

Module 1.1

Introduction to CN

1-1 DATA COMMUNICATIONS

*The term **telecommunication** means communication at a distance. The word **data** refers to information presented in whatever form is agreed upon by the parties creating and using the data. **Data communications** are the exchange of data between two devices via some form of transmission medium such as a wire cable.*

Effectiveness of data transfer:

- Delivery
- Accuracy
- Timeliness

Figure 1.1 Components of a data communication system

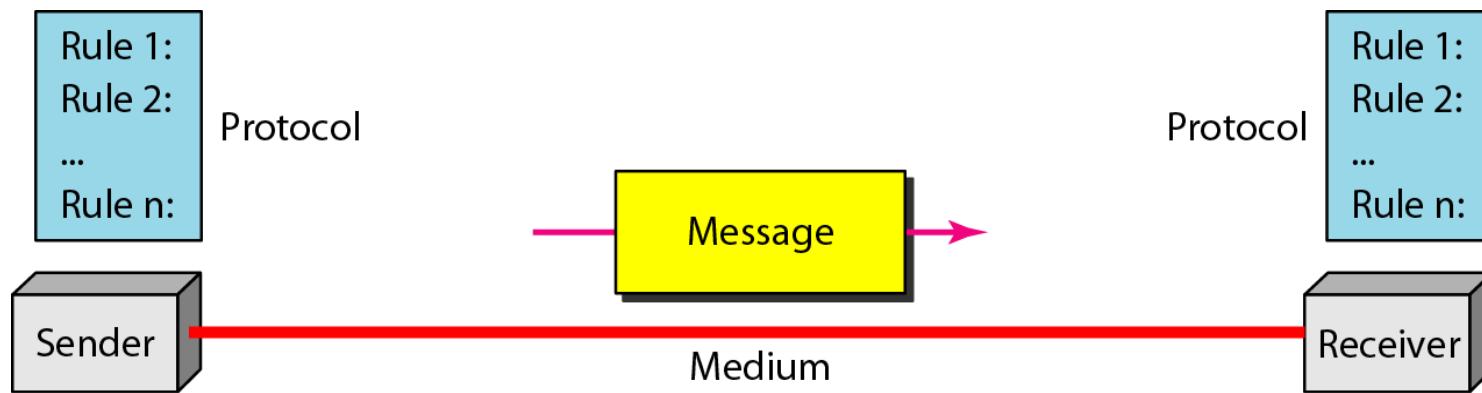
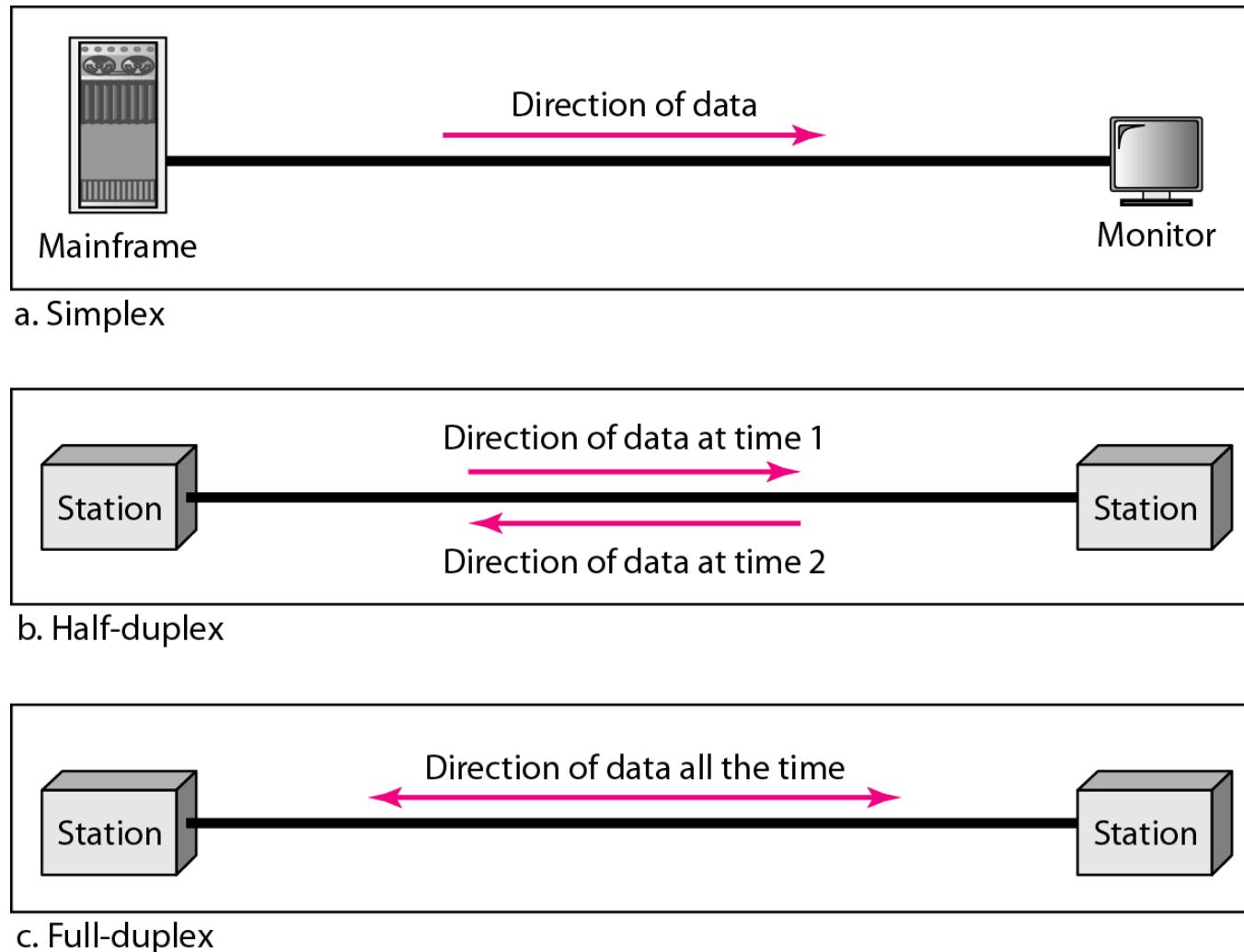


Figure 1.2 Data flow (*simplex*, *half-duplex*, and *full-duplex*)



1-2 NETWORKS

A **network** is a set of devices (often referred to as **nodes**) connected by communication **links**. A node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network. A link can be a cable, air, optical fiber, or any medium which can transport a signal carrying information.

Network Describes:

- Network Criteria
- Physical Structures
- Categories of Networks

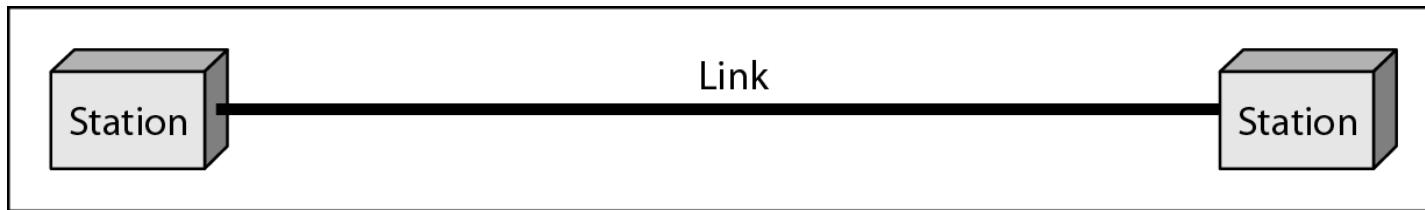
Network Criteria

- **Performance**
 - Depends on Network Elements
 - Measured in terms of Delay and Throughput
 - Transit time and response time
- **Reliability**
 - Failure rate of network components
 - Measured in terms of availability/robustness
- **Security**
 - Data protection against corruption/loss of data due to:
 - Errors
 - Malicious users

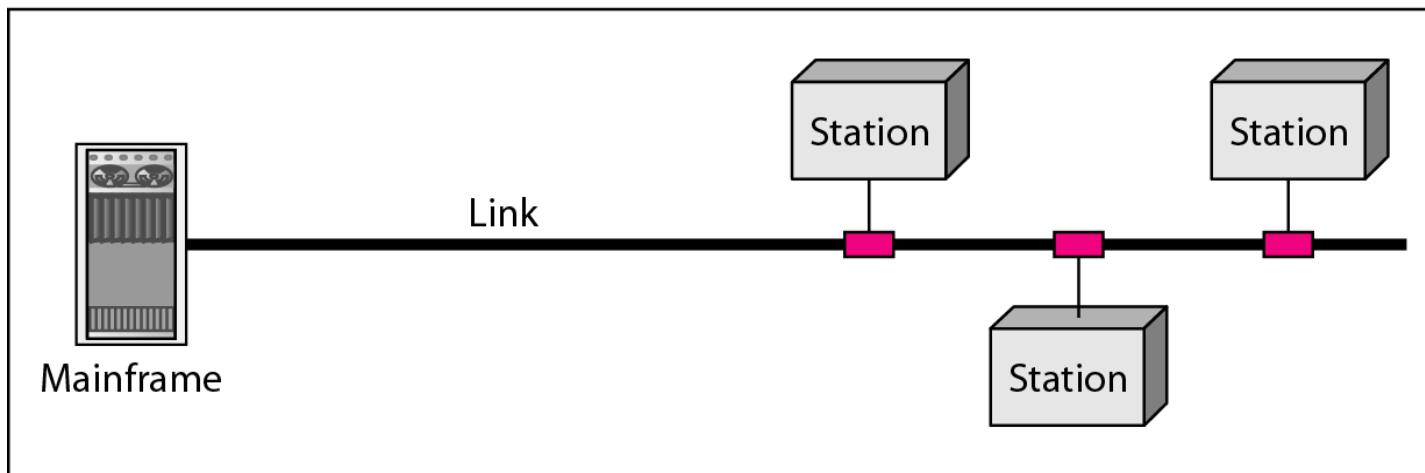
Physical Structures

- **Type of Connection**
 - Point to Point - single transmitter and receiver
 - Multipoint - multiple recipients of single transmission
- **Physical Topology**
 - Connection of devices
 - Type of transmission - unicast, multicast, broadcast

Figure 1.3 *Types of connections: point-to-point and multipoint*



a. Point-to-point



b. Multipoint

Figure 1.4 *Categories of topology*

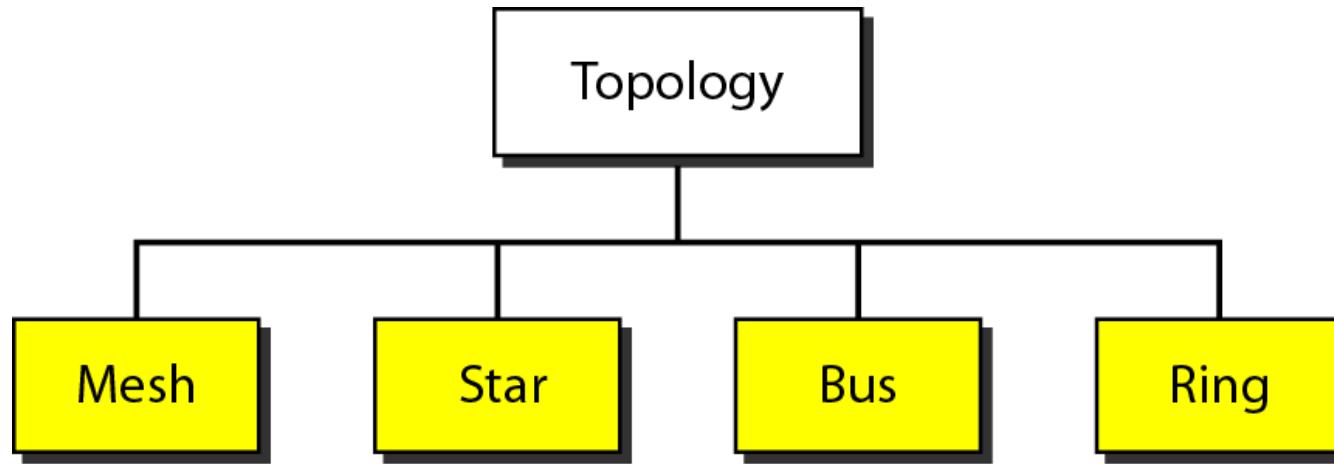
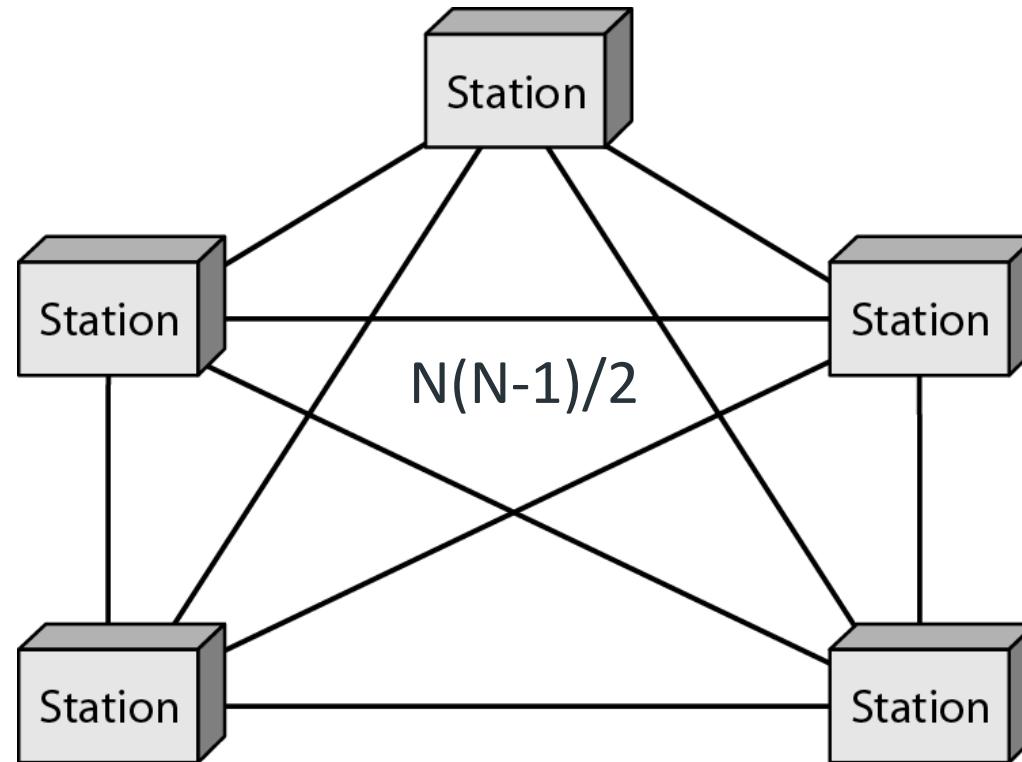


Figure 1.5 A fully connected mesh topology (five devices)



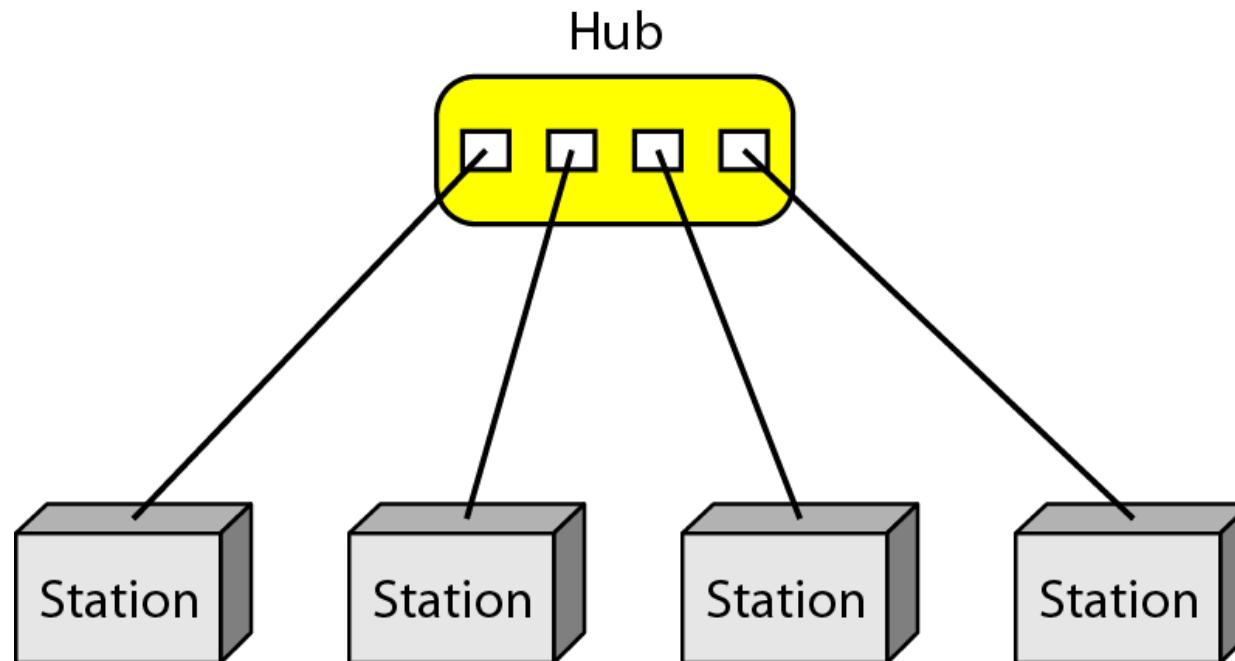
Advantages of Mesh Topology :

- Failure during a single device won't break the network.
- There is no traffic problem as there is a dedicated point to point links for every computer.
- Fault identification is straightforward.
- This topology provides multiple paths to succeed in the destination and tons of redundancy.
- It provides high privacy and security.
- Data transmission is more consistent because failure doesn't disrupt its processes.
- Adding new devices won't disrupt data transmissions.
- This topology has robust features to beat any situation.
- A mesh doesn't have a centralized authority.

Disadvantages of Mesh Topology :

- It's costly as compared to the opposite network topologies i.e. star, bus, point to point topology.
- Installation is extremely difficult in the mesh.
- Power requirement is higher as all the nodes will need to remain active all the time and share the load.
- Complex process.
- The cost to implement mesh is above other selections.
- There is a high risk of redundant connections.
- Each node requires a further utility cost to think about.
- Maintenance needs are challenging with a mesh.

Figure 1.6 *A star topology connecting four stations*



Advantages of Star Topology

- It is very reliable – if one cable or device fails then all the others will still work
- It is high-performing as no data collisions can occur
- Less expensive because each device only need one I/O port and wishes to be connected with hub with one link.
- Easier to put in
- Robust in nature
- Easy fault detection because the link are often easily identified.
- No disruptions to the network when connecting or removing devices.
- Each device requires just one port i.e. to attach to the hub.
- If N devices are connected to every other in star, then the amount of cables required to attach them is N. So, it's easy to line up.

Disadvantages of Star Topology

- Requires more cable than a linear bus .
- If the connecting network device (network switch) fails, nodes attached are disabled and can't participate in network communication.
- More expensive than linear bus topology due to the value of the connecting devices (network switches)
- If hub goes down everything goes down, none of the devices can work without hub.
- Hub requires more resources and regular maintenance because it's the central system of star .
- Extra hardware is required (hubs or switches) which adds to cost
- Performance is predicated on the one concentrator i.e. hub.

A tree topology connecting three stations

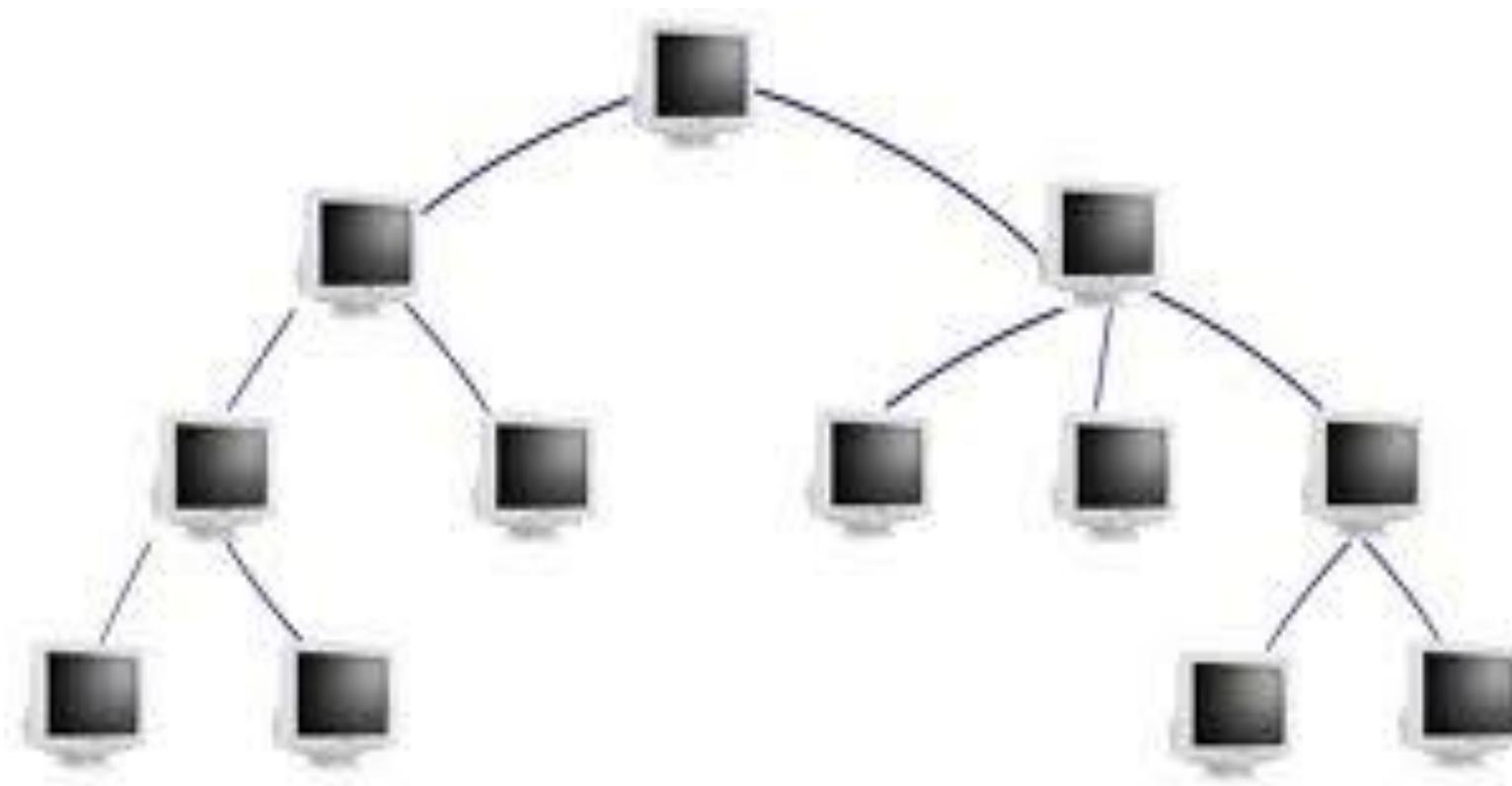
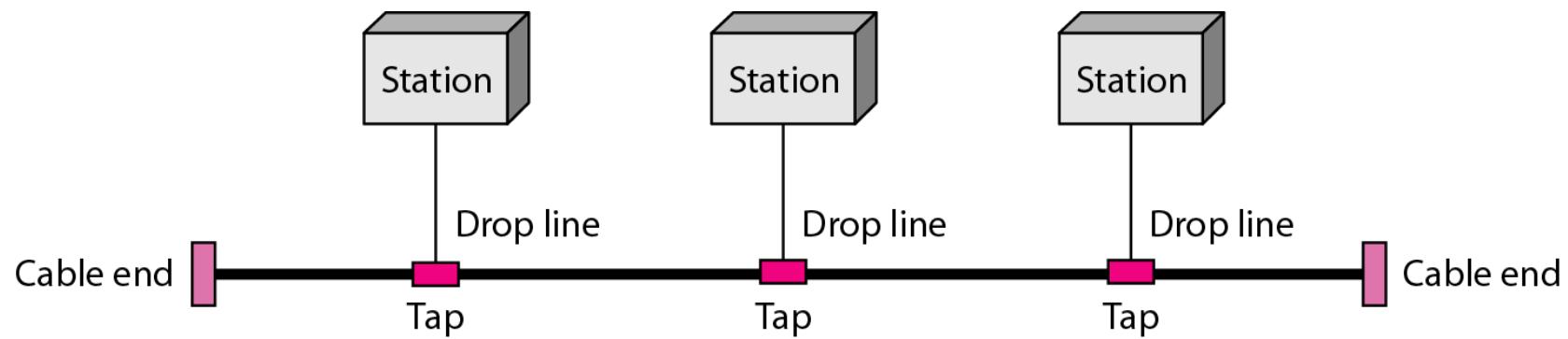


Diagram - Tree Topology

A bus topology connecting three stations



A ring topology connecting six stations

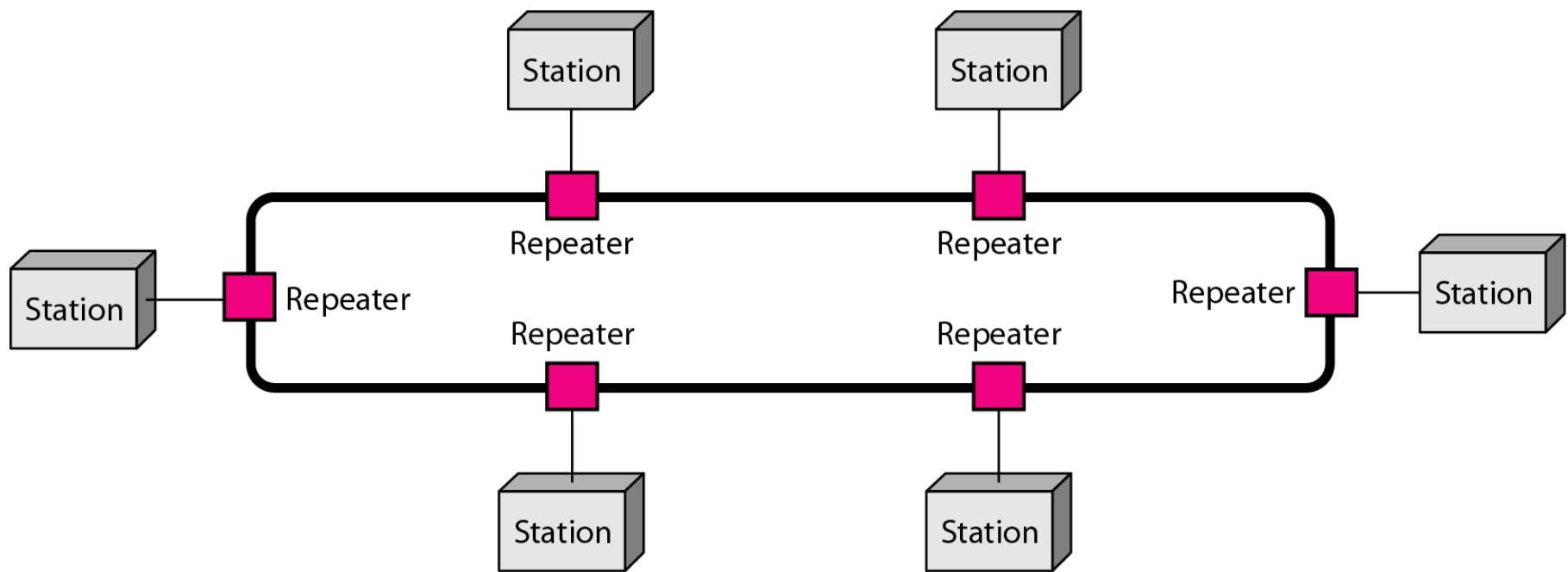
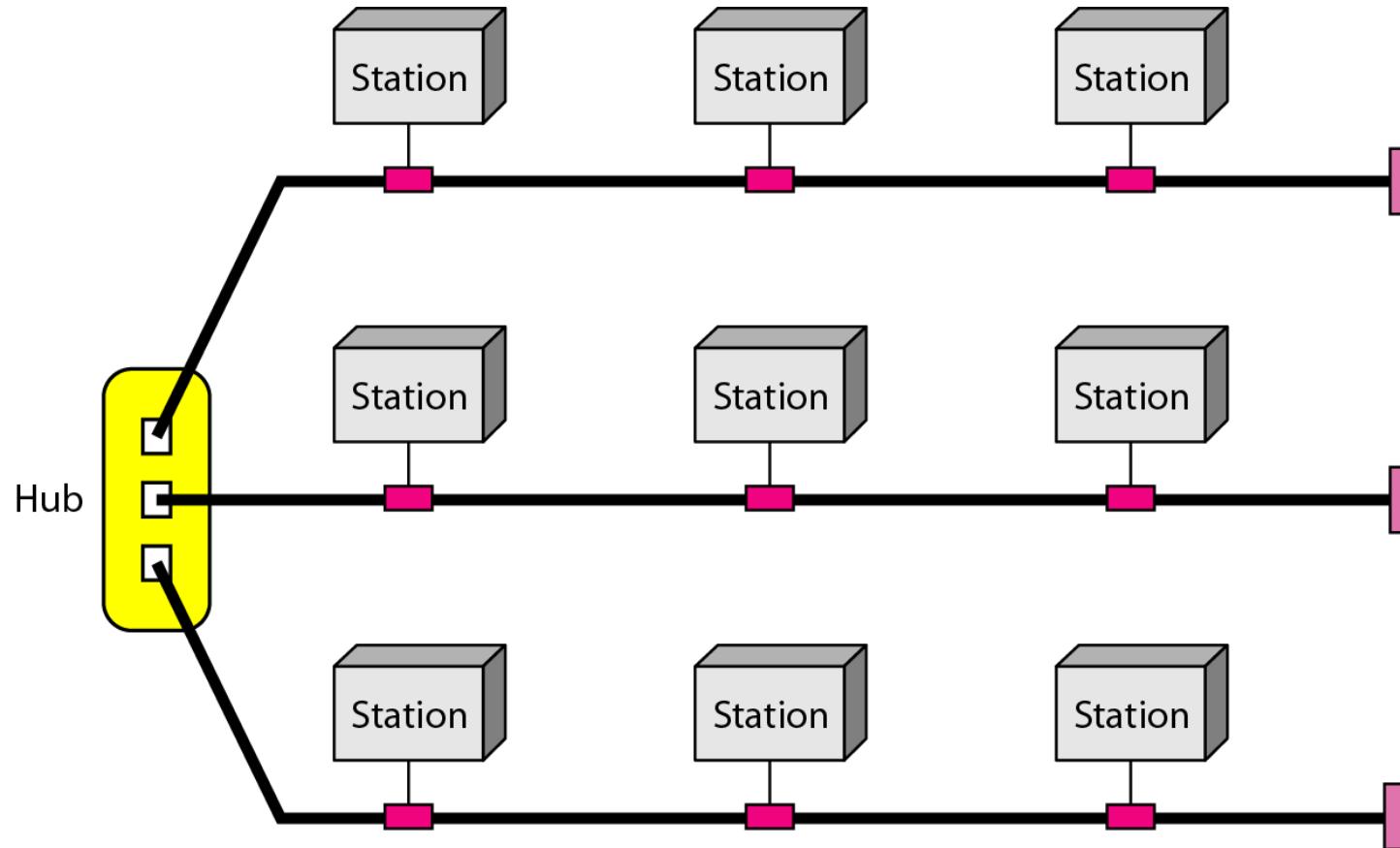


Figure 1.10 A hybrid topology: a star backbone with three bus networks



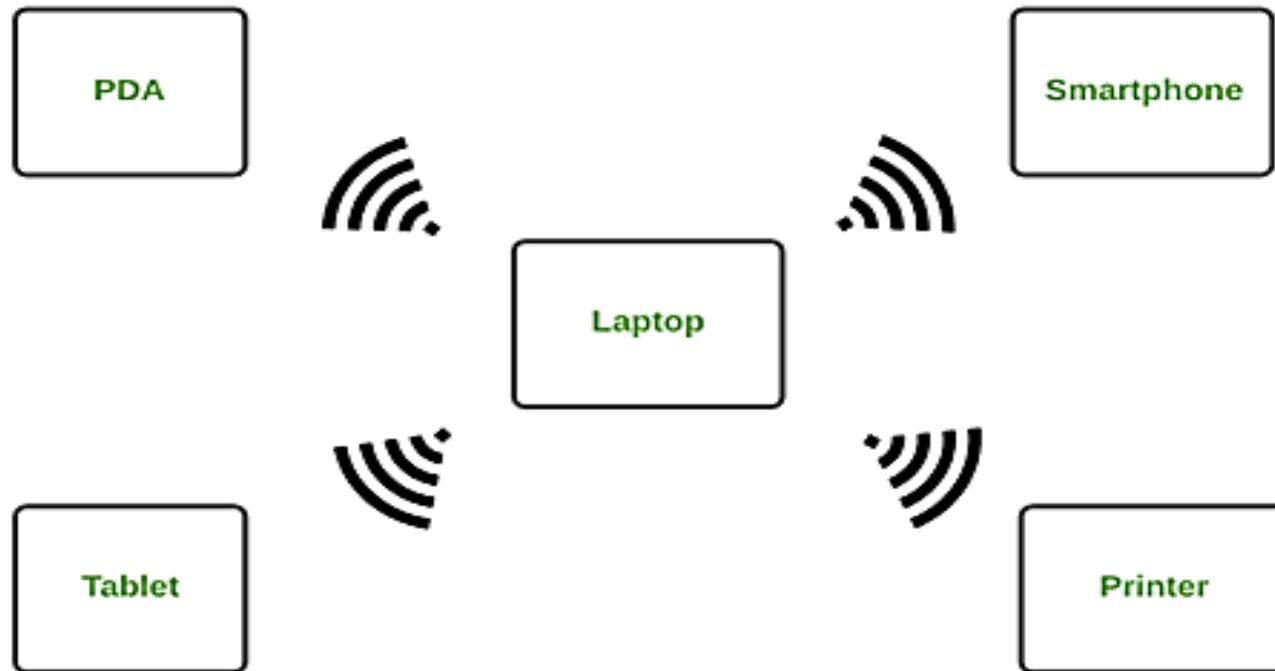
Advantage and Disadvantage

Advantages	Disadvantages
Bus topology is good for small networks	Bus topology is not suitable for detection of faults in the network nodes
Ring topology is an organised network where each node transmits data equally	In ring topology, data transfer takes place through each and every node to pass from one node to another
For heavy traffic we can use the mesh topology to transmit the data	Mesh topology required too many wirings
Star topology have centralised nature for simple operations	Setup cost of star topology is high
With the help of tree topology, we can easily identify the faults	Maintenance of tree topology is quite difficult

Types of Computer Networks

1. Personal Area Network (PAN)
2. Local Area Network (LAN)
3. Wide Area Network (WAN)
4. Wireless Local Area Network (WLAN)
5. Campus Area Network (CAN)
6. Metropolitan Area Network (MAN)
7. Storage Area Network (SAN)
8. System-Area Network (SAN)
9. Passive Optical Local Area Network (POLAN)
10. Enterprise Private Network (EPN)
11. Virtual Private Network (VPN)
12. Home Area Network (HAN)

PAN



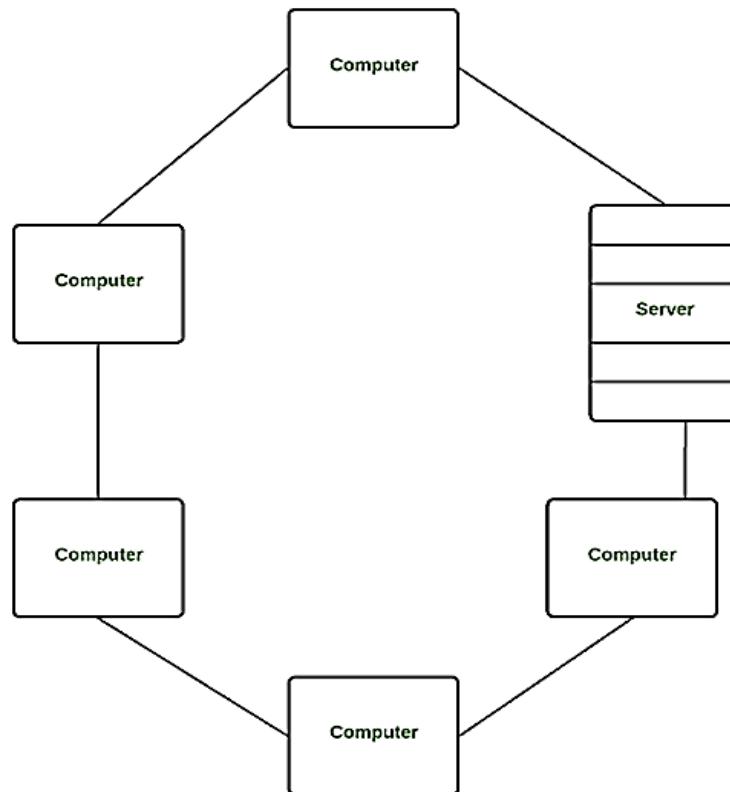
PAN is the most basic type of computer network. This network is restrained to a single person, that is, communication between the computer devices is centred only to an individual's work space. PAN offers a network range of 10 meters from a person to the device providing communication.

Examples of PAN are USB, computer, phone, tablet, printer, PDA, etc

2. Local Area Network (LAN) :

LAN is the most frequently used network. A LAN is a computer network that connects computers together through a common communication path, contained within a limited area, that is, locally. A LAN encompasses two or more computers connected over a server. The two important technologies involved in this network are Ethernet and Wi-fi.

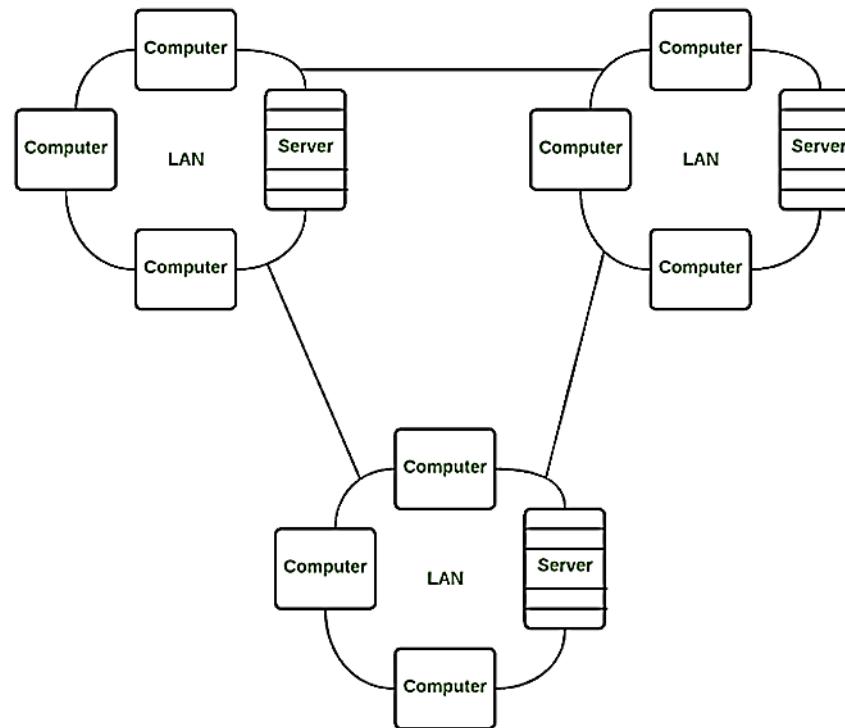
Examples of LAN are networking in a home, school, library, laboratory, college, office, etc.



3. Wide Area Network (WAN) :

WAN is a type of computer network that connects computers over a large geographical distance through a shared communication path. It is not restrained to a single location but extends over many locations. WAN can also be defined as a group of local area networks that communicate with each other.

The most common example of WAN is the Internet.

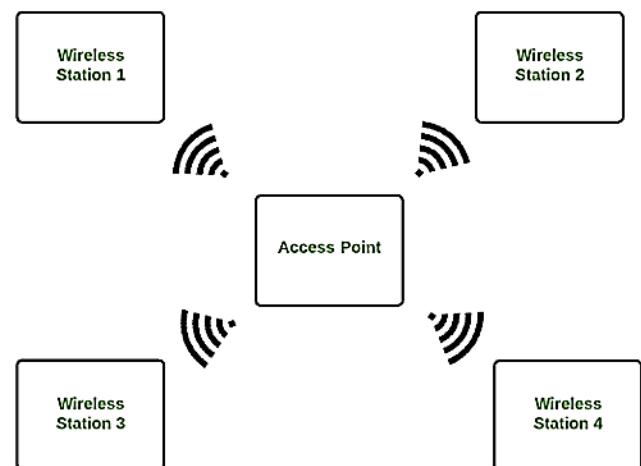


4. Wireless Local Area Network

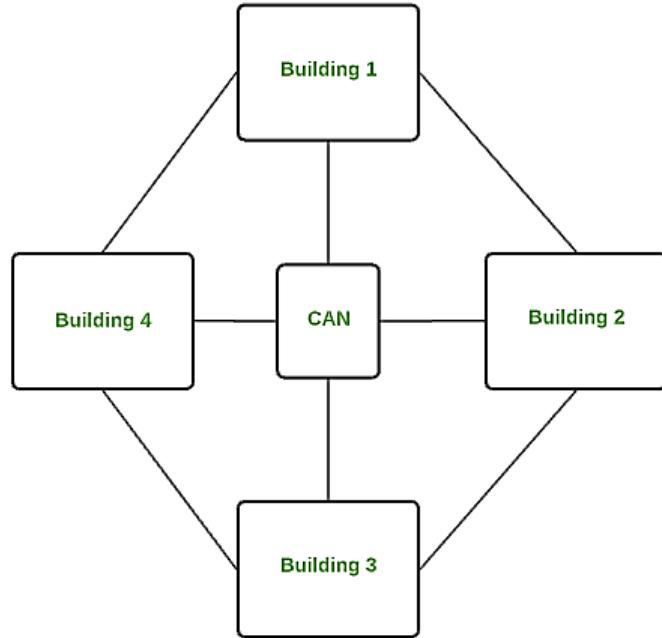
(WLAN) :

WLAN is a type of computer network that acts as a local area network but makes use of wireless network technology like Wi-Fi. This network doesn't allow devices to communicate over physical cables like in LAN but allows devices to communicate wirelessly.

The most common example of WLAN is Wi-Fi.



5- Campus area Network

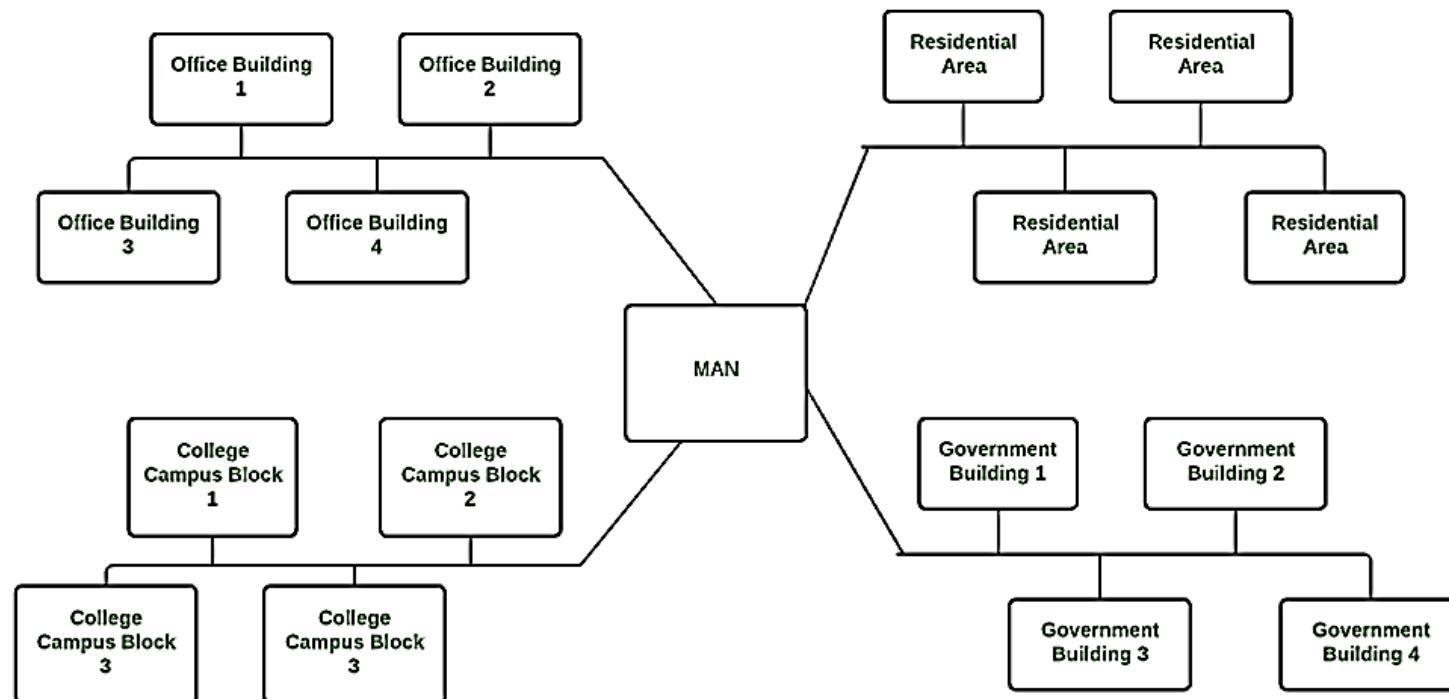


A campus area network (CAN) is a computer network that spans a limited geographic area. CANs interconnect multiple local area networks (LAN) within an educational or corporate campus.

6. Metropolitan Area Network (MAN) :

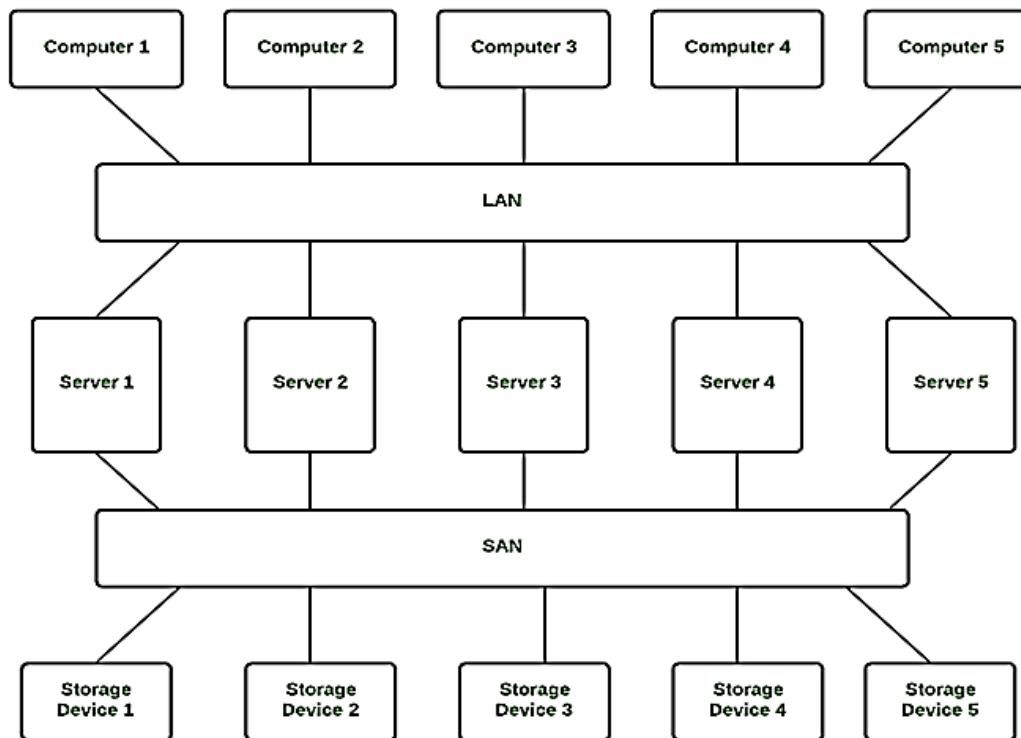
A MAN is larger than a LAN but smaller than a WAN. This is the type of computer network that connects computers over a geographical distance through a shared communication path over a city, town or metropolitan area.

Examples of MAN are networking in towns, cities, a single large city, large area within multiple buildings, etc.



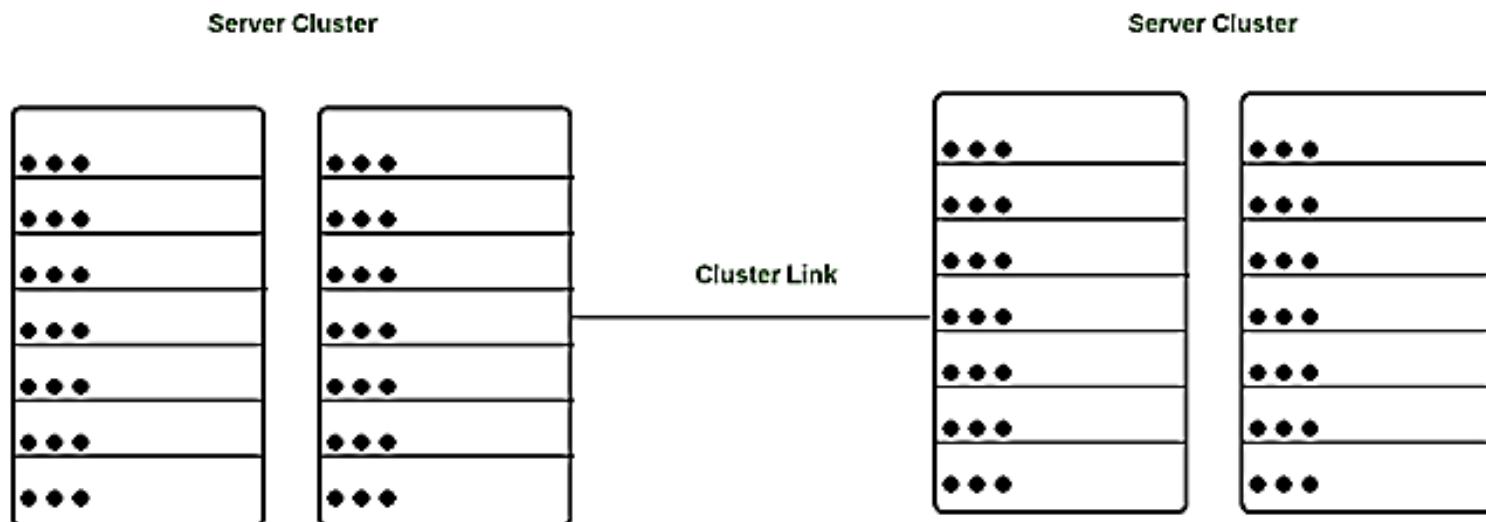
7. Storage Area Network (SAN) :

SAN is a type of computer network that is high speed and connects groups of storage devices to several servers. This network does not depend on LAN or WAN.. Instead, a SAN moves the storage resources from the network to its own high-powered network. A SAN provides access to block-level data storage. Examples of SAN are a network of disks accessed by a network of servers.



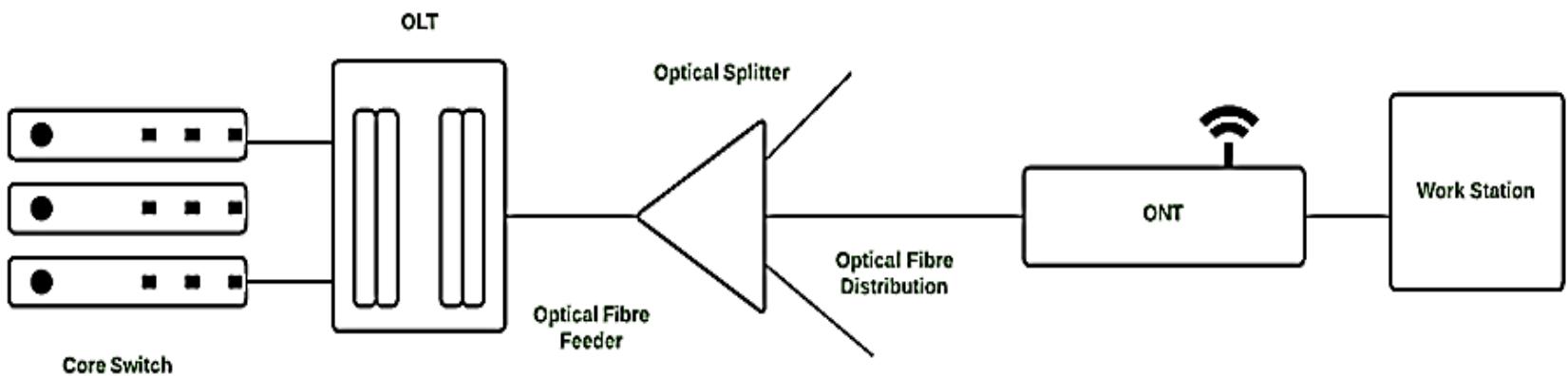
8. System Area Network (SAN) :

A SAN is a type of computer network that connects a cluster of high- performance computers. It is a connection-oriented and high bandwidth network. A SAN is a type of LAN that handles high amounts of information in large requests. This network is useful for processing applications that require high network performance. Microsoft SQL Server 2005 uses SAN through virtual interface adapter.



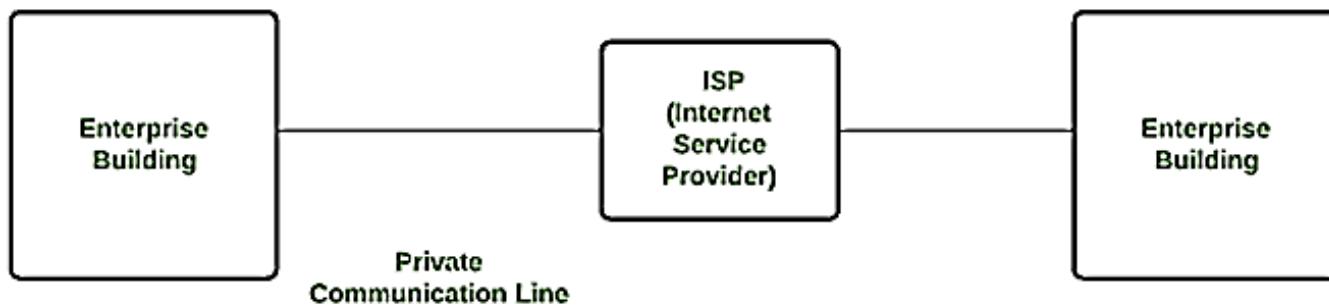
9. Passive Optical Local Area Network (POLAN) :

A POLAN is a type of computer network which is an alternative to a LAN. POLAN uses optical splitters to split an optical signal from a single strand of single mode optical fibre to multiple signals to distribute users and devices. In short, POLAN is a point to multipoint LAN architecture.



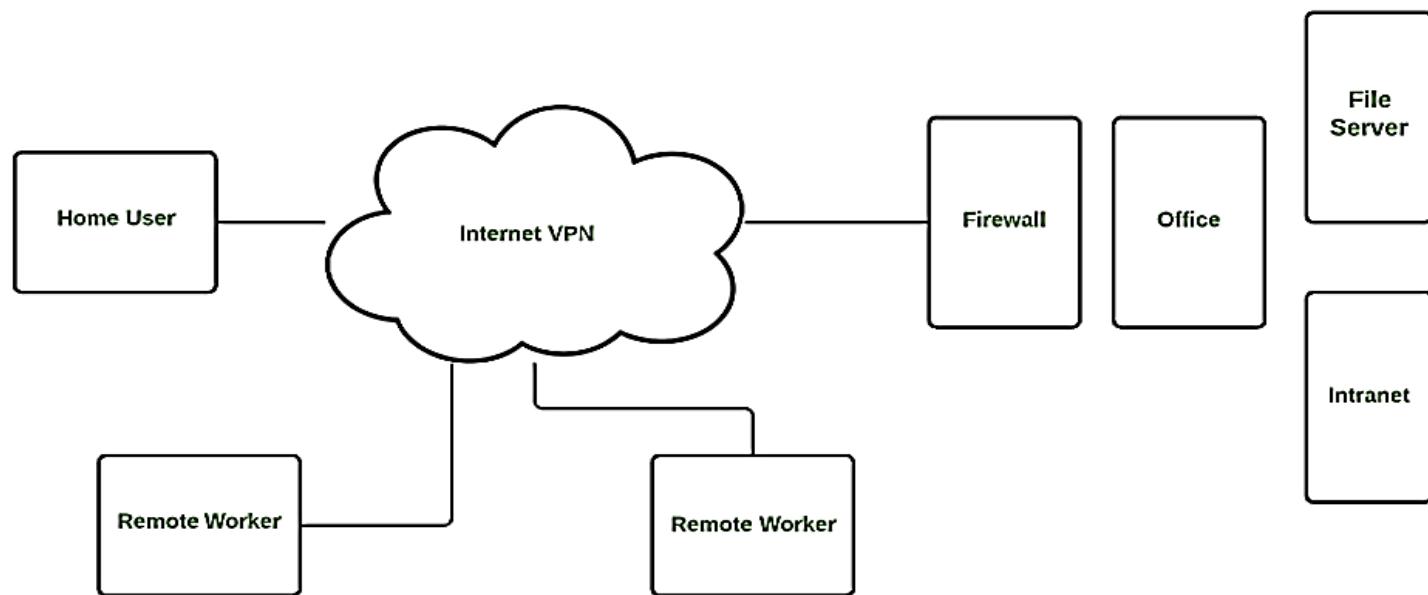
10. Enterprise Private Network (EPN) :

EPN is a type of computer network mostly used by businesses that want a secure connection over various locations to share computer resources.



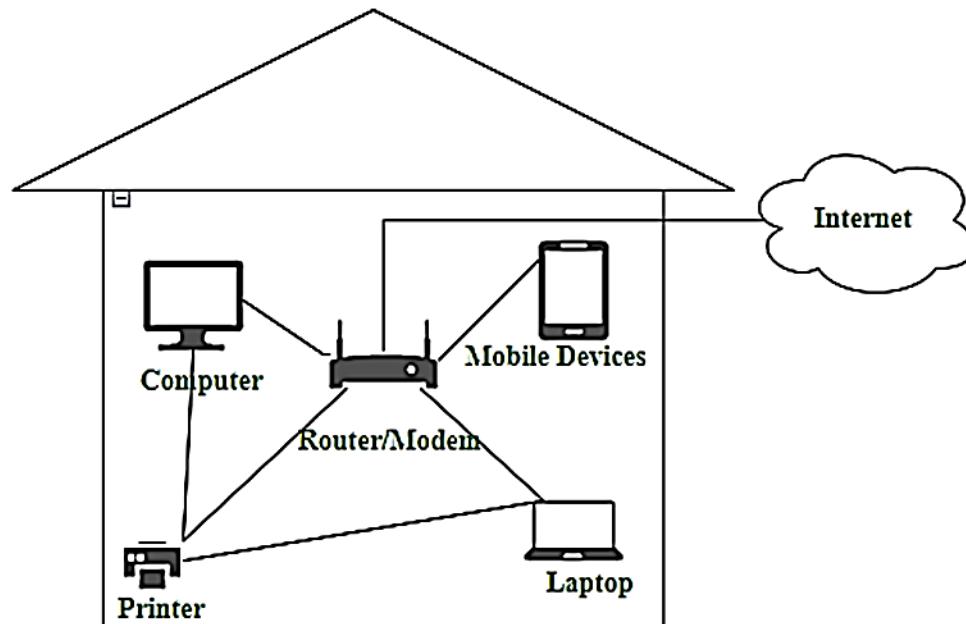
11. Virtual Private Network (VPN) :

A VPN is a type of computer network that extends a private network across the internet and lets the user send and receive data as if they were connected to a private network even though they are not. Through a virtual point-to-point connection users can access a private network remotely. VPN protects you from malicious sources by operating as a medium that gives you a protected network connection



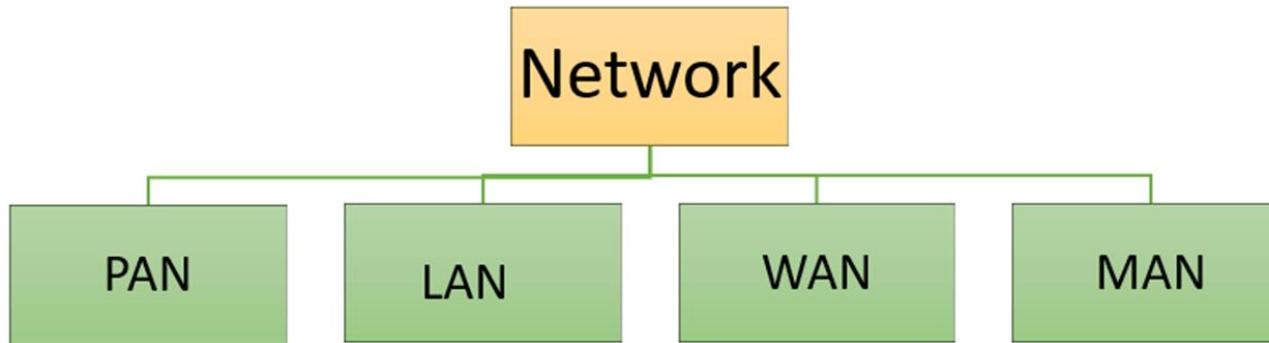
12. Home Area Network (HAN) :

Many of the houses might have more than a computer. To interconnect those computers and with other peripheral devices, a network should be established similar to the local area network (LAN) within that home. Such a type of network that allows a user to interconnect multiple computers and other digital devices within the home is referred to as Home Area Network (HAN). HAN encourages sharing of resources, files, and programs within the network. It supports both wired and wireless communication.



Home Area Network

Categories of Networks



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- Local Area Networks (LANs)
 - Short distances
 - Designed to provide local inter connectivity
- PAN
- Wide Area Networks (WANs)
 - Long distances
 - Provide connectivity over large areas
- Metropolitan Area Networks (MANs)
 - Provide connectivity over areas such as a city, a campus

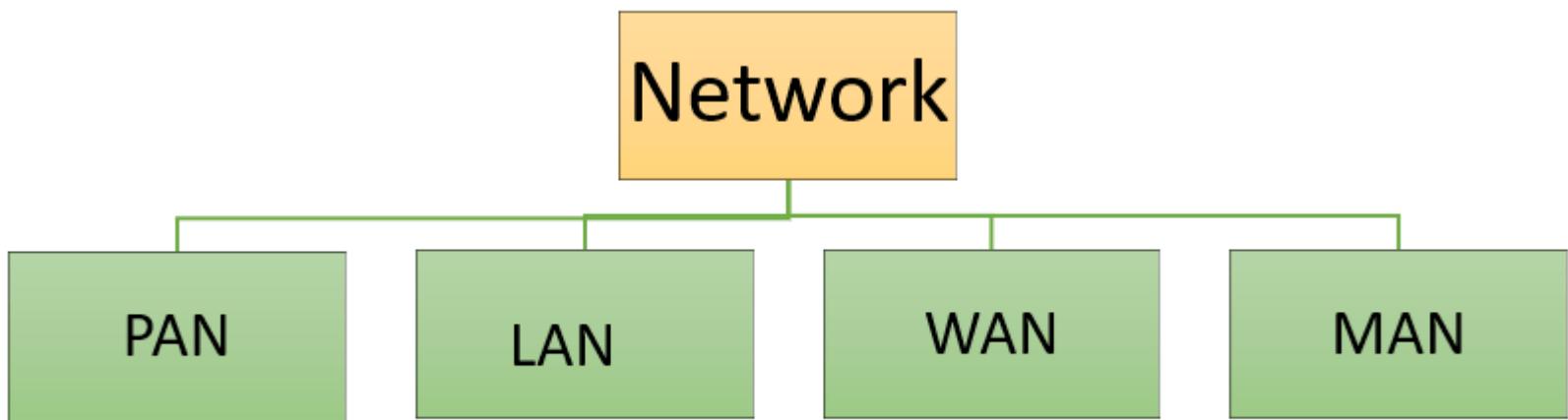


Figure 1.10 *An isolated LAN connecting 12 computers to a hub in a closet*

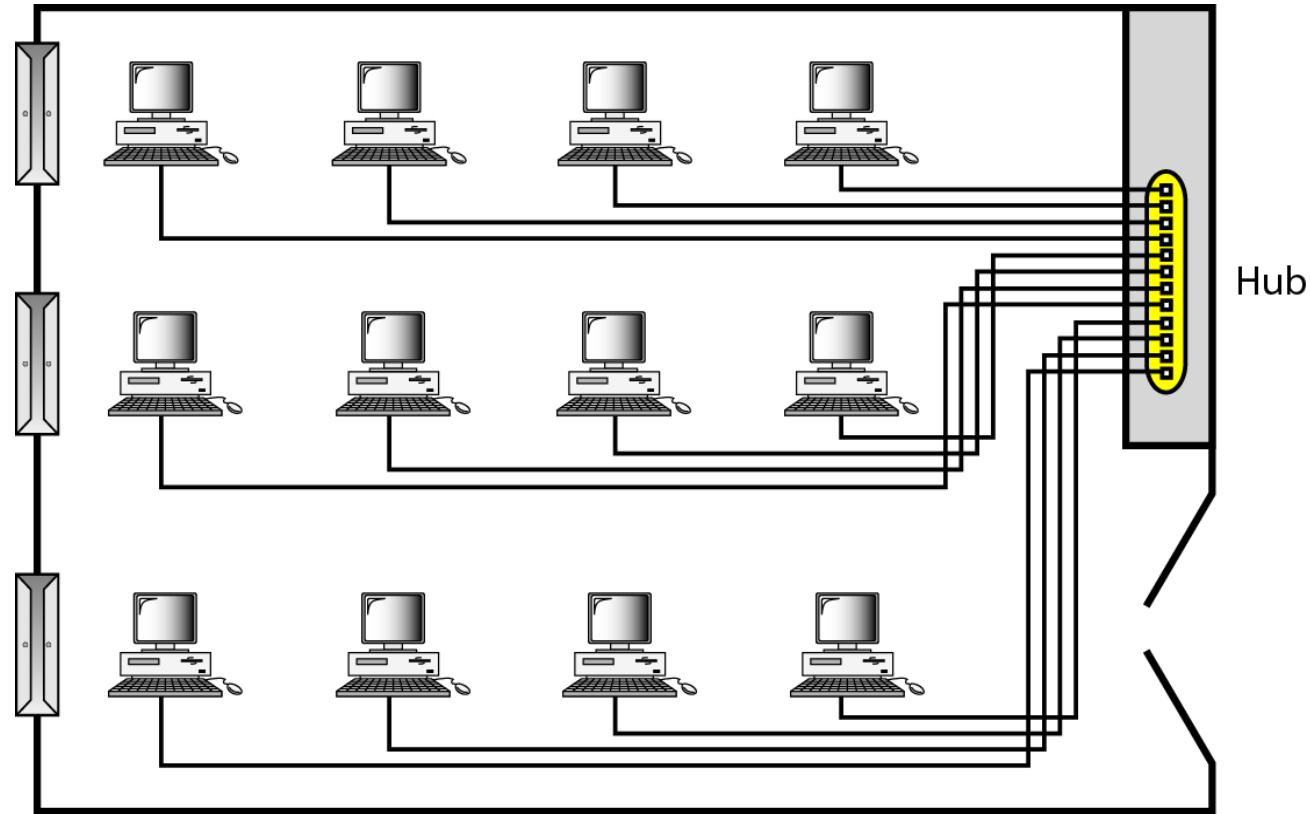
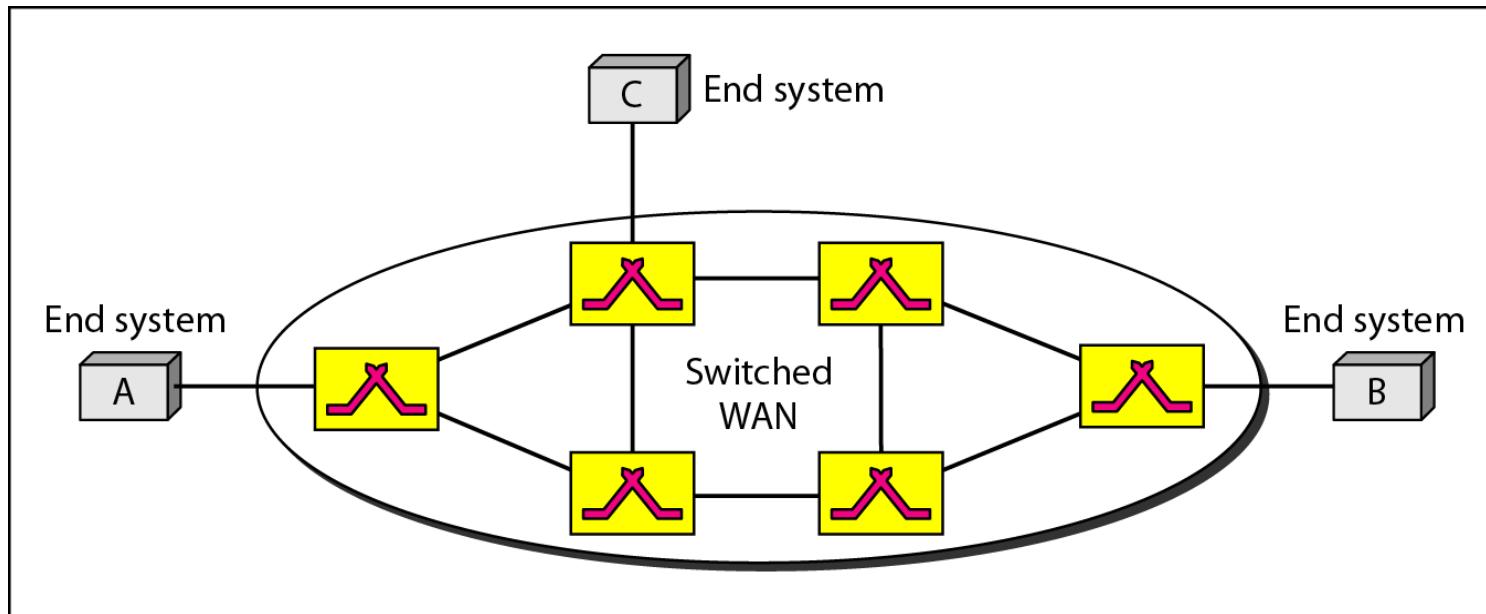
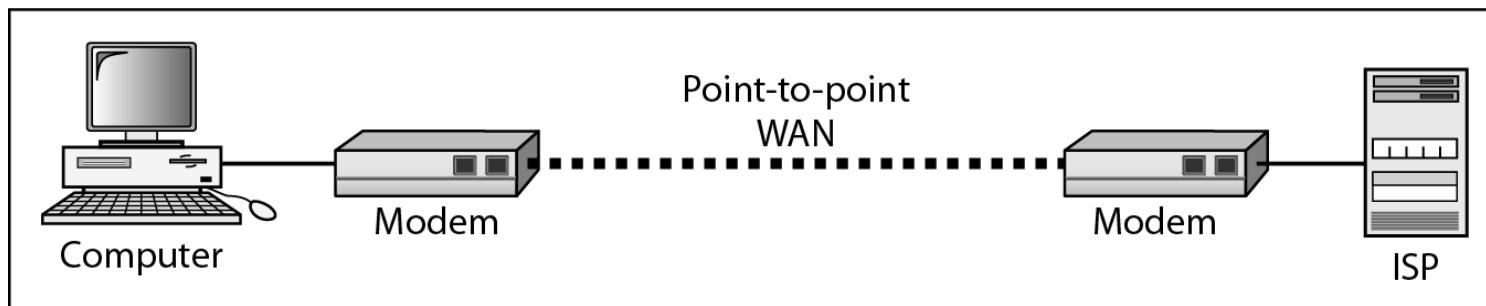


Figure 1.11 WANs: a switched WAN and a point-to-point WAN

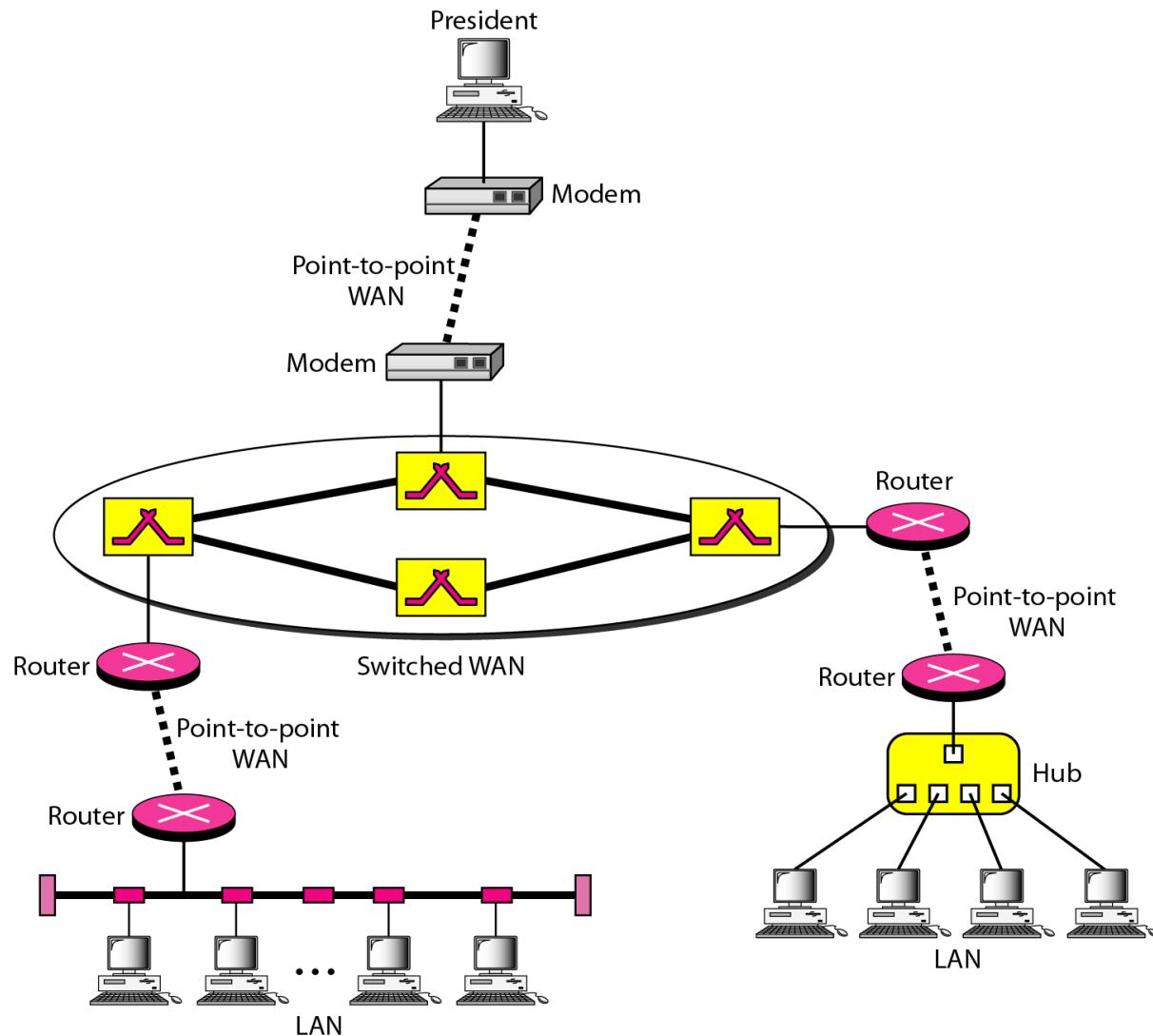


a. Switched WAN



b. Point-to-point WAN

Figure 1.12 A heterogeneous network made of four WANs and two LANs



1-3 THE INTERNET

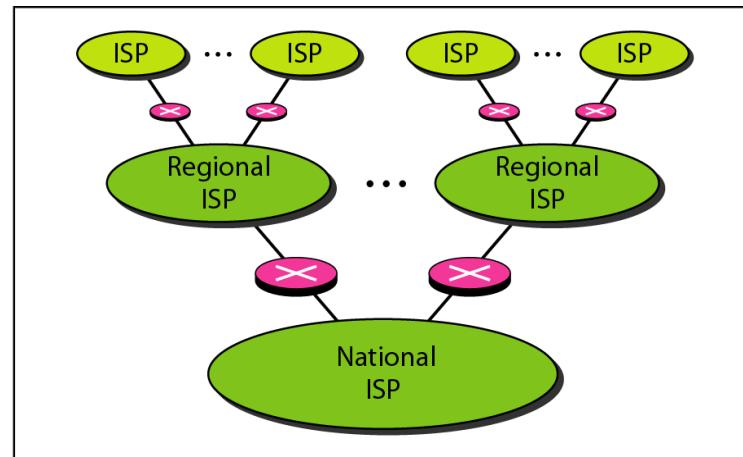
The Internet has revolutionized many aspects of our daily lives. It has affected the way we do business as well as the way we spend our leisure time. The Internet is a communication system that has brought a wealth of information to our fingertips and organized it for our use.

Topics discussed in this section:

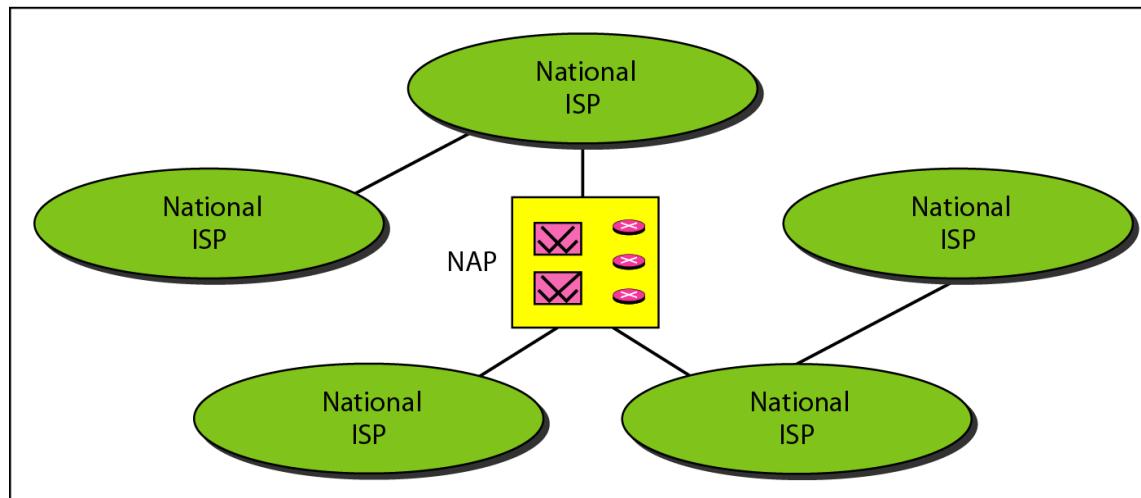
Organization of the Internet

Internet Service Providers (ISPs)

Figure 1.13 *Hierarchical organization of the Internet*



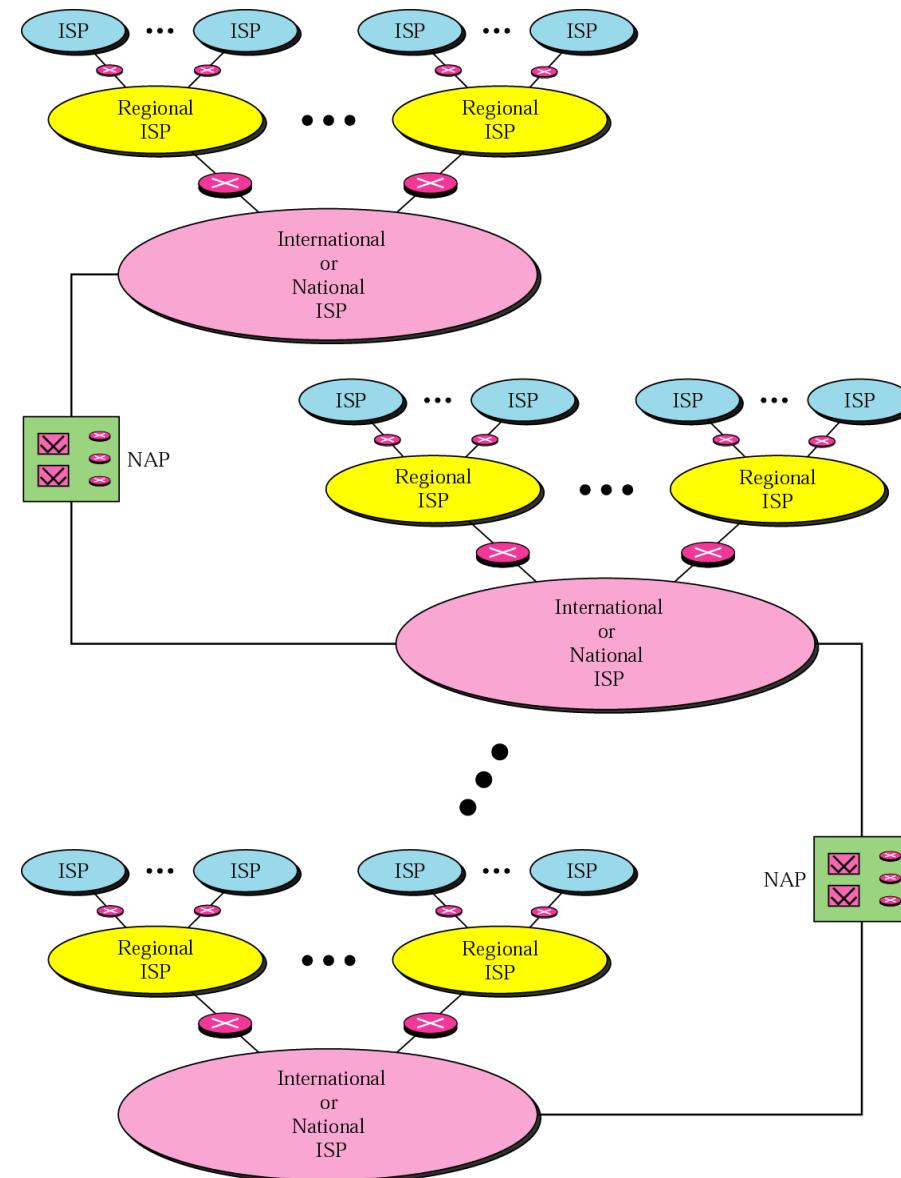
a. Structure of a national ISP



b. Interconnection of national ISPs

Figure 1-1

Internet today



1-4 PROTOCOLS

A protocol is synonymous with rule. It consists of a set of rules that govern data communications. It determines what is communicated, how it is communicated and when it is communicated. The key elements of a protocol are syntax, semantics and timing

Topics discussed in this section:

- Syntax
- Semantics
- Timing

Elements of a Protocol

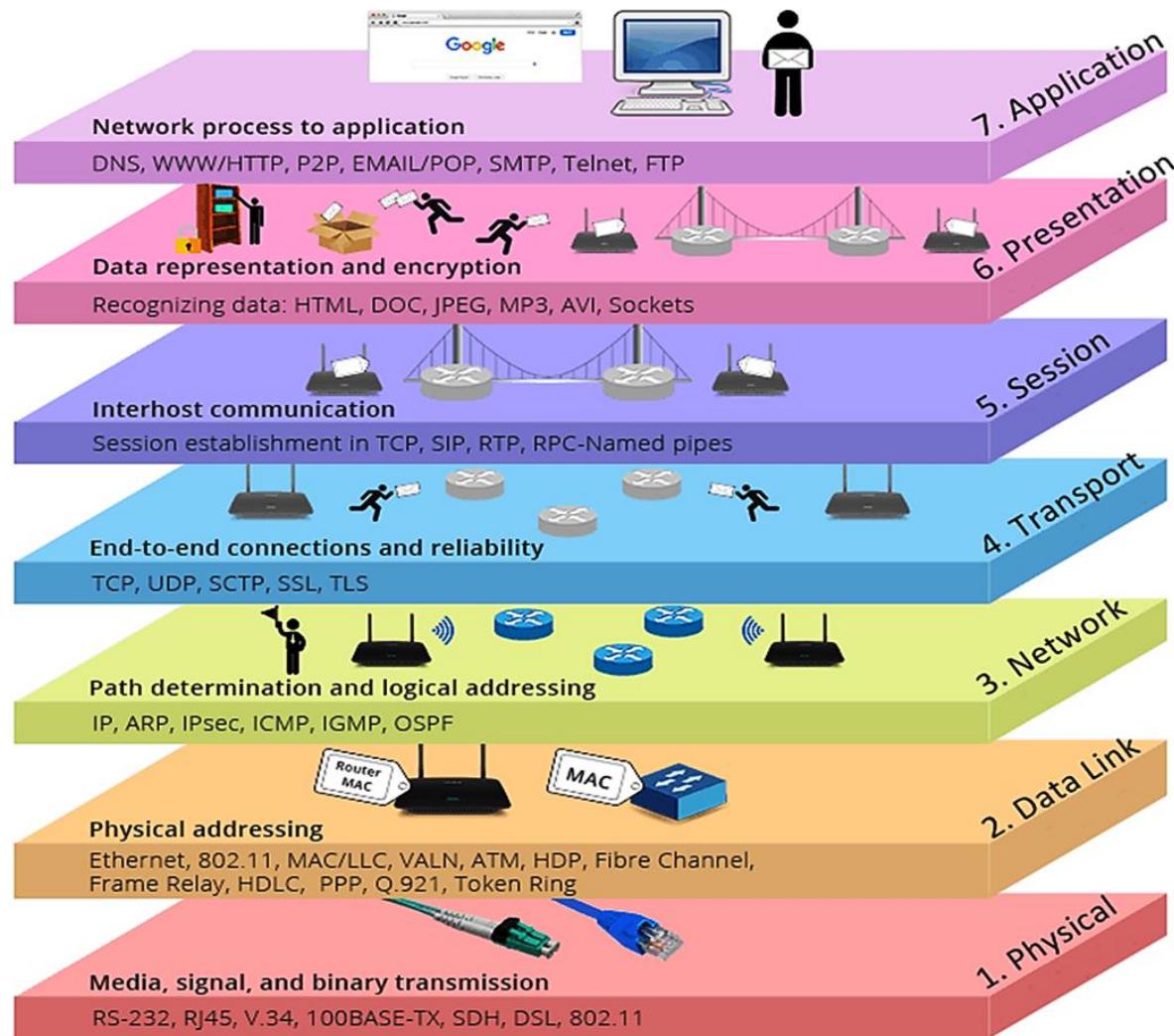
- **Syntax**
 - Structure or format of the data
 - Indicates how to read the bits - field delineation
- **Semantics**
 - Interprets the meaning of the bits
 - Knows which fields define what action
- **Timing**
 - When data should be sent and
 - What speed at which data should be sent or speed at which it is being received.

Standards

Standards are developed through the cooperation of standards creation committees, forums, and government regulatory agencies.

- ✓ **International Organization for Standardization (ISO)**
- ✓ **International Telecommunication Union**
- ✓ **American National Standards Institute (ANSI).**
- ✓ **Institute of Electrical and Electronics Engineers (IEEE).**
- ✓ **Electronic Industries Association (EIA).**

OSI Reference Model



Questions

- How to remember sequence of OSI ?
PDNTSPA
- IP Address belongs to layer 2 ?
- TCP belongs to layer 4 ?
- Is application layer user dependent?