11

NETWORK TOPOLOGIES

Unit Structure

11.0 OBJECTIVES

- To understand various network strategies and topologies, you will:
- Examine three common strategies used to connect nodes on a network.
- Explore network processing strategies and establish the differences between centralized and distributed processing.
- Identify and compare three common network classifications.
- Identify and define three common network topologies.

11.1 INTRODUCTION

This chapter presents an outline on Network topology is the layout pattern of interconnections of the various elements (links, nodes, etc.) of a computer or biological network. Network topologies may be physical or logical.

Physical topology refers to the physical design of a network including the devices, location and cable installation. Logical topology refers to how data is actually transferred in a network as opposed to its physical design. In general physical topology relates to a core network whereas logical topology relates to basic network. This chapter also presents an insight into the various networking strategies and the platform needed for networking.

11.2 AN OVERVIEW OF NETWORK

A network consists of two or more computers that are linked in order to share resources (such as printers and CDs), exchange files, or allow electronic communications. The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams.

Two very common types of networks include:

- Local Area Network (LAN)
- Wide Area Network (WAN)

You may also see references to a Metropolitan Area Networks (MAN), a Wireless LAN (WLAN), or a Wireless WAN (WWAN).

11.3 WHAT IS A NETWORK TYPE

11.3.1 Local Area Network

A Local Area Network (LAN) is a network that is confined to a relatively small area. It is generally limited to a geographic area such as a writing lab, school, or building.

Computers connected to a network are broadly categorized as servers or workstations. Servers are generally not used by humans directly, but rather run continuously to provide "services" to the other computers (and their human users) on the network. Services provided can include printing and faxing, software hosting, file storage and sharing, messaging, data storage and retrieval, complete access control (security) for the network's resources, and many others.

Workstations are called such because they typically do have a human user which interacts with the network through them. Workstations were traditionally considered a desktop, consisting of a computer, keyboard, display, and mouse, or a laptop, with with integrated keyboard, display, and touchpad. With the advent of the tablet computer, and the touch screen devices such as iPad and iPhone, our definition of workstation is quickly evolving to include those devices, because of their ability to interact with the network and utilize network services.

Servers tend to be more powerful than workstations, although configurations are guided by needs. For example, a group of servers might be located in a secure area, away from humans, and only accessed through the network. In such cases, it would be common for the servers to operate without a dedicated display or keyboard. However, the size and speed of the server's processor(s), hard drive, and main memory might add dramatically to the cost of the system. On the other hand, a workstation might not need as much storage or working memory, but might require an expensive display to accommodate the needs of its user. Every computer on a network should be appropriately configured for its use.

11.3.2 Wide Area Network

Wide Area Networks (WANs) connect networks in larger geographic areas, such as Maharashtra, India, or the world. Dedicated transoceanic cabling or satellite uplinks may be used to connect this type of global network.

Using a WAN, schools in Maharashtra can communicate with places like Tokyo in a matter of seconds, without paying enormous phone bills. Two users a half-world apart with workstations equipped with microphones and a webcams might teleconference in real time. A WAN is complicated. It uses multiplexers, bridges, and routers to connect local and metropolitan networks to global communications networks like the Internet. To users, however, a WAN will not appear to be much different than a LAN.

11.4Comparing types of network coverage

The table below compares the three types of networks:

LAN	MAN	WAN
Relatively small.	Can incorporate multiple LANs.	Uses data transmission networks to incorporate LANs and MANs.
Contained within a single building or campus.	Contained within a single city or metropolitan area.	Essentially unlimited geographic area.
Generally inexpensive to implement and maintain.	Expensive to implement and maintain.	Cost varies widely, depending on how it is configured.
Typically owned privately.	Typically owned by private providers.	

11.5 AN ILLUSTRATED EXAMPLE OF A UNIVERSITY NETWORK

Advantages of Installing a Network

- *User access control.*
  Modern networks almost always have one or more servers which allows centralized management for users and for network resources to which they have access. User credentials on a privately-owned and operated network may be as simple as a user name and password, but with ever-increasing attention to computing security issues, these servers are critical to ensuring that sensitive information is only available to authorized users.

- *Information storing and sharing.*
  Computers allow users to create and manipulate information. Information takes on a life of its own on a network. The network provides both a place to store the information and mechanisms to share that information with other network users.

- *Connections.*
  Administrators, instructors, and even students and guests can be connected using the campus network.

- *Services.*
  The institution can provide services, such as registration, college directories, course schedules, access to research, and email accounts, and many others. (Remember, network services are generally provided by servers).

- *Internet.*
  The institution can provide network users with access to the internet, via an internet gateway.

- *Computing resources.*
  The institution can provide access to special purpose computing devices which individual users would not normally own. For example, an institution network might have high-speed high quality printers strategically located around a campus for instructor or student use.

- *Flexible Access.*
  Institution networks allow students to access their information from connected devices throughout the school. Students can begin an assignment in their classroom, save part of it on a public access area of the network, then go to the media center after school to finish their work. Students can also work cooperatively through the network.

- *Workgroup Computing.*

Collaborative software allows many users to work on a document or project concurrently. For example, educators located at various institution within a county could simultaneously contribute their ideas about new curriculum standards to the same document, spreadsheets, or website.

Disadvantages of Installing a Network

- *Expensive to Install.*
  Large campus networks can carry hefty price tags. Cabling, network cards, routers, bridges, firewalls, wireless access points, and software can get expensive, and the installation would certainly require the services of technicians. But, with the ease of setup of home networks, a simple network with internet access can be setup for a small campus in an afternoon.

- *Requires Administrative Time.*
  Proper maintenance of a network requires considerable time and expertise. Many schools have installed a network, only to find that they did not budget for the necessary administrative support.

- *Servers Fail.*
  Although a network server is no more susceptible to failure than any other computer, when the files server "goes down" the entire network may come to a halt. Good network design practices say that critical network services (provided by servers) should be redundant on the network whenever possible.

- *Cables May Break.*
  The Topology chapter presents information about the various configurations of cables. Some of the configurations are designed to minimize the inconvenience of a broken cable; with other configurations, one broken cable can stop the entire network.

- *Security and compliance.*
  Network security is expensive. It is also very important. An institution network would possibly be subject to more

stringent security requirements than a similarly-sized corporate network, because of its likelihood of storing personal and confidential information of network users, the danger of which can be compounded if any network users are minors. A great deal of attention must be paid to network services to ensure all network content is appropriate for the network community it serves.

11.6 WHAT IS A TOPOLOGY?

A *topology* is a description of the layout of a specific region or area. A *network topology* is a description of the layout of the region or area covered by that network.

There are two types of connections that describe how many devices connect to a single cable or segment of transmission media. They are: point-to-point and multi-point.

Point-to-point connections provide a direct link between two devices; for example, a computer connected directly to a printer, or a modem to a mainframe.

Multi-point connections provide a link between three or more devices on a network. All computer networks rely upon point-to-point and multi-point connections.

11.6.1 The Technical Connotation of Topology

The virtual shape or structure of a network is referred as topology.

The pattern or layout of interconnections of different elements or nodes of a computer network is a network topology that might be logical or physical.

However, the complete physical structure of the cable (or transmission media) is called the *physical topology*. The physical topology of a network refers to the configuration of cables, computers, and other peripherals.

The way data flows through the network (or transmission media) is called the *logical topology*. A logical topology is the method used to pass information between workstations.

11.6.2What are the Basic Types of Topology?

There are seven basic topologies in the study of network topology:

1. Point-to-point topology,
2. Bus (point-to-multipoint) topology,
3. Ring topology,
4. Star topology,
5. Hybrid topology,
6. Mesh topology and
7. Tree topology.

The interconnections between computers whether logical or physical are the foundation of this classification.

Logical topology is the way a computer in a given network transmits information, not the way it looks or connected, along with the varying speeds of cables used from one network to another.

On the other hand the **physical topology** is affected by a number of factors:

- Troubleshooting technique,
- Installation cost,
- Office layout and
- Cables' types.

The physical topology is figured out on the basis of a network's capability to access media and devices, the fault tolerance desired and the cost of telecommunications circuits.

The classification of networks by the virtue of their physical span is as follows: Local Area Networks (LAN), Wide Area Internetworks (WAN) and Metropolitan Area Networks or campus or building internetworks.

11.6.3 How Is the Physical Topology Classified?

- **Point-to-Point Network Topology**

It is the basic model of typical telephony. The simplest topology is a permanent connection between two points. The value

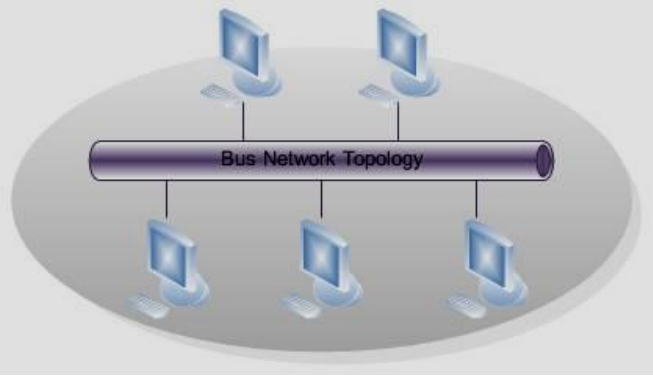
of a demanding point-to-point network is proportionate to the number of subscribers' potential pairs. It is possible to establish a permanent circuit within many switched telecommunication systems: the telephone present in a lobby would always connect to the same port, no matter what number is being dialed. A switch connection would save the cost between two points where the resources could be released when no longer required.

- **Bus Network Topology**

LANs that make use of bus topology connects each node to a single cable. Some connector connects each computer or server to the bus cable. For avoiding the bouncing of signal a terminator is used at each end of the bus cable. The source transmits a signal that travels in both directions and passes all machines unless it finds the system with IP address, the intended recipient. The data is ignored in case the address is unmatched. The installation of one cable makes bus topology an inexpensive solution as compared to other topologies; however the maintenance cost is high. If the cable is broken all systems would collapse.

- **Linear Bus:** If all network nodes are connected to a combine transmission medium that has two endpoints the Bus is Linear. The data transmitted between these nodes is transmitted over the combine medium and received by all nodes simultaneously.

- **Distributed Bus:** If all network nodes are connected to a combine transmission medium that has more than two endpoints created by branching the main section of the transmitting medium.



A linear bus topology consists of a main run of cable with a terminator at each end (See fig. 1). All nodes (file server, workstations, and peripherals) are connected to the linear cable. *A bus topology* uses one long cable (backbone) to which network

devices are either directly attached or are attached by using short drop cables. Because all workstations share this bus, a workstation checks for any information that might be coming down the backbone before sending their messages. All messages pass the other workstations on the way to their destinations. Each workstation then checks the address of each message to see if it matches its own. Note that bus network topologies, the backbone must be terminated at both ends to remove the signal from the wire after it has passed all devices on the network.

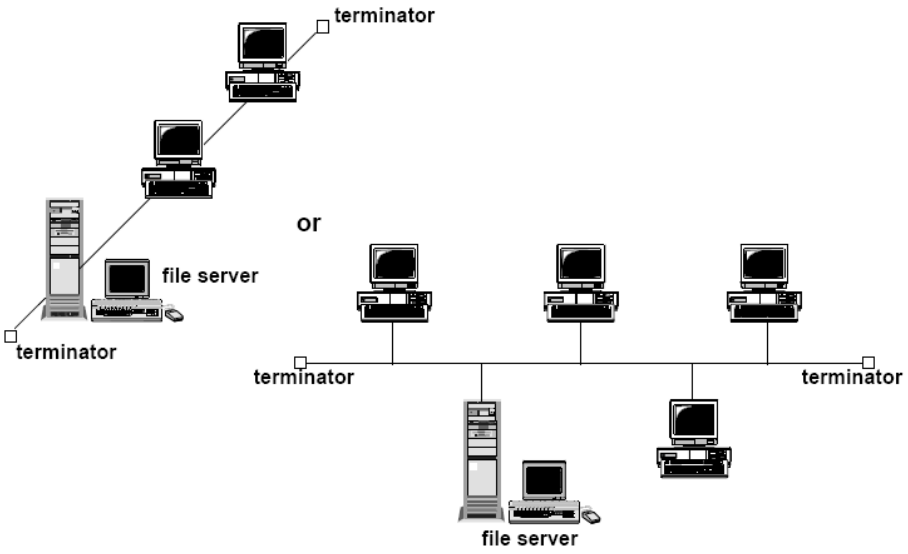


Fig. 1. Linear Bus topology

Advantages of a Linear Bus Topology

- Easy to connect a computer or peripheral to a linear bus.
- Requires less cable length than a star topology.

Disadvantages of a Linear Bus Topology

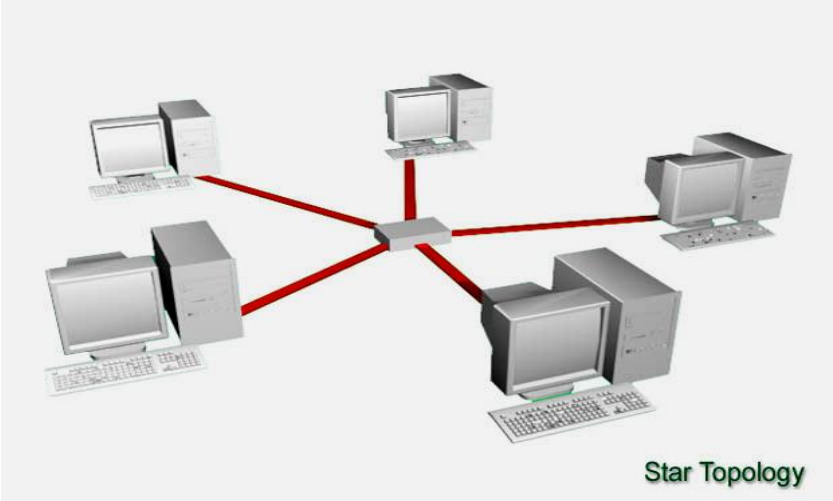
- Entire network shuts down if there is a break in the main cable.
- Terminators are required at both ends of the backbone cable.
- Difficult to identify the problem if the entire network shuts down.
- Not meant to be used as a stand-alone solution in a large building.

- **Star Network Topology**

The topology when each network host is connected to a central hub in LAN is called Star. Each node is connected to the hub with a point-to-point connection. All traffic passes through the hub that serves as a repeater or signal booster. The easiest topology to install is hailed for its simplicity to add more nodes but criticized for making hub the single point of failure. The network could be BMA (broadcast multi-access) or NBMA (non-broadcast multi-access) depending on whether the signal is automatically propagated at the hub to all spokes or individually spokes with those who are addressed.

- **Extended Star:** A network that keeps one or more than one repeaters between the central node or hub and the peripheral or the spoke node, supported by the transmitter power of the hub and beyond that supported by the standard of the physical layer of the network.

- **Distributed Star:** The topology is based on the linear connectivity that is Daisy Chained with no top or centre level connection points.



Advantages of a Star Topology

- Easy to install and wire.
- No disruptions to the network when connecting or removing devices.
- Easy to detect faults and to remove parts.

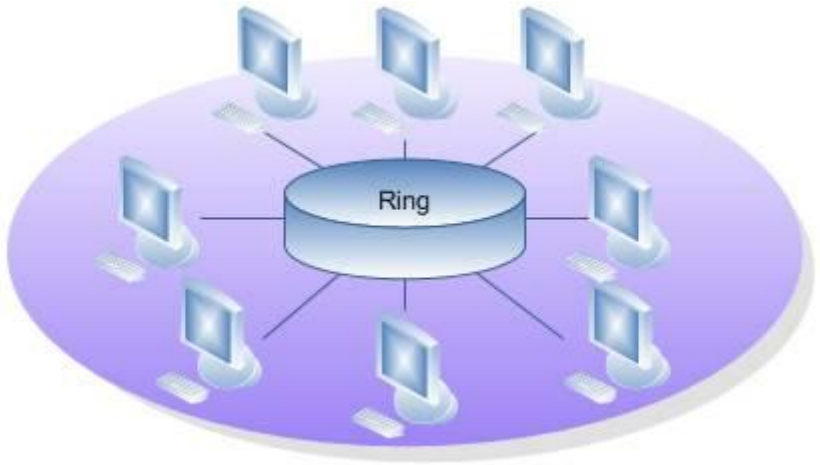
Disadvantages of a Star Topology

- Requires more cable length than a linear topology.
- If the hub, switch, or concentrator fails, nodes attached are disabled.
- More expensive than linear bus topologies because of the cost of the hubs, etc.

Ring Network Topology

Ring topology is one of the old ways of building computer network design and it is pretty much obsolete. FDDI, SONET or Token Ring technologies are used to build ring technology. It is not widely popular in terms of usability but incase if you find it anywhere it will mostly be in schools or office buildings.

Such physical setting sets up nodes in a circular manner where the data could travel in one direction where each device on the right serves as a repeater to strengthen the signal as it moves ahead.

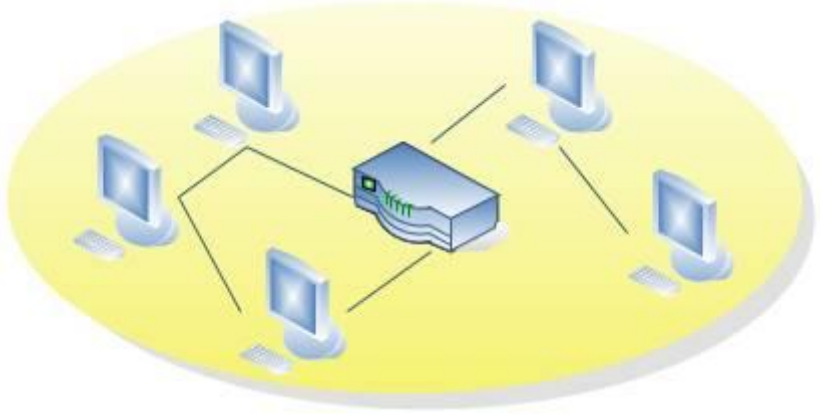


- **Mesh Network Topology**

The exponent of the number of subscribers is proportionate to the value of the fully meshed networks.

- **Fully Connected:** For practical networks such topology is too complex and costly but highly recommended for small number of interconnected nodes.

- **Partially Connected:** This set up involves the connection of some nodes to more than one nodes in the network via point-to-point link. In such connection it is possible to take advantage of the redundancy without any complexity or expense of establishing a connection between each node.

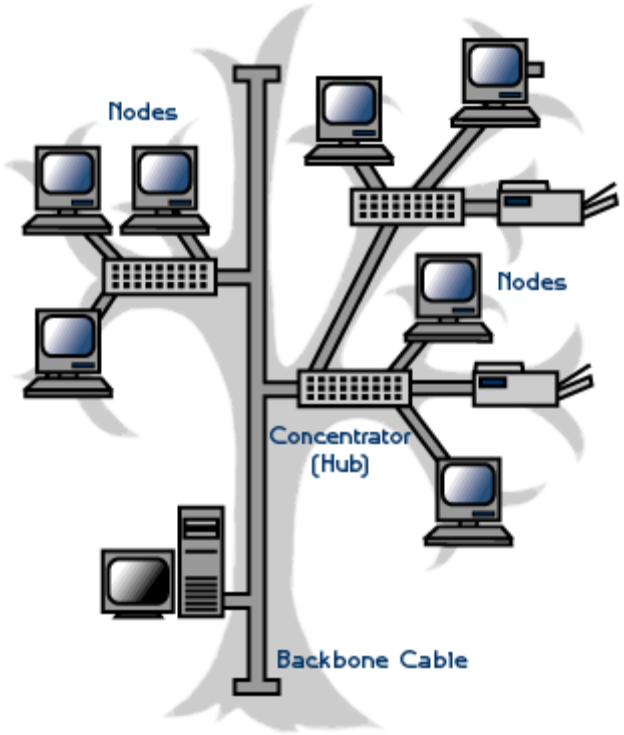


- **Hybrid Topology**

  Hybrid topologies are a combination of two or more different topologies. WANs sometimes have hybrid topologies because they connect a variety of LAN topologies. The big advantage of hybrid topologies is that they connect disparate topologies. However, the disadvantage of hybrid topologies is that they are potentially complex to establish and manage.

- **Tree Network Topology**

The top level of the hierarchy, the central root node is connected to some nodes that are a level low in the hierarchy by a point-to-point link where the second level nodes that are already connected to central root would be connected to the nodes in the third level by a point-to-point link. The central root would be the only node having no higher node in the hierarchy. The tree hierarchy is symmetrical. The BRANCHING FACTOR is the fixed number of nodes connected to the next level in the hierarchy. Such network must have at least three levels. Physical Linear Tree Topology would be of a network whose Branching Factor is one.



Advantages of a Tree Topology

- Point-to-point wiring for individual segments.
- Supported by several hardware and software venders.

Disadvantages of a Tree Topology

- Overall length of each segment is limited by the type of cabling used.
- If the backbone line breaks, the entire segment goes down.
- More difficult to configure and wire than other topologies.

Considerations When Choosing a Topology

- **Money**. A linear bus network may be the least expensive way to install a network; you do not have to purchase concentrators.

- **Length of cable needed**. The linear bus network uses shorter lengths of cable.

- **Future growth**. With a star topology, expanding a network is easily done by adding another concentrator.

- C**able type**. The most common cable in schools is unshielded twisted pair,

11.7 SUMMARY

- Knowledge of networking topologies is of core importance of computer networking design. Computer networks can only be developed using the knowledge about these topologies and decide to which topology design is best suited according to the requirement.

- A computer **network** consists of **nodes** and communication **links** whichimplement its **protocols**. It interconnects a set of **hosts** which conform to thenetwork protocols.

- A network may be classified as a **LAN**, **MAN**, or **WAN**, depending on itsgeographic spread, and as **private** or **public**, depending on its accessrestrictions.

- It may employ a **point-to-point** or a **broadcast** communication model. A point-to-point model may be based on **circuit switching** or **packetswitching**.

Exercises:

1. Classify the networks operated and/or utilized by your organization as LAN, MAN,WAN, private, public, point-to-point, broadcast, circuit-switched, or packetswitched.

2. Discuss and compare the advantages and disadvantages of circuit switching versuspacket switching. Name at least one well-known network which is based on eithertype of switching.

11.8 REVIEW QUESTION

1. What is a Network?

2. Explain Lan, Man, Wan?

3. Write a short note on Network coverage?

4. ExplainAn Illustrated Example of a University Network

5. *What is a Topology?*

6.What are the Basic Types of Topology?

7.How Is the Physical Topology Classified?

11.9 REFERENCES

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