Computer Network Fundamentals

Lecture 1:

Introduction to Computer Networks

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Network Definition

- **Network:** can be defined as two or more computers connected together in such a way that they can share information and resources.

– The purpose of a network is to share information and resources.

– The resources may be:

data, file, folder, printer, an Internet connection, applications, or anything else that exists on a computer

Network Definition

- **Data Network:** is a network that allows computers to exchange data.
  - The simplest data network is two PCs connected through a cable.
  - Most data networks connect many devices.

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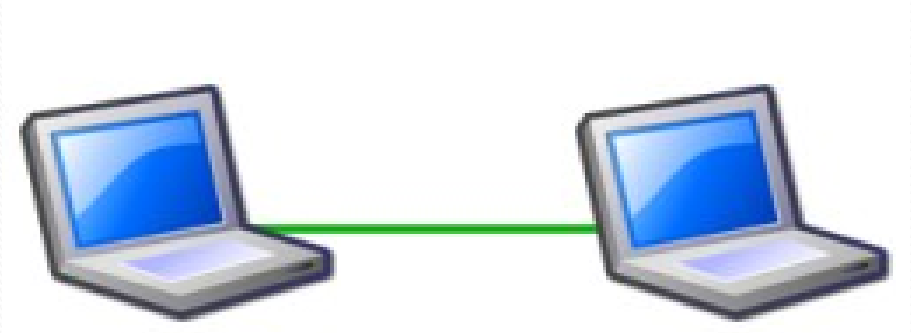


Network Definition

- **Computer Network** can be defined as a collection of devices that can store and manipulate electronic data, interconnected in such a way that network users can store, retrieve, and share information.

- **Internetwork** is a collection of individual networks connected by networking devices and function as a single large network.

  – The public Internet is the most common example which it is a single network that connects millions of computers.

Advantages of networking

1. Connectivity and Communication
2. Data Sharing
3. Hardware Sharing
4. Internet Access
5. Internet Access Sharing
6. Data Security and Management

Network Characteristics

- **Delivery**: The system must deliver data to the correct destination. Data must be received by the intended device or user and only by that device or user.

- **Accuracy**: The system must deliver the data accurately. Data that have been altered in transmission and left uncorrected are unusable.

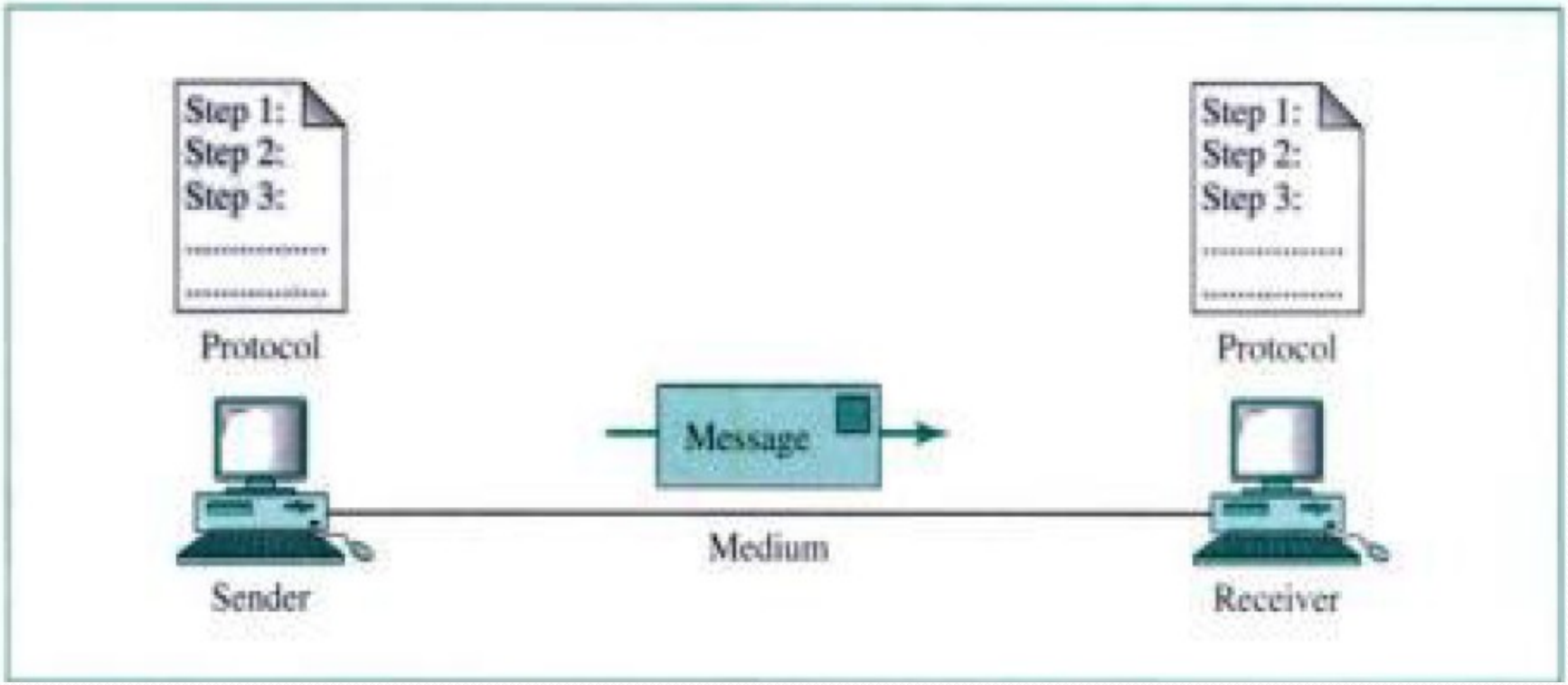
- **Timeliness**: The system must deliver data in a timely manner. Data delivered late are useless. In the case of video and audio, timely delivery means delivering data as they are produced, in the same order that they are produced, and without significant delay. This kind of delivery is called real-time transmission.

Elements of a Network

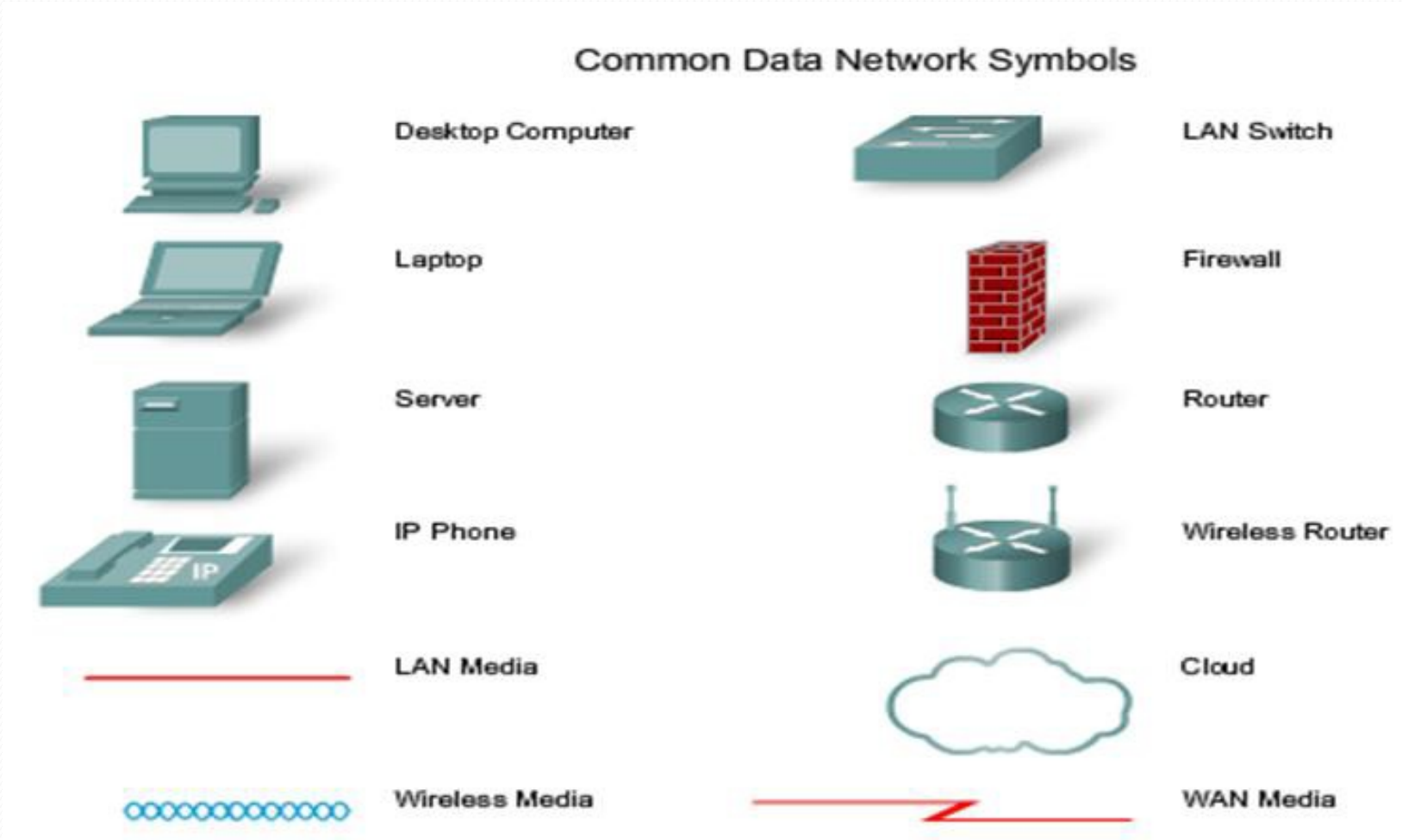
- **All networks have the following four basic elements:**
  - **Rules or agreements:** Rules or agreements (protocols) govern how the messages are sent, directed, received, and interpreted.
  - **Messages:** The messages or units of information travel from one device to another.
  - **Medium:** A medium is a means of interconnecting these devices, that is, a medium can transport the messages from one device to another.
  - **Devices:** Devices on the network exchange messages with each other.

Figure 1-1 depicts a small network featuring rules, messages, a medium, and two devices.

Elements of a Network



Elements of a Network

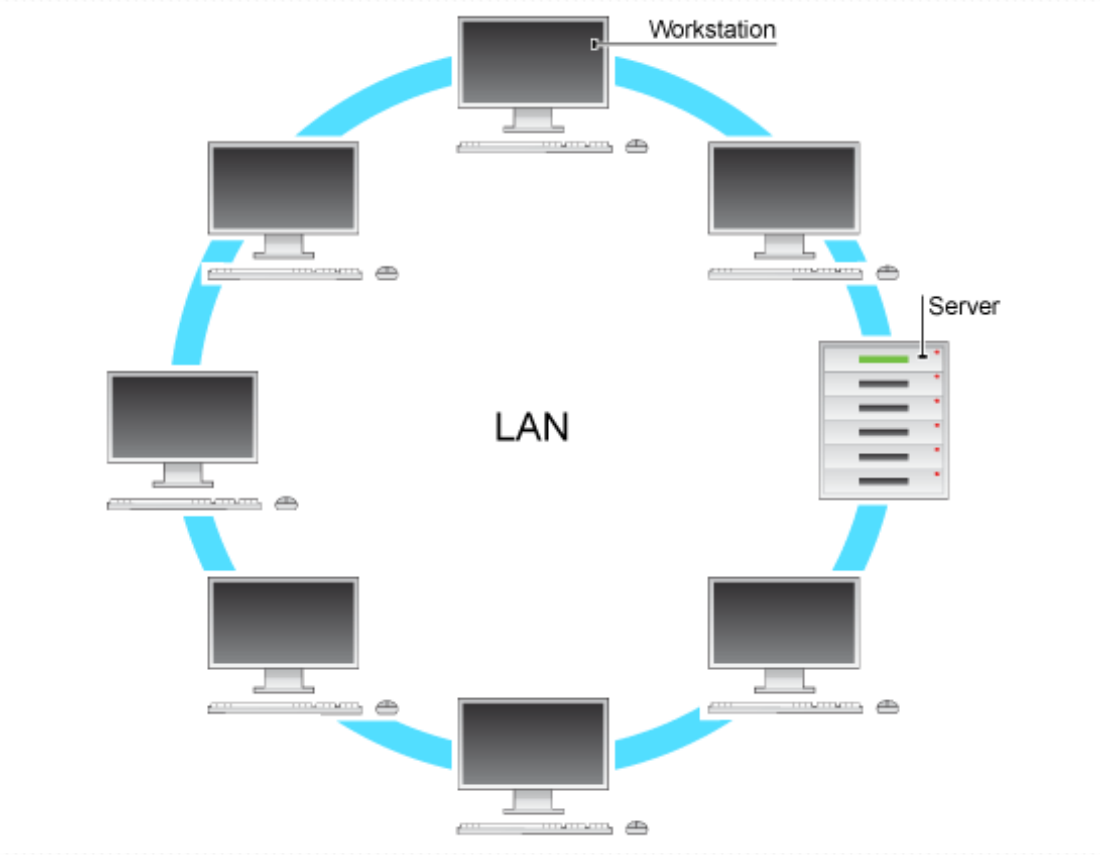


Local Area Networks (LANs):

- **(LAN)** is a computer network that covers a **small geographic area**, like a home, office, or group of buildings, to exchange files and messages and to access shared resources such as printers and disk storage.

- The simplest LAN consist of two computers connecting through a cable in a home office.

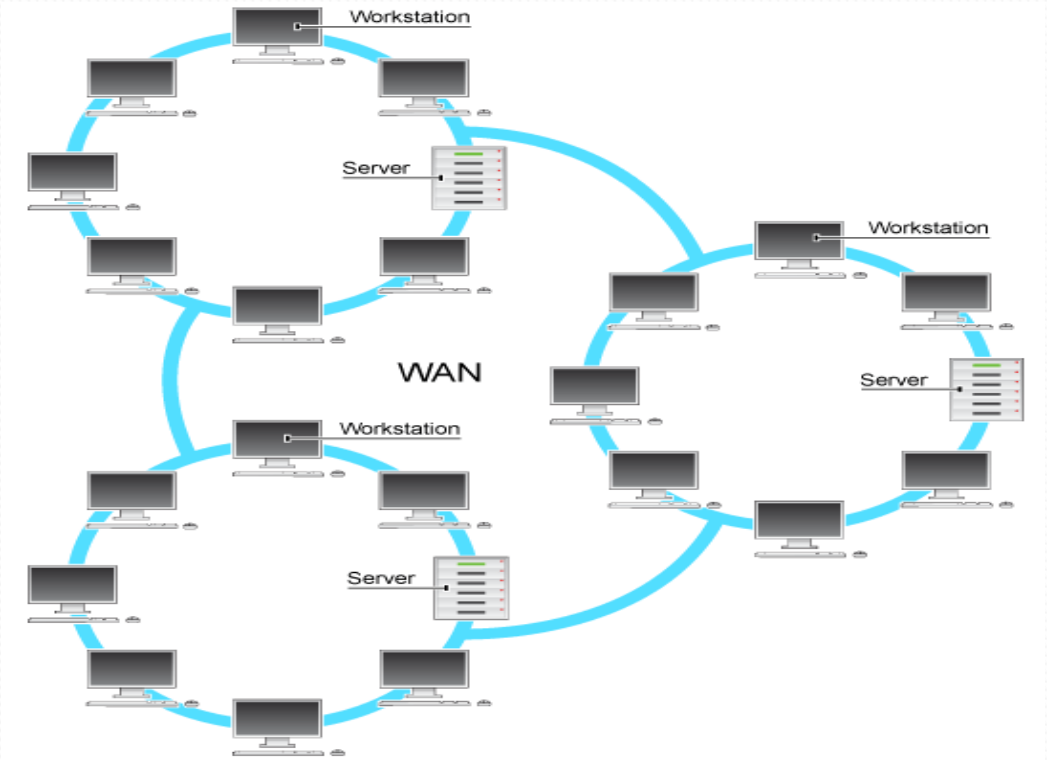
Network Classifications (LAN)



Network Classifications(WAN)

Wide Area Networks (WANs)

- **WAN** is a computer network that covers **a large geographic area** (i.e., any network whose communications links cross metropolitan, regional, or national boundaries). network that uses routers and public communications links.



Network Classifications(WAN)

The largest and most well-known example of a WAN is the **Internet.**

-WANs are used to connect LANs and other types of networks together, so that users and computers in one location can communicate with users and computers in other locations

Network Classifications(MAN)

Metropolitan Area Network (MAN):

- (MAN) is a network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN). The term is applied to the interconnection of networks in **a city** into a single larger network (which may then also offer efficient connection to a wide area network).

Data Flow

- **Communication** between two devices can be ***Simplex, Half-Duplex, or Full-Duplex:***

❖ **Simplex**

In simplex mode, the communication is unidirectional, as on a one-way street. Only one of the two devices on a link can transmit; the other can only receive. For example, **Keyboards.**

❖ **Half -Duplex**

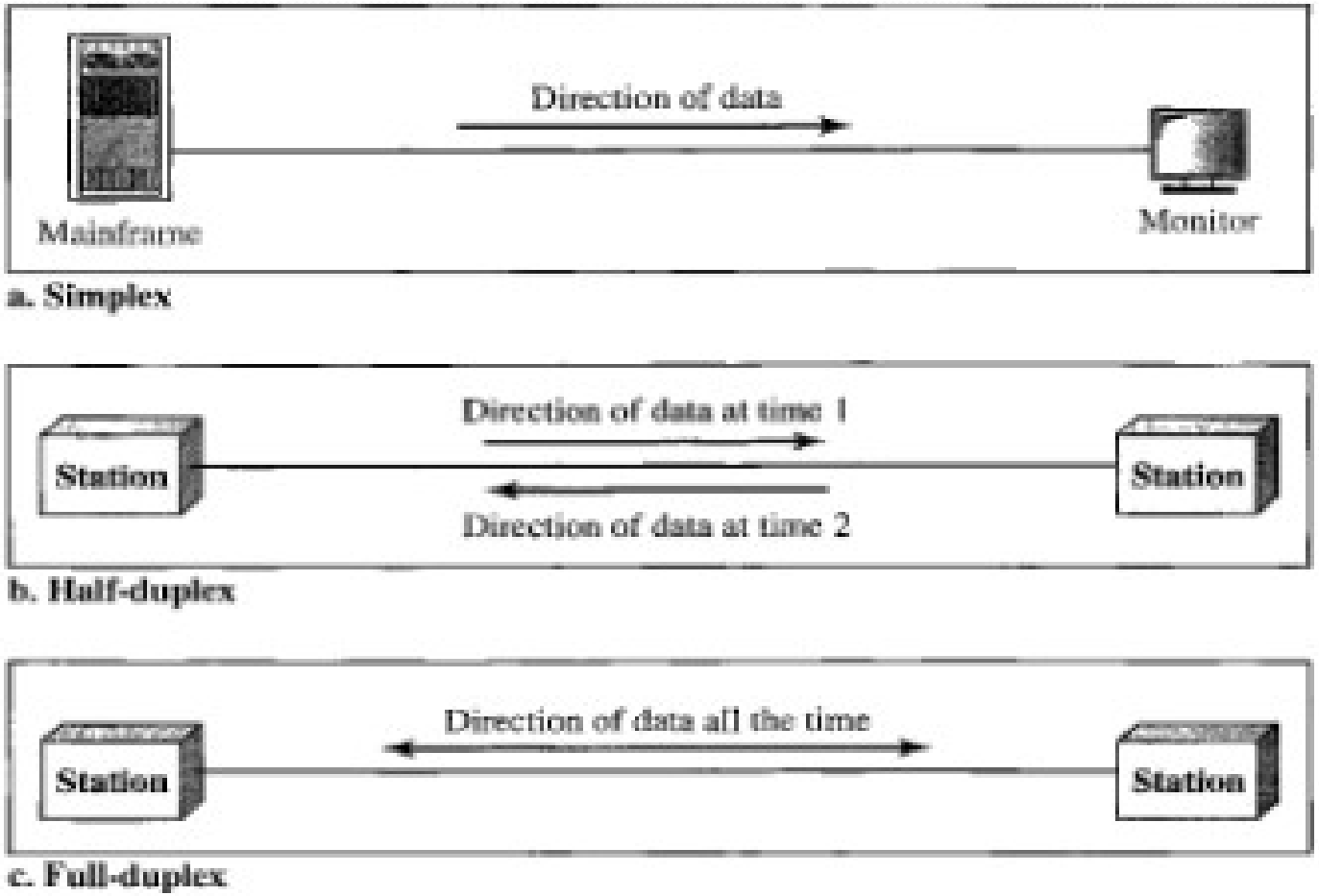
With half-duplex, communications happen in both directions, but in only one direction at a time. When two computers communicate using half-duplex, one computer sends a signal and the other receives; then, at some point, they switch sending and receiving roles. For example, push-to-talk technology (**walkie-talkie)**.

Data Flow (Cont.)

- **Full-duplex**

Full-duplex allows communication in both directions simultaneously. Both stations can send and receive signals at the same time. Full-duplex communications are similar to a **telephone call**, in which both people can talk simultaneously.

Data Flow


Direction of data
Mainframe
Monitor
a. Simplex
Direction of data at time 1
Station
Station
Direction of data at time 2
b. Half-duplex
Direction of data all the time
Station
Station
c. Full-duplex

Server, Workstation, and Client role in networking

- **Server**

A core component of the network, It **provides resources** to the clients on the network ("serves" them, in other words). Servers are typically powerful computers that run the software that controls and maintains the network. This software is known as the network operating system.

--A server computer provides a link to the resources necessary to perform any task.

-- for example **Print Server (**Controls and manages one or more printers for the network).

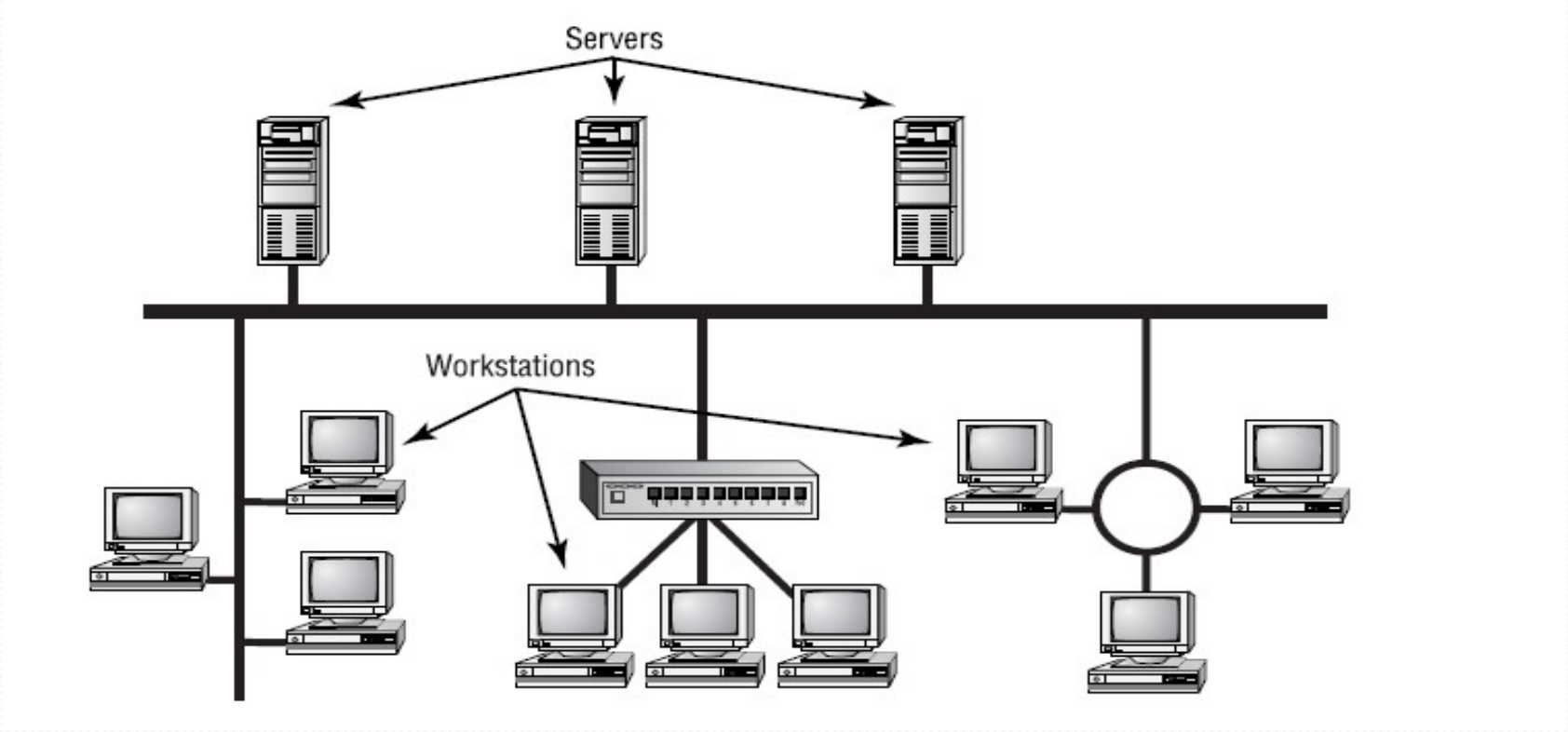
- **Client**

A ***client*** is any network entity that can **request resources** from the network. Client computers also depends primarily on the central server for processing activities.

Server, Workstation, and Client role in networking (Cont.)

- ***workstation***

Normally refers to any computer that is connected to the network and used by an individual to do work.



Network Architecture

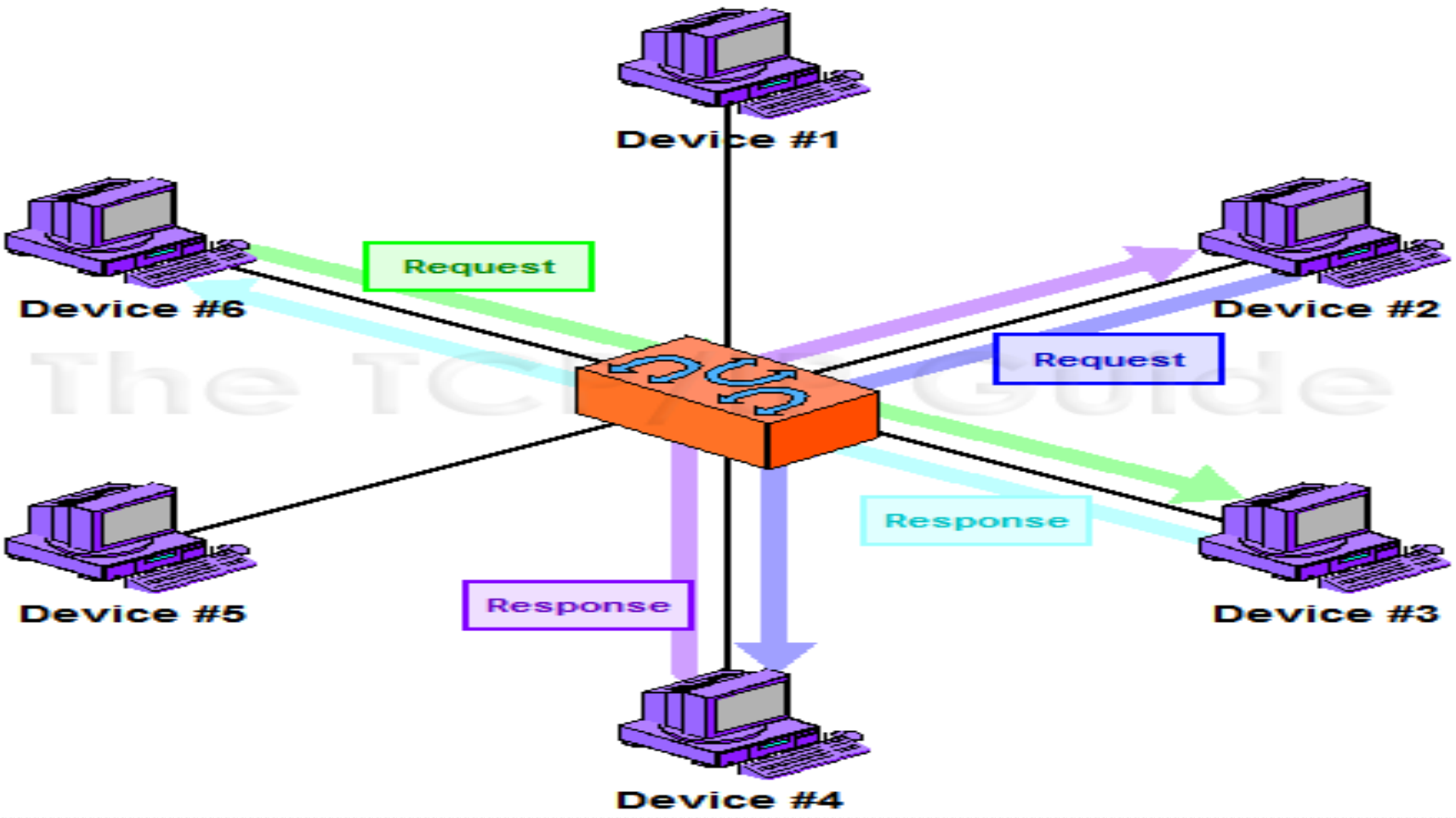
- As discuss previous, the purpose of networking is to share resources, but we don't know how this is accomplished?

-This depends on the **architecture of the network operating system software**. The two most common network types are **peer-to-peer and client/server.**

Peer-to-Peer Architecture

In peer-to-peer networks, the connected computers have no centralized authority. From an authority viewpoint, all of these computers are equal. Each computer in a peer-to-peer network can ***be both a client that requests resources and a server that provides resources.*** There is no assigned role for any particular device, and each of the devices usually runs similar software.

Peer-to-Peer Architecture

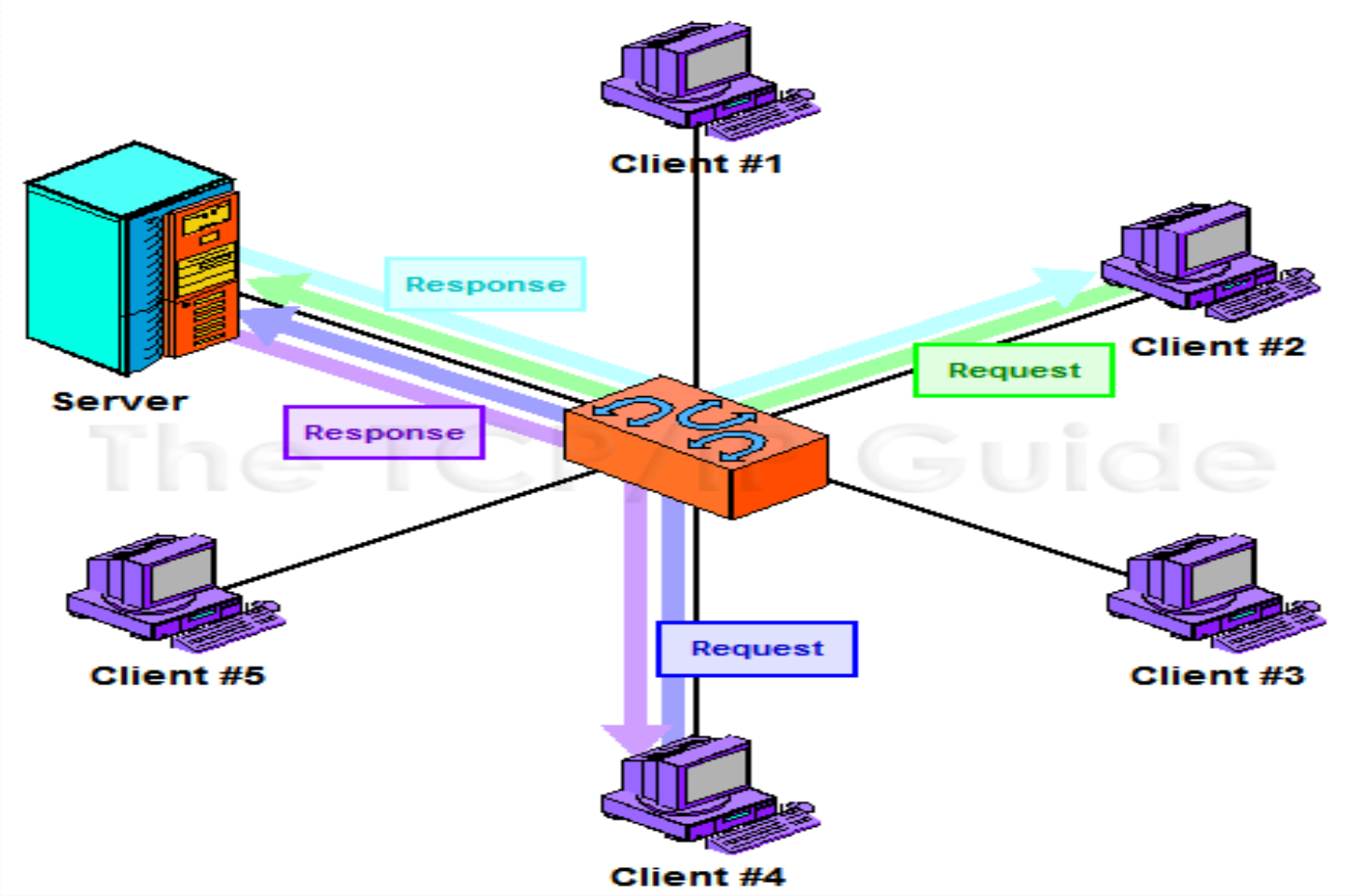


Client/Server Architecture

- **Client/Server Architecture**

In this design, 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.

Client/Server Architecture(Cont.)



Network Topology

- **A topology** is basically a map of a network. The physical topology of a network describes the layout of the cables and workstations and the location of all network components. Topologies can be either physical or logical.

  --***Physical topologies***

  The term physical topology refers to the way in which a network is laid out physically. Two or more devices connect to a link; two or more links form a topology.

  --***Logical topologies*** describe how the network messages travel.

- The cables or connections in a physical topology are often referred to as network media (or physical media).

Network Topology

- **There are four famous type of topology:**
  - **Bus** (can be both logical and physical)
  - **Star** (physical only)
  - **Ring** (can be both logical and physical)
  - **Mesh** (can be both logical and physical)

Network Topology (BUS)

- **Bus Topology**

A bus is the simplest physical topology. It consists of a **single cable** that runs to every workstation.

**This topology uses the least amount of cabling, but also covers the shortest amount of distance.

**When communicating on a network that uses a bus topology, all computers see the data on the wire.

**With a logical bus topology, messages pass through the trunk, and each workstation checks to see if the message is addressed to itself. If the address of the message matches the workstation's address, the network adapter copies the message to the card's on-board memory.

Network Topology (BUS)

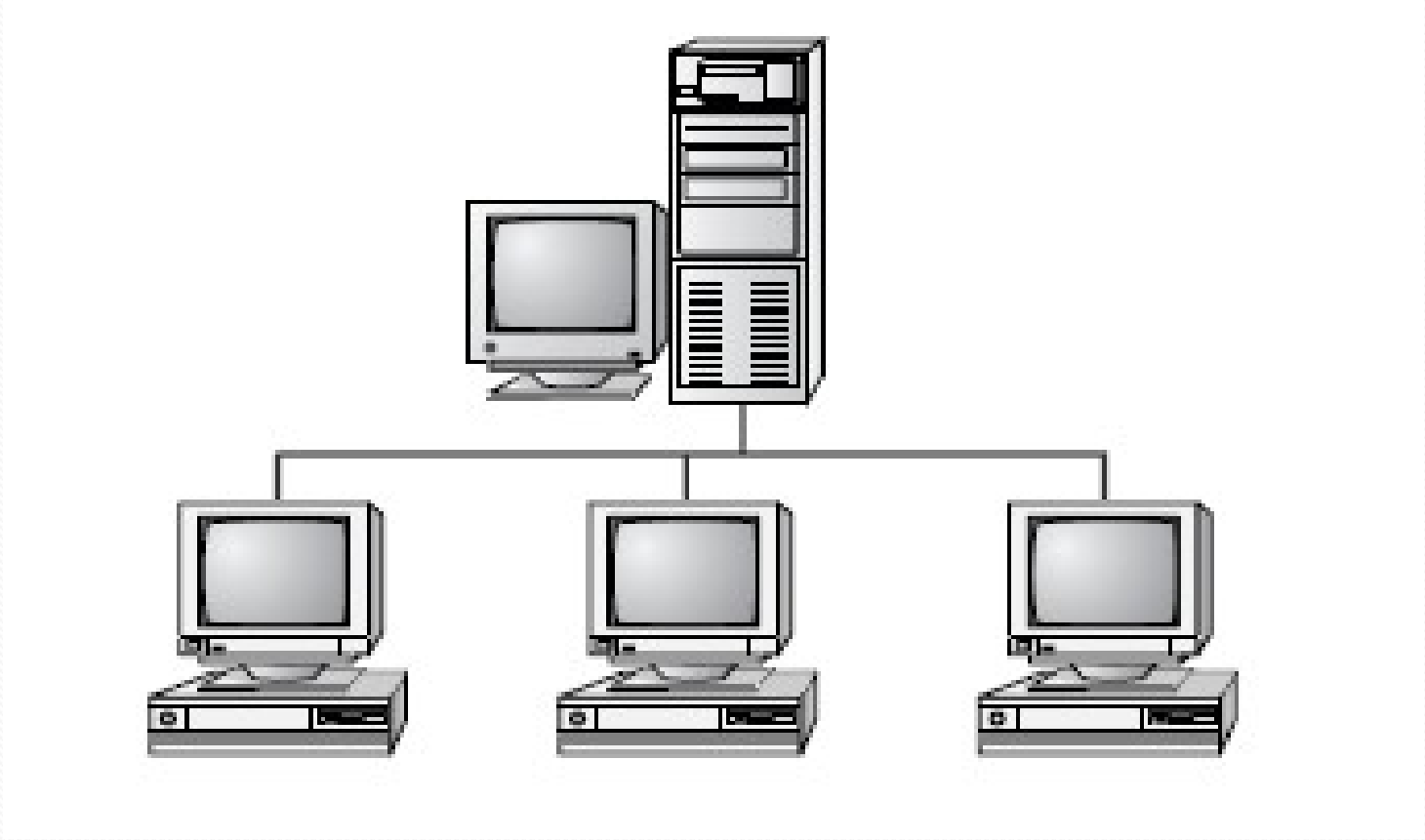
- **A bus topology has the following characteristics:**

1. Is simple to install.
2. Is relatively inexpensive.
3. Uses less cable than other topologies.

- **The following characteristics describe the conside of a bus topology:**

1. Is difficult to move and change.
2. Has little fault tolerance (a single fault can bring down the entire network).
3. Is difficult to troubleshoot.

Network Topology (BUS)



Network Topology (Star)

- **Star Topology**

A physical star topology branches each network device off a central device called a *hub*, making it very easy to add a new workstation.

--Star topologies are easy to install. A cable is run from each workstation to the hub. The hub is placed in a central location in the office.

--Star topologies are more expensive to install than bus networks, because there are several more cables that need to be installed, plus the cost of the hubs that are needed.

Network Topology (Star)

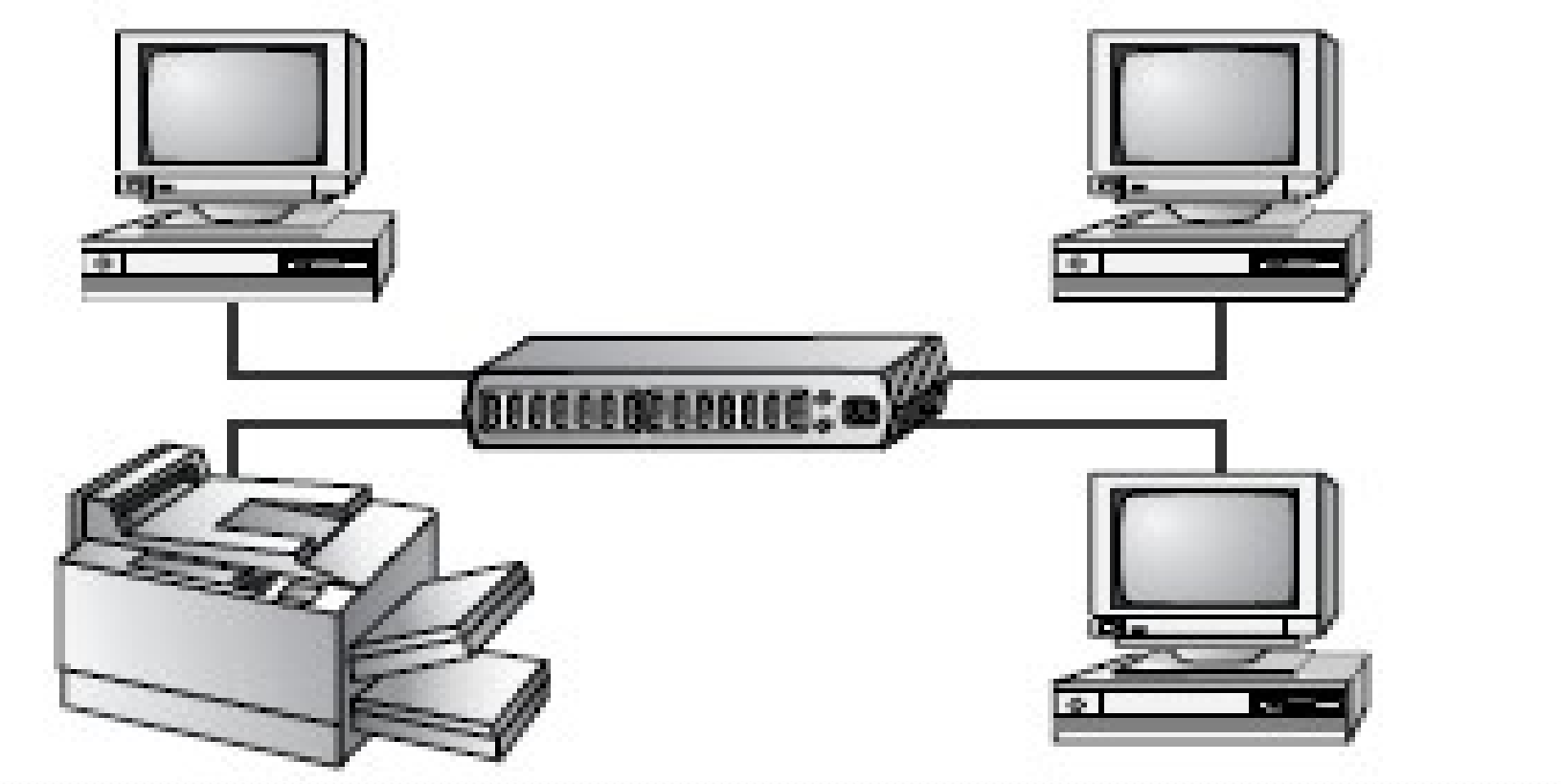
- **The star topology has advantages:**

1. New stations can be added easily and quickly.
2. A single cable failure won't bring down the entire network.
3. It is relatively easy to troubleshoot.

- **The disadvantages of a star topology include the following:**

1. Total installation cost can be higher because of the larger number of cables, but prices are constantly becoming more and more competitive.
2. It has a single point of failure (the hub, or other central device).

Network Topology (Star)



Network Topology (Ring)

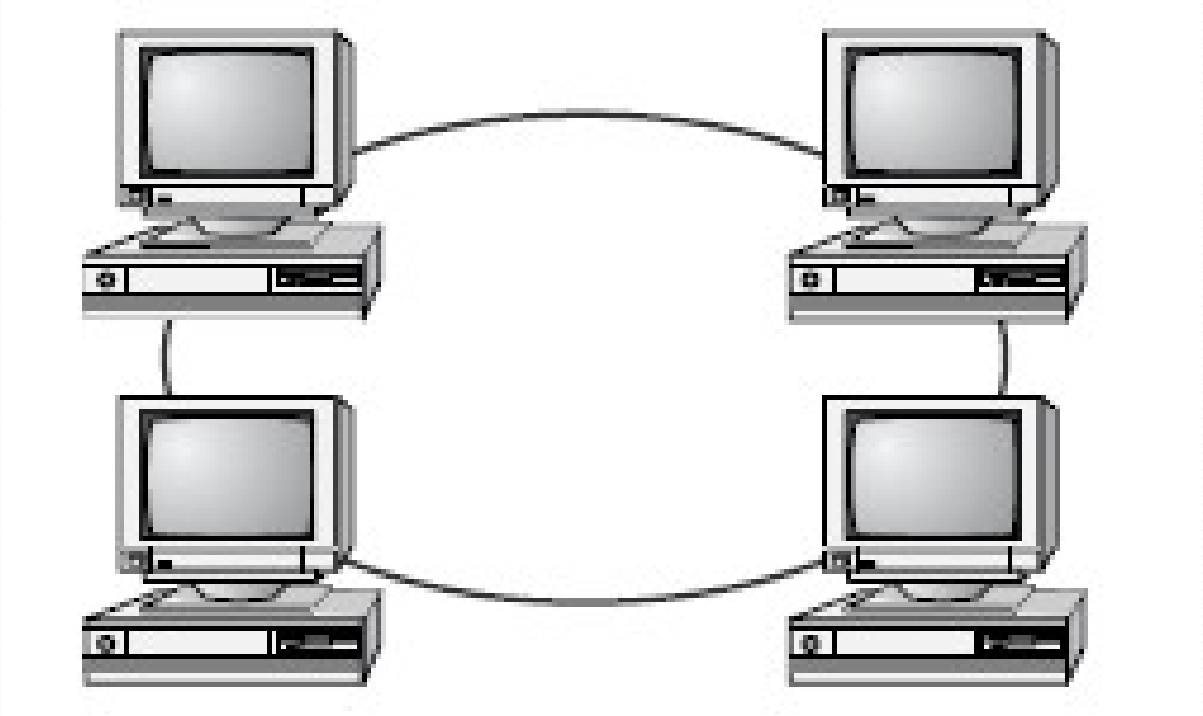
- **Ring Topology**

In this topology, computer is connected directly to two other computers in the network. Data moves down a one-way path from one computer to another. Each entity participating in the ring reads a message, then regenerates it and hands it to its neighbor on a different network cable.

➢ **A ring topology has the following characteristics:**

1. Expensive, because multiple cables are needed for each workstation.
2. The ring makes it difficult to add or remove new computers.
3. Difficult to reconfigure(the ring topology network will go down if one entity is removed from the ring.).
4. Not fault tolerant. A single cable fault can bring down the entire network.
5. The physical ring topology is seldom used.

Network Topology (Ring)



Network Topology(Mesh)

- The *mesh topology* is the simplest **logical topology** in terms of data flow, but it is the most complex in terms of physical design.

In this **physical topology**, each device is connected to every other device This topology is rarely found in **LAN**s, mainly because of the complexity of the cabling.

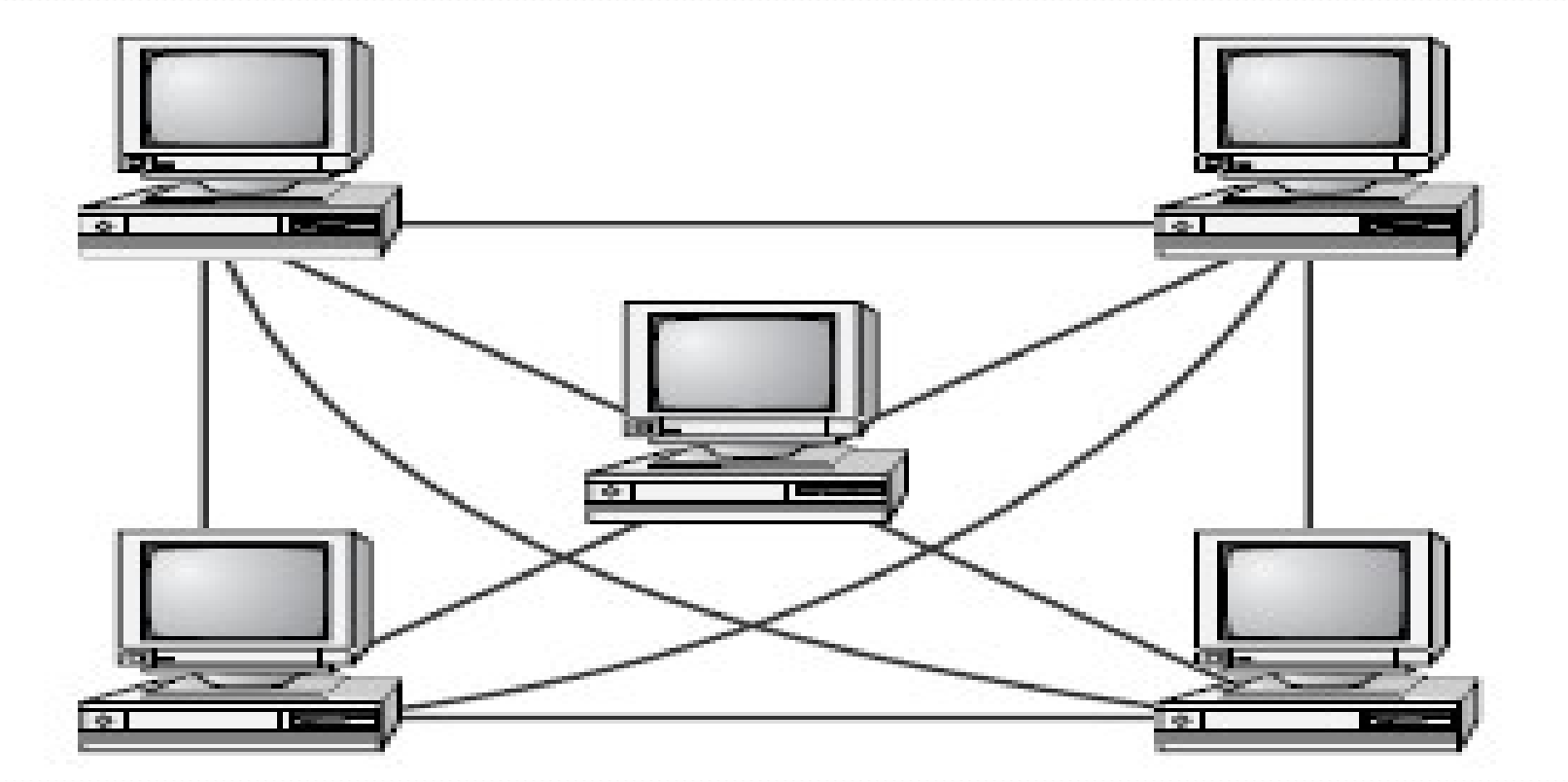
If there are *n* computers, there will be (*n* * (*n*–1)) / 2 cables in the network. For example, if you have five computers in a mesh network, it will use 5 * (5 – 1) / 2, which equals 10 cables. This complexity is compounded when you add another workstation.

For example, your five-computer, 10-cable network will jump to 15 cables just by adding one more computer. Imagine how the person doing the cabling would feel if you told them you had to cable 50 computers in a mesh network —they'd have to come up with 50 × (50 – 1) ÷ 2 = 1225 cables!

Network Topology (Mesh)

- Because of its **design**, the physical mesh topology is very expensive to install and maintain.
- Cables must be run from each device to every other device. The advantage you gain from it is its high fault tolerance.
- With a logical mesh topology, however, there will always be a way of getting the data from source to destination. It may not be able to take the direct route, but it can take an alternate, indirect route. It is for this reason that the mesh topology is still found in WANs to connect multiple sites across WAN links. It uses devices called *routers* to search multiple routes through the mesh and determine the best path. However, the mesh topology does become inefficient with five or more entities.

Network Topology (Mesh)



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