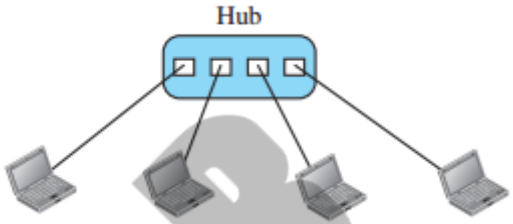
❖ Physical Topologies

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. The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to one another. There are four basic topologies possible: mesh, star, bus, and ring.

1) Star Topology

In a star topology, each device has a dedicated point-to-point link only to a central controller, usually called a hub. The devices are not directly linked to one another. Unlike a mesh topology, a star topology does not allow direct traffic between devices. The controller acts as an exchange: If one device wants to send data to another, it sends the data to the controller, which then relays the data to the other connected device.



Advantages:

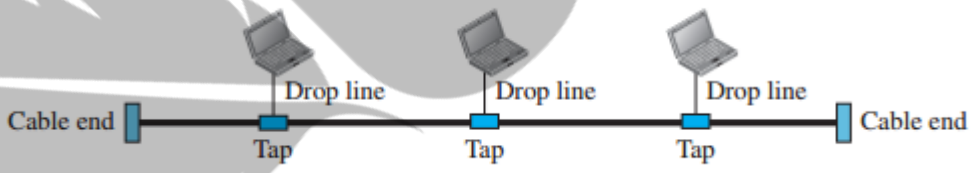
- ✓ It is easy to maintain and modify network.
- ✓ Adding and removing computers can be done without disturbing the network.
- ✓ Finding faults become very simple.
- ✓ Single computer failure does not bring down the whole network.
- ✓ It is more flexible than other topologies.

Disadvantages:

- ✓ If central hub fails, the entire network break downs.
- ✓ It requires a large length of cable to connect computers/devices.
- ✓ It is more expensive

2) Bus Topology

A bus topology is multipoint in which one long cable acts as a backbone to link all the devices in a network. Nodes are connected to the bus cable by drop lines and taps. A drop line is a connection running between the device and the main cable. A tap is a connector that either splices into the main cable or punctures the sheathing of a cable to create a contact with the metallic core. As a signal travels along the backbone, some of its energy is transformed into heat. Therefore, it becomes weaker and weaker as it travels farther and farther. For this reason there is a limit on the number of taps a bus can support and on the distance between those taps.



Advantages:

- ✓ It is simple and easy to use.
- ✓ It requires small length of cables to connect computers/devices.
- ✓ It is less expensive.
- ✓ It is easy to extend a bus. It allows more computers to join network.
- ✓ If one node fails, it does not affect the rest of network.

Disadvantages:

- ✓ It is difficult to troubleshoot.
- ✓ It only supports small number of computers.
- ✓ The network speed slows down as the number of computer increases.

1) Tree Topology

A tree topology combines the characteristics of bus and star topologies. It consists of different groups of computers attached in star topology. The groups are then connected to a bus backbone cable. Tree topology is used for expansion of an existing network.

Advantages:

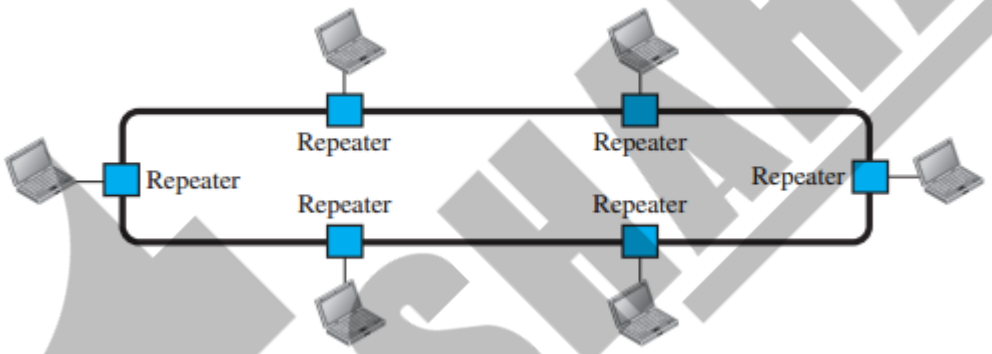
- ✓ It provides point-to-point wiring for individual segments.
- ✓ It is supported by several hardware and software vendors.

Disadvantages:

- ✓ Overall length of each segment is limited by the type of cabling used.
- ✓ The entire network goes down if the backbone line breaks.
- ✓ It is more difficult to configure and wire than other topologies.

2) Ring Topology

In a ring topology, each device has a dedicated point-to-point connection with only the two devices on either side of it. A signal is passed along the ring in one direction, from device to device, until it reaches its destination. Each device in the ring incorporates a repeater. When a device receives a signal intended for another device, its repeater regenerates the bits and passes them along.



Advantages:

- It is less expensive than star topology.
- Every computer has equal access to the network.

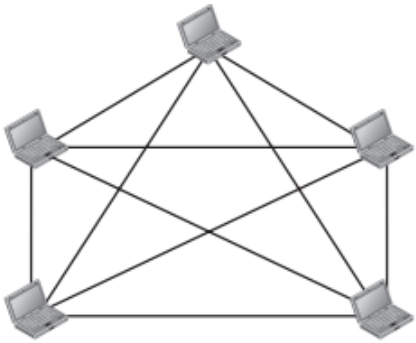
Disadvantages:

- Failure of one computer in the ring can affect the whole network.
- It is difficult to troubleshoot.
- Adding and removing computers affects the whole network.

5) Mesh Topology

In a mesh topology, every device has a dedicated point-to-point link to every other device. The term dedicated means that the link carries traffic only between the two devices it connects. To find the number of physical links in a fully connected mesh network with n nodes, we first consider that each node must be connected to every other node. Node 1 must be connected to n – 1 nodes, node 2 must be connected to n – 1nodes, and finally node n must be connected to n – 1 nodes. We need n (n – 1) physical links. However, if each physical link allows communication in both directions (duplex mode), we can divide the number of links by 2. In other words, we can say that in a mesh topology, we need n (n – 1) / 2 duplex-mode links.

$n = 5$
10 links.



Advantages:

1) It has multiple links so if one route is blocked, the other routes can be used for data communication.
2) Its performance is not affected with heavy load of data transmission.
3) It is easy to troubleshoot.

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Disadvantages:

- A full mesh network can be very expensive.
- It is difficult to install and reconfigure.

❖ Network Types

1) LAN

A local area network (LAN) is usually privately owned and connects some hosts in a single office, building, or campus. Depending on the needs of an organization, a LAN can be as simple as two PCs and a printer in someone's home office, or it can extend throughout a company and include audio and video devices. Each host in a LAN has an identifier, an address that uniquely defines the host in the LAN.

- ✓ The scope of LAN is small, typically a building or cluster of buildings.
- ✓ LAN is usually owned by same organization.
- ✓ Data rates of LAN are typically greater than WAN.

2) WAN

A wide area network (WAN) is also an interconnection of devices capable of communication. However, there are some differences between a LAN and a WAN. A LAN is normally limited in size, spanning an office, a building, or a campus; a WAN has a wider geographical span, spanning a town, a state, a country, or even the world. A LAN interconnects hosts; a WAN interconnects connecting devices such as switches, routers, or modems. A LAN is normally privately owned by the organization that uses it; a WAN is normally created and run by communication companies and leased by an organization that uses it. We see two distinct examples of WANs today: point-to-point WANs and switched WANs**.** A **point-to-point WAN** is a network that connects two communicating devices through a transmission media (cable or air).A **switched WAN** is a network with more than two ends. We can say that a switched WAN is a combination of several point-to-point WANs that are connected by switches.
Traditionally, WANs have been implemented using one of two technologies: circuit switching and packet switching. Subsequently, frame relay and ATM networks assumed major roles.

- ➢ **Circuit Switching**

Circuit switching is a method of implementing a telecommunications network in which two network nodes establish a dedicated communications channel (circuit) through the network before the nodes may communicate. The circuit guarantees the full bandwidth of the channel and remains connected for the duration of the communication session. The circuit functions as if the nodes were physically connected as with an electrical circuit. Data generated by the source station are transmitted along the dedicated path as rapidly as possible. At each node, incoming data are routed or switched to the appropriate outgoing channel without delay. The most common example of circuit switching is the telephone network.

- ➢ **Packet Switching**

In a packet-switching network, it is not necessary to dedicate transmission capacity along a path through the network. Rather, data are sent out in a sequence of small chunks, called packets. Each packet is passed through the network from node to node along some path leading from source to destination. At each node, the entire packet is received, stored briefly, and then transmitted to the next node. Packet-switching networks are commonly used for terminal-to-computer and computer-to-computer communications.

- ➢ **Frame Relay**

In frame relay data packets are sent to the frame relay network or cloud, which is networks of different devices, and service provider sends the data to the receiver. This is cheaper connection than point to point leased line connection. Frame relay networks are designed to operate efficiently at user data rates of up to 2 Mbps.

- ➢ **ATM**

Asynchronous transfer mode, sometimes referred to as cell relay, is a culmination of developments in circuit switching and packet 1switching. ATM can be viewed as an evolution from frame relay. The most obvious difference between frame relay and ATM is that frame relay uses variable-length packets, called frames, and ATM uses fixed-length packets, called cells. By using a fixed packet length, the processing overhead is reduced even further for ATM compared to frame relay. The result is that ATM is designed to work in the range of 10s and 100s of Mbps, and in the Gbps range.

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❖ Internet History

Early History

There were some communication networks, such as telegraph and telephone networks, before 1960. These networks were suitable for constant-rate communication at that time, which means that after a connection was made between two users, the encoded message (telegraphy) or voice (telephony) could be exchanged. A computer network, on the other hand, should be able to handle bursty data, which means data received at variable rates at different times. The world needed to wait for the packet-switched network to be invented.

Birth of Packet-Switched Networks

The theory of packet switching for bursty traffic was first presented by Leonard Kleinrock in 1961 at MIT. At the same time, two other researchers, Paul Baran at Rand Institute and Donald Davies at National Physical Laboratory in England, published some papers about packet-switched networks.

ARPANET

In the mid-1960s, mainframe computers in research organizations were stand-alone devices. Computers from different manufacturers were unable to communicate with one another. The Advanced Research Projects Agency (ARPA) in the Department of Defense (DOD) was interested in finding a way to connect computers so that the researchers they funded could share their findings, thereby reducing costs and eliminating duplication of effort. In 1967, at an Association for Computing Machinery (ACM) meeting, ARPA presented its ideas for the Advanced Research Projects Agency Network (ARPANET), a small network of connected computers. The idea was that each host computer (not necessarily from the same manufacturer) would be attached to a specialized computer, called an interface message processor (IMP). The IMPs, in turn, would be connected to each other. Each IMP had to be able to communicate with other IMPs as well as with its own attached host.

By 1969, ARPANET was a reality. Four nodes, at the University of California at Los Angeles (UCLA), the University of California at Santa Barbara (UCSB), Stanford Research Institute (SRI), and the University of Utah, were connected via the IMPs to form a network. Software called the Network Control Protocol (NCP) provided communication between the hosts.

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