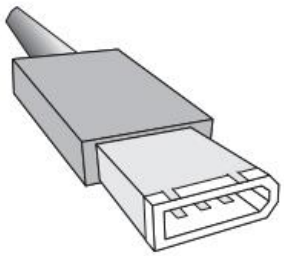
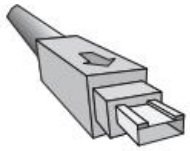


FIGURE 1.15 Four-pin FireWire connector (male)



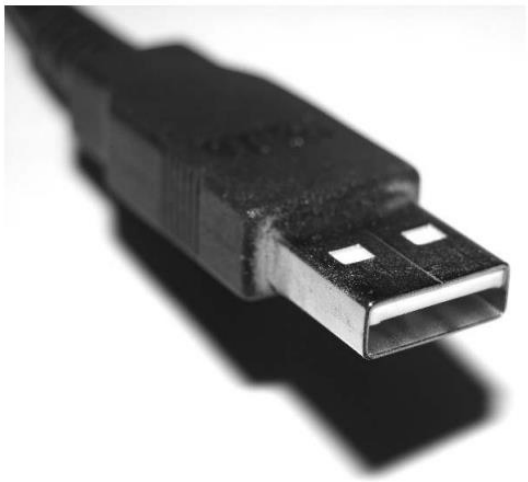
Universal Serial Bus (USB):

- USB offers a maximum of 127 external device connections.
- It is more flexible and versatile than traditional serial or parallel connections.
- USB supports various peripherals, including printers, scanners, keyboards, joysticks, and mice.
- USB devices can be connected directly to a PC's USB ports or via USB hubs.
- You can chain multiple USB hubs for more connections, but in practice, around 12 USB devices are supported on most computers.

FIGURE 1.16 A USB port

FIBER-OPTIC CABLE:

FIGURE 1.17 A USB plug



Pros:

- Immune to Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI).
- Can transmit data over long distances, up to 40 kilometers.

Cons:

- Installation is difficult and requires a significant investment in materials.
- Two main types of fiber-optic cable: single-mode fiber (SMF) for longer distances and multimode fiber (MMF) for shorter distances.
- Identification of fiber type: Yellow jacket for single mode, orange for multimode, and check the writing on the cable (e.g., 62.5/125 for multimode).

Fiber-Optic Connectors:

- Common connectors include ST (straight tip) and SC (subscriber/square connector).
- ST connector uses a BNC attachment mechanism and is widely used.
- SC connector is a latched connector, used for both single-mode and multimode optical fibers.
- Small Form Factor (SFF) connectors, like MT-RJ and LC, allow more terminations in the same space.

FIGURE 1.18 An example of an ST connector

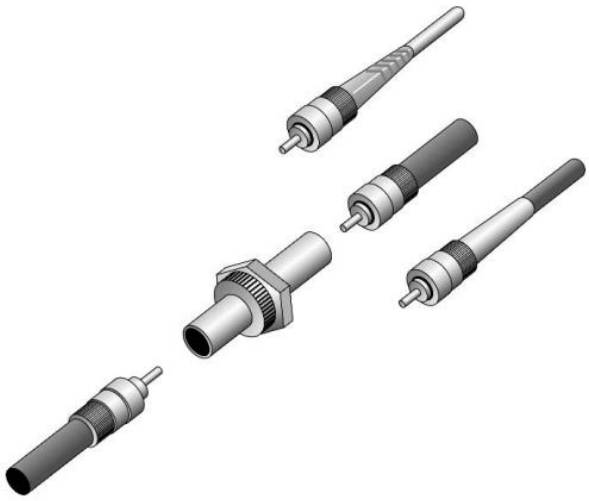
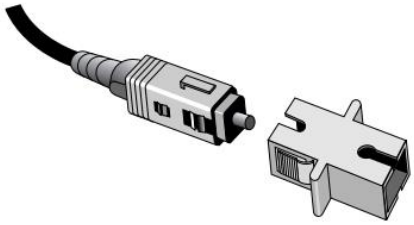


FIGURE 1.19 A sample SC connector



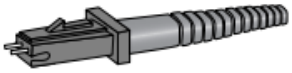
MT-RJ

- The MT-RJ fiber-optic connector was the first small form factor fiber-optic connector to see widespread use. It is one-third the size of the SC and ST connectors it most often replaces.

It had the following benefits:

- Small size
- TX and RX strands in one connector
- Keyed for single polarity
- Pre-terminated ends that require no polishing or epoxy
- Easy to use

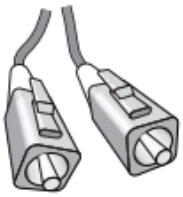
FIGURE 1.20 A sample MT-RJ fiber-optic connector



LC

- Local Connector is a newer style of SFF fiber-optic connector that is overtaking MT-RJ as a fiber-optic connector. It is especially popular for use with Fibre Channel adapters and Gigabit Ethernet adapters. It has similar advantages to MT-RJ and other SFF-type connectors but is eas ier to terminate. It uses a ceramic insert as standard-sized fiber-optic connectors do. Figure 1.21 shows an example of the LC connector.

FIGURE 1.21 A sample LC fiber-optic connector



Cable Type Summary

Table 1.2 summarizes the cable types.

TABLE 1.2 Common Ethernet and FDDI Cable Types

Ethernet Name	Cable Type	Maximum Speed	Maximum Transmis sion Dis tance	Notes
10Base5	Coax	10Mbps	500 meters per segment	Also called Thicknet, this cable type uses vampire taps to connect devices to cable.
10Base2	Coax	10Mbps	185 meters per segment	Also called Thinnet, a very popular implementation of Ethernet over coax.
10Base-T	UTP	10Mbps	100 meters per segment	One of the most popular net-work cabling schemes.
100Base-TX	UTP, STP	100Mbps	100 meters per segment	Two pairs of Category 5 UTP.
10Base-FL	Fiber	10Mbps	Varies (ranges from 500 meters to 2000 meters)	Ethernet over fiber optics to the desktop.
100Base-FX	Multimode fiber	100Mbps	2000 meters	100Mbps Ethernet over fiber optics.
1000Base-T	UTP	1000Mbps	100 meters	Four pairs of Category 5e or higher.
1000Base-SX	Multimode fiber	1000Mbps	550 meters	Uses SC fiber connectors. Max length depends on fiber size.
1000Base-CX	Balanced, shielded cop-per	1000Mbps	25 meters	Uses special connector, the HSSDC.
1000Base-LX	Multimode and single-mode fiber	1000Mbps	550 meters multi-mode/2000 meters single mode	Uses longer wavelength laser than 1000Base-SX. Uses SC and LC connectors.
10GBase-SR	Multimode fiber	10Gbps	300 meters	850 nm laser. Max length depends on fiber size and quality.
10GBase-LR	Single-mode fiber	10Gbps	10 kilometers	1310 nm laser. Max length depends on fiber size and quality.
10GBase-ER	Single-mode fiber	10Gpbs	40 kilometers	1550 nm laser. Max length depends on fiber size and quality.
FDDI	Multimode fiber	100Mbps	10 kilometers	Uses MIC connector.

COMMON NETWORK CONNECTIVITY DEVICES:

❖ **Network Interface Card (NIC):**

- Connects a computer to the network.
- Can be an expansion card or built into the motherboard.
- Equipped with LEDs for diagnostics, including Link and Activity LEDs.

❖ **Hub:**

- Connects network segments in a star topology.
- Acts as a repeater, broadcasting data to all connected devices.
- Used in a physical star/logical bus topology.

❖ Switch:

- Connects multiple segments.
- Recognizes frame boundaries and destination MAC addresses.
- Forward frames only to the port where the destination device resides.
- Provides better performance compared to hubs.

❖ Bridge:

- Connects two similar network segments.
- Keeps traffic separated between segments.
- Allows traffic to pass through only if intended for the opposite side.

❖ Router:

- Connects multiple and dissimilar network segments into an internetwork.
- Makes intelligent routing decisions based on network performance data.
- Complex devices with their own operating systems.

❖ Gateway:

- Connects dissimilar network environments.
- Translates data between different protocols and character sets.
- E.g., LAN to mainframe, email gateways for LAN-based email to SMTP.

❖ Other Devices:

- In addition to these network connectivity devices, there are several devices that, while maybe not directly connected to a network, participate in moving network data:
  - ➔ Modems
  - ➔ ISDN terminal adapters
  - ➔ Wireless access points
  - ➔ CSU/DSUs
  - ➔ Transceivers (media converters)
  - ➔ Firewalls

Modems:

- A modem stands for MOdulator/DEModulator, and it converts digital data into an analog carrier for transmission and vice versa.
- Three main types of modems: Traditional (POTS), DSL, and Cable.
- Traditional (POTS) modems convert signals for plain old telephone service (POTS) lines.
- DSL provides high data rates and allows simultaneous phone calls over the same line.
- Cable modems use cable television infrastructure to deliver Internet services.

ISDN Terminal Adapters:

- ISDN (Integrated Services Digital Network) offers high-speed Internet access.
- An ISDN Terminal Adapter connects your computer to ISDN services.
- Unlike traditional modems, ISDN TAs don't change digital signals to analog but between different digital transmission formats.
- It typically has a phone jack and an Ethernet jack for connection.

Wireless Access Points (WAPs):

- WAPs allow wireless connectivity to a wired network via radio frequency technology.
- They are equivalent to hubs or switches for wireless devices and often support both wired and wireless connections.
- Commonly used in public areas like libraries, coffee shops, and hotels for providing wireless internet access.

CSU/DSUs (Channel Service Unit/Data Service Unit):

- CSU/DSUs are used in T-series or digital serial technology connections, such as T1 lines.
- CSU terminates the line at the customer's premises and provides diagnostics.
- DSU handles the actual transmission of the signal and can provide buffering and data flow control.
- Sometimes both components are built into a router.

Transceivers (Media Converters):

- Transceivers or media converters allow devices to connect to different media types.
- Often used to convert between copper and fiber-optic cabling or between different Ethernet technologies.
- Essential for connecting devices designed for different media types.

Firewalls:

- Firewalls protect LAN resources from Internet-based attacks and control network traffic.
- They can be hardware-based "black boxes" or software-based on servers or routers.
- Typically, have at least two network connections, one to the Internet (public side) and one to the network (private side).
- Some firewalls have a third connection for a demilitarized zone (DMZ) for servers that need both public and private access.
- Firewalls are crucial for the security of Internet-connected networks.

Module 1 lang tohh guyss ang haba kasi di ko na kaya gawin

Sana mapatawad nyo pa ako

"Believe in yourself and all that you are. Know that there is something inside you that is greater than any obstacle."

HAUP NA IT-NET01 TO