1.4 Network topologies

The network topology is the pattern in which several machines (nodes) are connected together. In the following subsections, more details about the different types of network topologies are provided.

1.4.1 Bus topology

Figure 1.7 illustrates a bus topology in which all devices are connected to a central cable, called the bus or backbone. Bus networks are relatively inexpensive and easy to install for small networks. Ethernet systems use a bus topology.

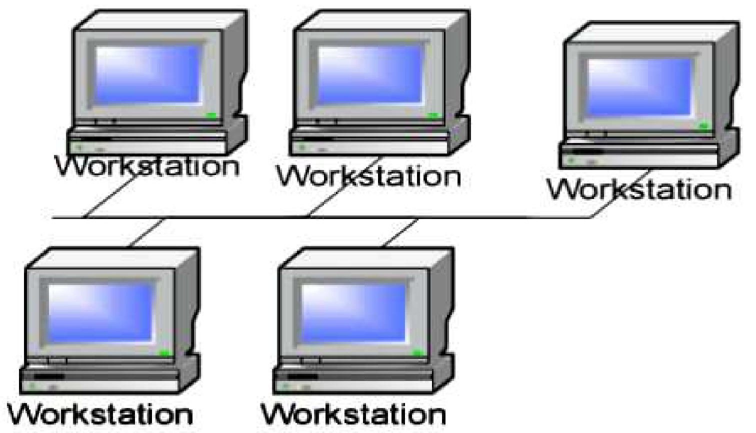

Figure 1.7 ♦ Bus topology

1.4.2 Star topology

Figure 1.8 illustrates a star topology in which all devices are connected to a central *hub*. A hub is a connection device for networks. Allows multiple segments or computers to connect and share packets of information.
Star networks are relatively easy to install and manage, but bottlenecks can occur because all data must pass through the hub.

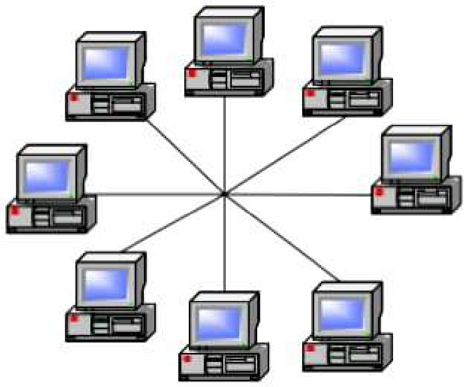

Figure 1.8 ♦ Star topology

1.4.3 Ring topology

Figure 1.9 illustrates a ring topology in which all devices are connected to one another in the shape of a closed loop, so that each device is connected directly to two other devices, one on either side of it. Ring topologies are relatively expensive and difficult to install, but they offer high bandwidth and can span large distances.
Bandwidth measures how much data can be transferred over a communications medium within a fixed period of time; is usually expressed in bits per second (bps), kilobits per second (Kbps), or megabits per second (Mbps)

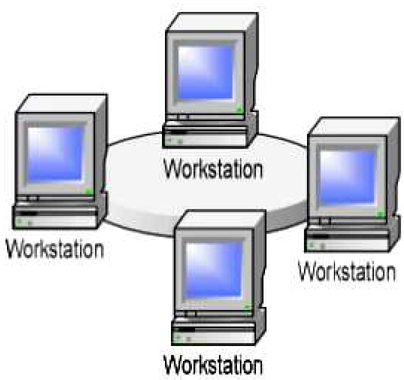

Figure 1.9 ♦ Ring topology

1.4.4 Tree topology

A tree topology combines characteristics of linear bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable.

These topologies can also be combined. For example, a bus-star network consists of a high-bandwidth bus, called the *backbone,* which connects a collection of slower-bandwidth star segments.

1.5 Network Architecture

Several types of network architecture exist. The most widely used are the Client/Server based architecture and the peer-to-peer based network architecture. With a Client/Server based architecture, the communicating computers or processes are classified into either a client or server based on their different responsibilities. However with the peer-to-peer architecture, the communicating network devices have equivalent responsibilities. In the next subsection more details is provided about those types of network architecture. Both client/server and *peer-to-peer architectures* are widely used, and each has unique advantages and disadvantages.

1.5.1 Client/Server Based Network Architecture:

Client/Server Network Architecture is one in which each computer or process on the network is either a *client* or a *server*. Servers are powerful computers or processes dedicated to managing disk drives (*file servers*), printers (*print servers*), or network traffic (*network servers*). Clients can be PCs or workstations running several applications. Clients rely on servers for resources, such as files, devices, and even processing power. Client-Server Architecture can be defined as any network-based software system that uses client software to request a specific service, and corresponding server software to provide the service from another computer on the network. Client-server architecture is sometimes called *two-tier architectures.*

1.5.2 Peer-to-Peer Network Architecture:

Peer-to-peer or abbreviated P2P is a communication model in which each party has the same capabilities and either party can initiate a communication session.
In another words, in a P2P network architecture, all communicating devices share part of their own hardware resources (processing power, storage capacity, network link capacity,

printers, etc). These shared resources are necessary to provide the service offered by the network example file sharing or shared workspace for collaboration. They are accessible by other peer directly without passing intermediary entities.

Other models with which it might be contrasted include the client/server model and the *master/slave* model. In some cases, peer-to-peer communications is implemented by giving each communication node both server and client capabilities. In recent usage, peer-to-peer has come to describe applications in which users can use the Internet to exchange files with each other directly or through a mediating server. This is the oldest model in the world of communications and it is coming on the scene nowadays with file sharing applications like Napster.

1.6 Network Transmission Techniques

In a communication network, data can be transmitted to the appropriate destination using different switching techniques. The switching techniques describe how data is processed and routed in the network. The basic switching techniques are the circuit switching, Packet Switching and Message Switching. The packet switching technique can be one of two types: either datagram packet switching or virtual-circuit packet switching. More details about those techniques is provided in the following sections.

1.6.1 Circuit Switching:

In Circuit Switched Network(Figure 1.10), a dedicated channel (or *circuit*) is established for the duration of a transmission, the resources needed along a path (buffers, link bandwidth) to provide for communication between the end systems are reserved for the duration of the session. The most ubiquitous circuit-switching network is the telephone system, which links together wire segments to create a single unbroken line for each telephone call. The Integrated Services of Digital Networks (ISDN) is also one of the most important circuit-switching networks.

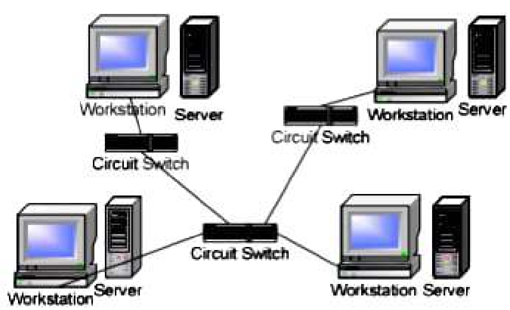

Figure 1.10♦ Circuit Switched Network (the links are reserved for the entire session of transmission)

Circuit-switching systems are ideal for communications that require data to be transmitted in real-time since the data is not delayed. Circuit-switching networks are sometimes called *connection-oriented* networks. Note, however, that although packet switching is essentially connectionless, a packet switching network can be made connection-oriented by using a higher-level protocol. TCP, for example, makes IP networks connection-oriented.
It is important to notice that with the circuit switching technique the created circuit occupies a fixed capacity of each link for the entire lifetime of the connection therefore; the capacity allocated by this circuit can not be used by other circuits. For this reason, switched networks are some times called connection oriented networks.
The circuit switched communication involves three phases:

- Circuit establishment
- Data transfer
- Circuit termination.

1.6.2 Packet Switching:

The other common communications method is packet switching, which divides messages into packets and sends each packet individually. It is a method of slicing digital messages into packets, sending the packets along different communication paths as they become available, and then reassembling the packets once they arrive at their destination. Figure 1.11 describes the structure of a packet which consists of three fields: header, data, and trailer. In packet-switched network, the resources are not reserved. Most packet switches use store and forward transmission. The transmission process involves routing and transferring data by means of addressed packets so that a channel is occupied during the transmission of the packet only, and upon completion of the transmission the channel is made available for the transfer of other traffic. The Internet is based on a packet-switching protocol, TCP/IP (Figure 1.12).

Figure 1.11: Packet structure

Most data today is sent, using digital signals, over networks that use *packet-switching*. Using packet-switching, all network users can share the same paths at the same time and the particular route a data unit travels can be varied as conditions change. Packets in the same message may travel different routes and may not arrive in the same order that they were sent. At the destination, the packets in a message are collected and reassembled into the original message.

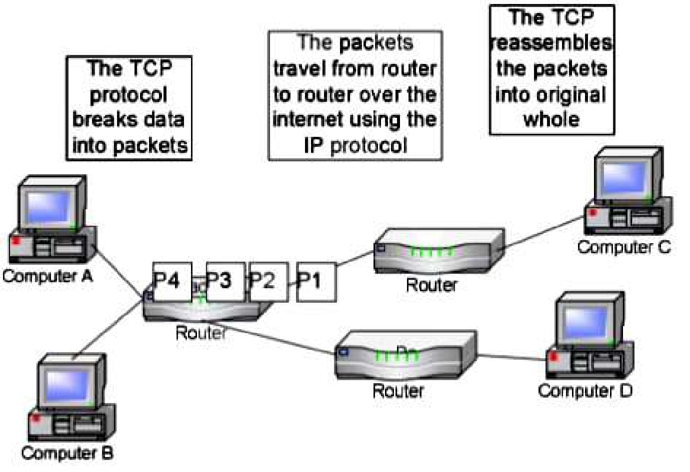

Figure 1.12 ♦ Routing Internet Messages: TCP/IP and Packet Switching

1.6.2.1 1.5.2.1 Datagram Packet Switching

In datagram packet switching, packets are called datagram. The datagram are processed independently. If Host A sends two packets back-to-back to Host B over a datagram packet network, the network cannot tell that the packets belong together. In fact, the two packets can take different routes.
Processing packets independently in a datagram switching network will result in an out of order reception of the transmitted data; therefore each packet header must contain the full address of the destination in order to be routed independently.

1.6.2.2 Virtual Circuit Packet Switching

As the name suggests, the Virtual-circuit packet switching is a hybrid of circuit switching and packet switching. With this technique, all data is transmitted as packets, which are sent along a pre-established path called virtual circuit. With this technique, packets are guaranteed to be delivered in-sequence; however Packets from different virtual circuits may be interleaved. It is important here to note that, with the virtual circuit packet switching technique Packet headers don't need to contain the full destination address of the packet.
Communication with virtual circuits (VC) takes place in three phases:

- VC Establishment
- Data Transfer
- VC Disconnect

1.6.3 Message Switching:

In message switching, instead of segmenting messages, the message is sent into the network as a whole (Figure 1.13). Therefore the messages stay intact as they traverse the network.

The message switching technique suffers from a major problem: end-to-end delay, which is very high compared to the previous techniques.

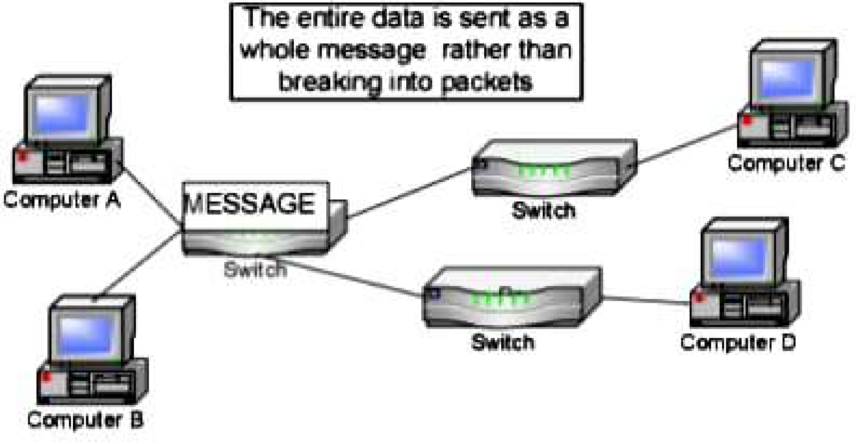

Figure 1.13 ♦ Message Switching