CHAPTER 2 Information Networks

Overview

Information networks, or computer networks, are at the convergence of two important technologies: **computing** and **telecommunications**. This convergence has resulted in local area networks (LANs), metropolitan networks (MANs), wide-area networks (WANs), and the Internet. Computer networks were originally research experiments between the computer scientists, telecommunication engineers, and other researchers. These scientific and engineering experiments, however, have since become immense social experiments as well. Information networks have brought many useful benefits. At the same time, however, they have given rise to some problems as well.

Information networks such as the World Wide Web are characterized by the interplay between heterogeneous content and a complex link structure involved. Link structure can be a powerful source of information about the underlying content in the network. We can think of a network as a large circulatory system, through which information continuously flows. This diffusion of information can happen rapidly or slowly; it can be disastrous -- in a panic or failure -- or beneficial -- as in the spread of innovations. So, In the context of the Web, we can try to identify high-quality information resources it contains.

The information networks can be examined from many points of view, partly because of the cultural meaning we ascribe to computing and telecommunications and the central role that they play in politics, social interactions, and commerce etc. As international business information is fast becoming a prime commodity, so information based networks are being frequently developed to help small and medium enterprises communicate about business needs, expand their markets, share their resources, knowledge and experience.

2.1 Workgroup Computing

Workgroup computing is highly important aspect of modern world computing in today's business, academic, technological and research oriented atmosphere. It is also known as ***collaborative computing*** and it enables the individuals and teams of certain projects to use computer networks for the purpose of cooperation, consultation, and information sharing. With the help of groupware, many users or researchers can work on their projects by sharing the same domain of information online. It also permits the individuals to collaborate with their colleagues to work on company information over the network. At the same time, they can also link to other important contacts outside their organization.

The information may reside on heterogeneous type of databases, it may be made available using altogether different operating systems, and it may be using different platforms. But as long as the users are communicating with each other through a common shareware and they belong to same group, they will keep on working without any hassles and problems. In fact, it is the smart service of **communication technology** that has brought about a revolution in this type of computing. The concept of "**global village**" has become a reality now and the computer community is "**chatting**" with each other as if they are sitting face to face.

2.2 E-mail and its benefits

E-mail or **Electronic mail**, is the process of sending messages directly from one computer to another (linked through wired or wireless connections) . The sender and receiver may be sitting in the same building or anywhere in the world. It works perfectly only if the intended receiver has the e-mail facility to which the sender is connected. It reaches to many people with the same message, reduces the paper flood, and does not interrupt meetings as the ringing phone does. The e-mail allows users to send text messages, documents, and images anywhere over the network. This facility in mostly provided by some specialized websites called E-mail servers i.e. Yahoo, Hotmail, Gmail etc, and it works purely in a client-server computing environment.

Benefits: E-mail has a number of advantages over other communication methods such as:

- We of communication with anyone has nothing to do with distance or the size of can communicate quickly with any one on the internet. E-mail usually reaches its destination in a matter of minutes or seconds.
- The cost the message It is cost-effective way to communicate with friends, colleagues, or business associates regardless of where they are physically located.
- We can send letters, notes, files, data, or reports all using the same techniques. Once we learn how to use the e-mail program, everything is sent the same way.
- The recipient, working on the computer, is not interrupted by the arrival of the e-mail. It is put in his mail box (on the server) and can be seen and worked upon later, using the e-mail program.
- The user's computers may be off when the mails arrive (all will stay in the server) and can be read anytime.
- E-mails are not anonymous, they always carry an address of the originator. Therefore, we are always sure about where it is coming from and where it is going to.

2.3 Internet

The **Internet** is a wonderful and amazing arena where we can find information about almost any thing of the world. On the Internet, we have ocean of knowledge about the books, magazines, encyclopedia, and any other type of reference material readily available. In addition, we can have expert opinions on any topic and can communicate with world community on all ranges of subjects. Essentially, the Internet has brought the world nations to the realization of a "**Global Village**", in which we feel, everyone as close as our neighbor.

The Internet is not a real entity or a place that has a building or a place. Instead, it is the result of a collaborative effort of people and computers throughout the world. The end result is an electronic link to the world of information and entertainment. In simple words, the Internet is a network of connected computers that provide us a facility of exchange data, messages, and files with other computers that are connected to the Internet.

2.3.1 Birth of Internet

During late 1960s, it was designed as ARPANET (**A**dvanced **R**esearch **P**roject **A**gency **NET**work) by the US Department of Defense – DARPA, in collaboration with other universities and research organizations. In the beginning, ARPANET was used mainly for communication technology research and development, with scientists at various sites connected through a network, to share the information.

Later, throughout 1970s and 1980s, ARPANET evolved into several other networks dedicated mostly to military use. In 1989, all the previous networks, created for military use, were abandoned and replaced by National Science Foundation's NSFNET. This was the turning point, as the Internet began serving the civilian community along with the military as well. Now the service was available to anybody in the community and people started patronizing and monitoring the Internet. Today, even the Internet has become too much commercialized; NSF is still donating a lot of fund to it.

The Internet has grown rapidly since 1990. According to the Internet Society (the monitoring organization), the number of computer networks in the Internet is more than Two Million and the number of computers that connect to these networks is more than Hundred Million. To understand how the Internet works, we need to have a sufficient knowledge of "Networking" i.e. the connectivity of computers.

2.3.2 How the Internet is Useful

The basic understanding of a lay man about the Internet is "What kind of information is available on the Internet and how". Before 1998, people used to think about Internet as having only one specific segment i.e. the World Wide Web. But actually, the Internet has many more components of immense utilization. Few of them are as given below:

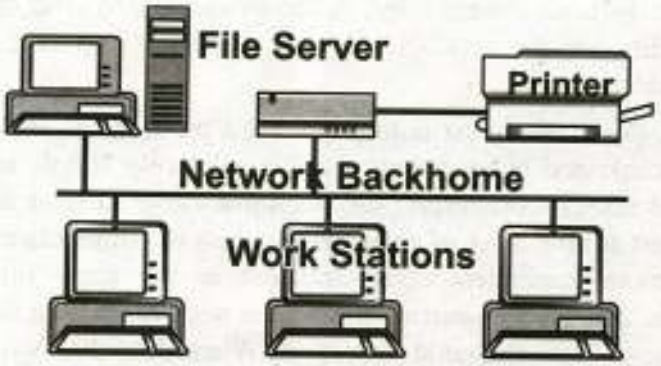
- **World Wide Web(www):** www is a collection of millions of uploading web pages/web sites. It organizes the Internet-related resources so that we can easily access the information available on the Internet.
- **Electronic mail (e-mail):** As defined earlier, it is the process of sending and receiving messages and files among the Internet users.
- **Telnet:** It is the software tool that allows one computer to connect to another computer and make use of the other computer's information.
- **File Transfer Protocol (FTP):** It is also an Internet software tool for transferring files from one computer to another. The process of transferring a file from a remote computer to our local computer is called **downloading.** The process of transferring a file from our own computer to the remote computer (on the Internet) is called **uploading.**
- **Gopher:** It is an access and retrieval system covering a wide range of information, from reference materials to magazine articles to government documents and speeches.
- **Chat groups:** The Internet users with similar interests, form up their forums, to have online real-time discussions over the Internet.
- **Intranet:** An intranet is a privately owned, secure, business network based on Internet technology, although not necessarily connected to the Internet. The term "intranet" appeared when companies discovered that they could use Internet technologies to make company-internal information available to all employees, no matter where the employees were located or what kind of hardware they were using; that they could still secure the information from unwanted access by outsiders; and that, along with these advantages, they could make the information available at the lowest possible.
- **Extranet:** An "extranet" is two or more intranets connected in such a way that they enable collaboration among the companies that own the separate intranets. On an extranet each connected company usually makes some selected part of its intranet accessible to the employees of one or more other companies. For example, several companies might create an extranet

to consolidate data gathering and share data, to jointly develop and share training programs and other material, or to coordinate project management for a common work project. On an extranet each company uses the security inherent in its own intranet to the keep employees of other companies from accessing information they do not need to see.

The collaborative business application is a powerful extranet tool cost.

2.4 Components of network

LANs do not use the telephone network. Its networks are constructed with standard set of components, as discussed below:



Local Area Network (LAN)

Note: It is high time to mention here is that although Chatting facility is of immense importance and use, our youth, especially the students, are misusing it for hours and hours thus, wasting their precious time of study.

- All networks need some system for interconnection. In some LANs, a shared network cable connects the nodes. Low-cost LANs are connected with twisted wire pairs, but many LANs use coaxial cable or fiber optic cable, which are both more expensive and faster. Some LANs are wireless, using infrared or radio wave transmissions instead of cables. Wireless networks are easy to set up and reconfigure, since there are no cables to connect the devices, but they have slower transmission rates and limit the distance between nodes.
- A **network-interface-card (NIC),** connects each computer to the wiring in the network. NIC is a circuit board that fits in one of the computer's internal expansion slots. Some computers have built in NIC.
- Similar networks can be connected by a **bridge,** which recognizes the messages on a network and passes on those addressed to nodes in other network.
- A **gateway** is a collection of hardware and software resources that lets a node communicate with a computer on another different network. A

gateway, for example, could connect an attorney on a local area network to a legal service offered through a wide-area-network (WAN will be discussed after this topic).

- A **router** is a device that connects two or more networks it consist of a combination of hardware and software. The hardware can be a network server, a separate computer, or a special black box device. The hardware includes the physical interfaces to the various networks in the internetwork. These interfaces can be Token Ring, Ethernet, T1, Frame Relay, Asynchronous Transfer Mode (ATM), or any number of other technologies. The two main pieces of software in a router are the operating system and the routing protocol. Management software can be another software component of a router.

LAN's Protocols: Networks have certain rules, called **Protocols,** to send and receive data, and it is defined in the network software. The most common of them are explained as under:

- **Ethernet:** Currently, this is the most commonly used protocol. It uses a high-speed network cable and bus topology, so it is relatively simple and cheaper. Since all the nodes (computers) use the same cable to send and receive data, they must follow a set of rules about when to communicate, otherwise, two or more computers could transmit at the same time, causing lost messages. Before transmitting the data, a node listens" to find out if the cable is in use. If so, the node must wait. When the cable is free from other transmission, the node can begin transmitting immediately. This process is also known as **CSMA/CD** (**C**arrier **S**ense **M**ultiple **A**ccess with **C**ollision **D**etection).

  If by chance, two nodes transmit data at the same time, the messages collide. When a collision occurs, a special message, lasting a fraction of a second, is sent out over the network to indicate that it is jammed. Each node stops transmitting, waits a random period of time, and then transmits again. Since the wait period for each node is random, it is unlikely that they will begin transmitting at the same time again.

- **Token Ring:** It is closely associated with IBM, works on the concept of a ring network topology and a token (a kind of electronic signal). The method of controlling access to the shared network cable is called **token passing**.

- Only one token is available on the network. When a node on the network wishes to transmit, it first captures the token, only then it can transmit data. When the node has sent its message, it releases the token back to the network. Since only one token is circulating around the network, only one device is able to access the network at a time. Thus no collision occurs but the only disadvantage is its slow data transfer rate.

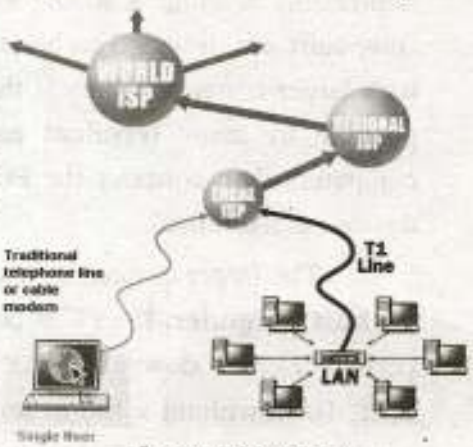
- **ARCnet:** The ARCnet (**A**ttached **R**esource **C**omputer **net**work) has both a topology and networking technology all its own. It uses either twisted-pair wire or coaxial cable, and the star topology is informed with hubs attached to the network.

  The original ARCnet protocol was very slow, but it became popular because it was inexpensive, reliable, and easy to set up and to expand. Fast ARCnet increased the transmission rate to 100 Mbits per second and includes the capability to use fiber optic cable.

- **TCP/IP** (**T**ransmission **C**ontrol **P**rotocol / **I**nternet **P**rotocol): TCP/IP is the protocol used by every computer on the Internet. A protocol is a set of rules and procedures that defines how computer receive and transmit data over the network. Every computer on the Internet must have TCP/IP configured.
  - TCP/IP ensures a reliable connection between the computers communicating over the Internet. It also defines a mechanism through which every computer on the Internet is identified separately.
  - TCP/IP software differs for different computers but it always present the same interface to the network. It does not matter if the system on the other end is a supercomputer, a mainframe, minicomputer or microcomputer; as long as it is using TCP/IP, it can send and receive data through the Internet.

- **ISDN(I**ntegrated **S**eraries **D**igital **N**etwork): ISDN is a set of international communication standreds for software control of transmitting voice, vidoe, and data simulaneously as digital signals over twisted-pair telephone lines. Basic rate ISDN provides better quality than analog connections and more relible digital connections at higher speeds than those offered by analog connections

- **DSL (D**igital **S**ubscriber **L**ine**):** DLS provide high speed, digital data trandmission from homes and businesses over existing telephone lines. The exiting lines are analog and the transmission is digital, so modems are necessary with DSL technology. DSL is a popular alternative to ISDN.



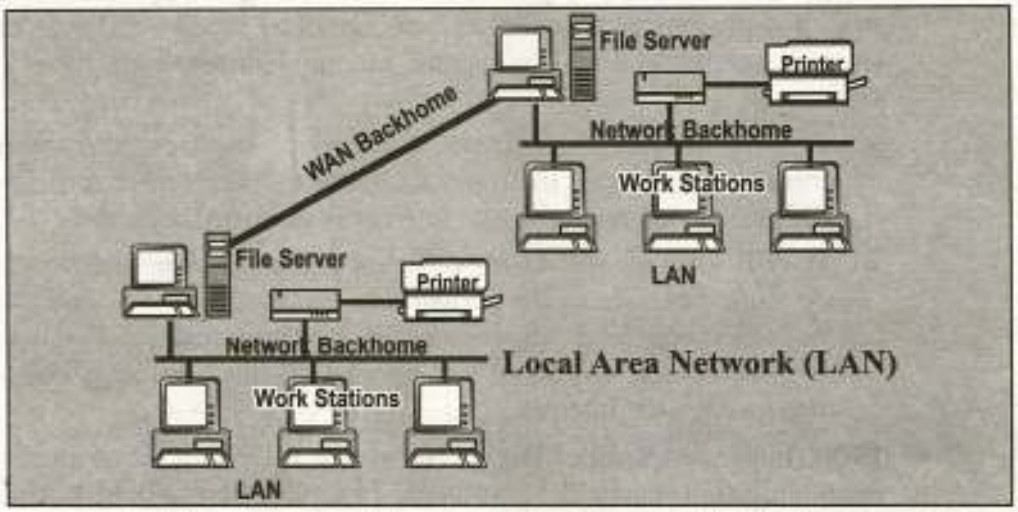
Structure of the Internet

2.5 LAN VS WAN

2.5.1 Local Area Network (LAN)

A local area network is a collection of computers, usually micro-computers, that share hardware, software, and data. In simple terms, LANs hook personal computers together through communications media so that each computer can share the resources of others. As the name implies, LANs cover short distances, usually one office or building or a group of buildings that are close to each other.

2.5.2 Wide Area Network (WAN)



A wide area network is a network of geographically distant computers terminals. In practice, a personal computer sending data to some remote area is probably sending it to the mainframe or minicomputer. Since the larger computers are designed to be accessed by terminals, a PC can communicate with larger computers only if the PC imitates to be a terminal. This is made possible by using **terminal emulation software** on the PCs. The larger computers then consider the PC or workstation as just another input/output device i.e. a terminal.

The larger computer to which the terminal or PC is attached is called the **host computer.** If a PC is being used as a terminal, **file transfer software** permits users to download data files from the host or upload data files to the host. To **download** a file means to retrieve it from another computer and to send it to the computer of the user who requested the file. To **upload** a file, a user sends a file to another computer.

All the communication across the WAN is made possible via ordinary telephone lines, microwave or satellite links.

Typically, a WAN is two or more LANs connected together across a wide geographical area using the connectivity mentioned above. The Internet is the ultimate WAN because it connects many thousands of computers and LANs around the world, ultimately making it as WWW (World Wide Web).

2.5.3 Metropolitan Area Network (MAN)

A metropolitan area network (MAN) is a communications network covering a geographical area the size of a city. The purpose of a MAN is often to bypass local telephone companies when accessing long distance services. Mobile phones (Cellular) systems are often MANs.

2.6 Networking Concepts

A **network** is a way to connect computers together so that they can communicate, exchange information and pool their resources amongst each other.

In business or education, scientific or technological research, educational institutes or office atmosphere, networks have revolutionized the use of computer technology. Be it a local area or wide area network, the world community has come closer to each other. The ocean of information is virtually on our table, using the smart powers of browsing and surfing the resources of world's largest network i.e. **Internet.**

2.6.1 Uses of Networks

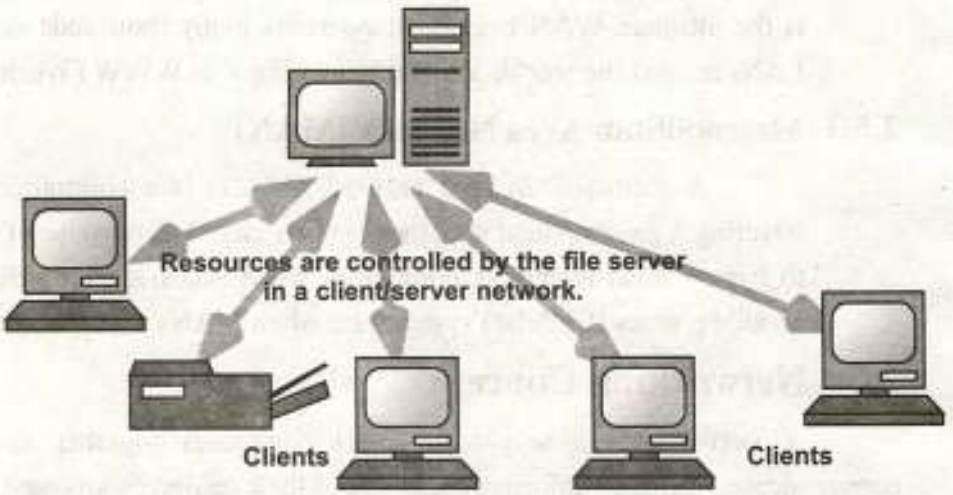
Following are few uses of a Network:

- Networks allow users simultaneous access to shared programs and data.
- Networks also allow users to share peripheral devices, such as printers and hard disks.
- Networks usually include the capability to send e-mail along with big attachments (files etc.)
- Some networks also aid communication by providing tools for teleconferencing and videoconferencing

2.6.2 Network Modal

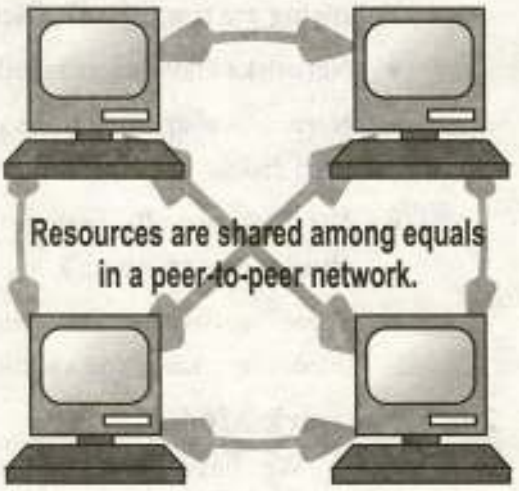
We have basically two types (modals) of network modals, as discussed below:

Client / Server (Dedicated Server Network): This arrangement involves a **server**, which is a computer that controls the network. In particular, a server has the hard disks holding shared files/databases and often shared quality printer, which can be used by all nodes, as shown in the figure below:



The clients are all the other computers on the network. Under this arrangement, the server usually does processing. Client / Server has attracted a lot of attention because a well-designed system reduces the volume of data traffic on the network and allows faster response at each node. (Also, since the server does most of the heavy work, less expensive computers clients can be used as nodes.)

Peer-to-Peer: All computers in a peer-to-peer arrangement have equal status. No one has control over others. With all files and peripheral devices distributed across several computers, users share each other's data devices as needed. The main disadvantage in this approach is lack of speed as most peer-to-peer networks slow down under heavy use. Its main disadvantage is the lack of security.



Hybrid: Many networks are hybrid i.e. a combination of both client/server and peer-to-peer approaches. This approach takes the advantages of both the above mentioned models.

2.6.3 Network Standards

The standards are the precise documents containing technical and physical specifications about the network being designed. Normally those standards are taken into considerations, which are worldwide, acceptable.

By following certain standards, the networks can be reliable, efficient and trustworthy. Normally, two types of standards given below are followed :

De Facto standard: De facto means "by tradition" or "by facts". These standards are most commonly used by the organizations worldwide.

De jure standard: De jure means "according to law or regulation". The networks governing body have properly approved these standards. Few of these governing bodies are:

- American National Standard Institute (ANSI)
- The Institute of Electrical and Electronics Engineers (IEEE)
- The International Standard Organization (ISO)
- The International Telecommunication Union-Telecommunication standardization Sector (ITU-T, formally CCITT) consultative committee for international telegraphy and Telephony.
- The Electronic Industries Association (EIA)
- Telcordia

2.6.4 Network Topologies

In networking, the term topology refers to the layout of connected devices on a network. One can think of a topology as a network's "shape".

Network topologies are categorized into the following basic types:

Bus , Ring , Star , Tree and Mesh.

More complex networks can be built as hybrids of two or more of the above basic topologies.

Bus: Bus networks (not to be confused with the system bus of a computer) use a common backbone to connect all devices. A single cable, the backbone functions as a shared communication medium, that devices attach or tap into with an interface connector. A device wanting to communicate with another device on the network broadcast message onto the wire that all other devices see, but only the intended recipient actually accepts and processes the message.

Ethernet bus topologies are relatively easy to install and don't require much cabling compared to the alternatives. 10Base-2 ("ThinNet") and 10Base-5

("ThickNet") both were popular Ethernet cabling options years ago. However, bus networks work best with a limited number of devices. If more than a few dozen computers are added to a bus, performance problems will likely result. In addition, if the backbone cable fails, the entire network effectively becomes unusable.

CSMA/CD (Carrier Sense Multiple Access/Collision Detection): It is a local area network access method in which contention between two or more stations is resolved by collision detection. When two stations transmit at the same time, they both stop and signal a collision has occurred. Each then tries again after waiting a predetermined time period. To avoid another collision, the stations involved each choose a random time interval to schedule the retransmission of the collided frame. To make sure that the collision is recognized, Ethernet requires that a station must continue transmitting until the 50 microsecond period has ended. If the station has less than 64 bytes of data to send, then it must pad the data by adding zeros at the end. Used with Ethernet.

CSMA/CS (Carrier Sense Multiple Access/Carrier Sense): A node listens to the bus for a predetermined amount of time before transmitting and waits until the talking node has completed transmission.

CSMA/CR (Carrier Sense Multiple Access/Collision Resolution): It allows multiple devices to talk at once, a protocol determines which device receives priority.

Ring: In a ring network, every device has exactly two neighbors for communication purposes. All messages travel through a ring in the same direction (effectively either "clockwise" or "counterclockwise"). A failure in any cable or device breaks the loop and can take down the entire network. Token passing scheme is used in this topology, which has been discussed earlier.

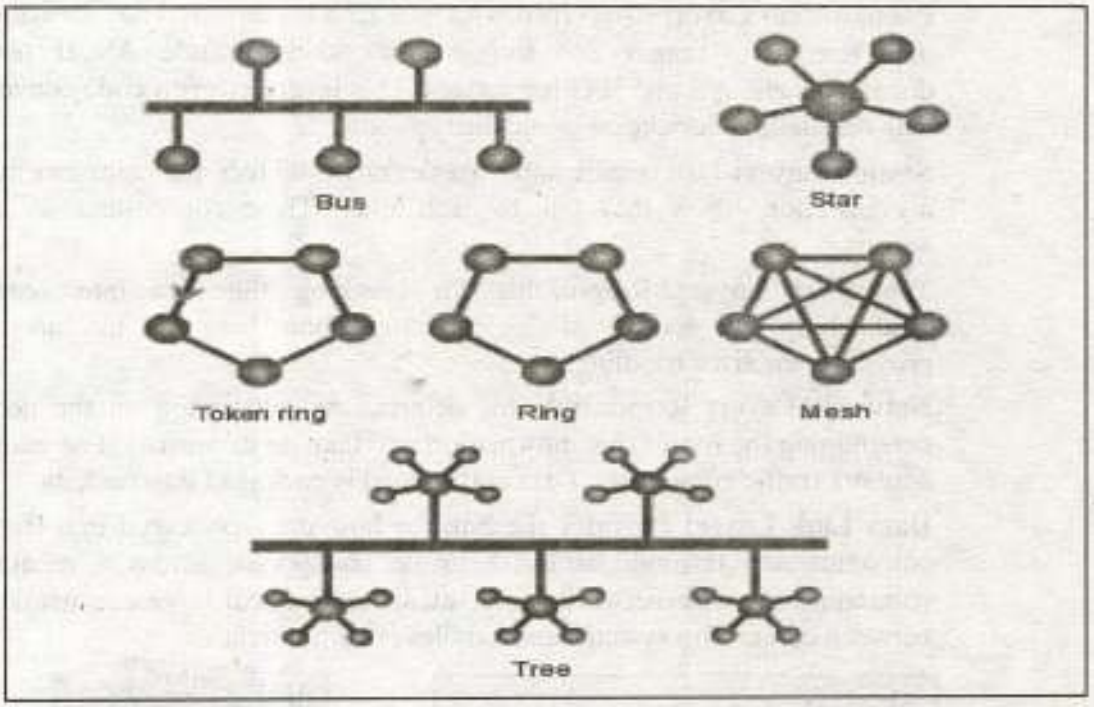
Star: Many home networks use the star topology. A star network features a central connection point called a "hub" that may be an actual **hub** or a **switch**. Devices typically connect to the hub with Unshielded Twisted Pair (UTP) Ethernet. Compared to the bus topology, a star network generally requires more cable, but a failure in any star network cable will only take down one computer's network access and not the entire LAN. If the hub fails, however, the entire network also fails.

Tree: Tree topologies integrate **multiple** star topologies together onto a bus. In its simplest form, only hub devices connect directly to the tree bus, and each hub functions as the "root" of a tree of devices. This bus/star hybrid approach supports future expandability of the network much better than a bus (limited in the number of devices due to the broadcast traffic it generates) or a star (limited by the number of hub ports) alone.

Mesh: Mesh topologies involve the concept of routes. Unlike each of the previous topologies, messages sent on a mesh network can take any of several possible paths from source to destination. (Recall that in a ring, although two cable paths exist, messages can only travel in one direction.) Some WANs, like the Internet, employ mesh routing. A mesh offers several advantages over other network topologies.

- Mesh network has high fault tolerance due to multiple links.
- Due to multiple links mesh network can work fine even under severe loads.
- Troubleshooting of mesh network is easy as compared to other networks. If data is not communicated between any two computer then it means that there is some fault in direct links between them.

Disadvantages include the difficulty of installation and reconfiguration, as well as the cost of maintaining redundant links.



2.6.5 Open Systems Interconnection (OSI) Model

The Open Systems Interconnection (OSI) model began as a reference model, but has since been implemented. It was created by the International Organization for Standardization (ISO) to provide a logical framework for how data communication processes should interact across networks. Standards were created for the computer industry allowing different networks to work together efficiently.

There are 7 layers in the OSI model. Each layer is responsible for a particular aspect of data communication. For example, one layer may be responsible for establishing connections between devices, while another layer may be responsible for error checking during transfer.

The layers of the OSI model are divided into two groups: the upper layer and lower layer. The upper layers focus on user applications and how files are represented on the computers prior to transport. For the most part, network engineers are more concerned with the lower layers. It's the lower layers that concentrate on how the communication across a network actually occurs.

Application Layer: Provides network services to user applications. It is responsible for exchanging information between programs running on the machine, such as an e-mail program, and other services running on a network, such as a print server or another computers' application.

Presentation Layer: Concerned with how data is converted and formatted for data transfer. Examples of format conversions include ASCII text for documents and .gif and JPG for images. This layer performs code conversion, data translation, compression and encryption.

Session Layer: Determines how two devices establish, maintain and manage a connection - how they talk to each other. These connections are called sessions.

Transport Layer: Responsible for breaking the data into segments, establishing an end-to-end logical connection between machines, and providing for error handling.

Network Layer: Responsible for determining addressing on the network, determining the routes that information will take on its journey, and managing network traffic congestion. Data at this level is packaged into packets.

Data Link Layer: Provides the link for how data, packaged into frames is communicated through hardware to be transported across a medium. It communicates with network cards, manages physical layer communications between connecting systems and handles error notification.

Physical Layer: Specifies how data is processed into bits and physically transferred over medium, such as cables. It's responsible for activating and maintaining the physical link between systems.

Exercise 2C

1. Fill in the blanks:

(i) Collection of raw facts is called_____.

(ii) A receiver is also called _____.

(iii) Two forms of data transmission are_____ and _____.

(iv) TCP/IP stands for _____.

(v) Data in _____ can travel in both direction but not at the same time.

(vi) _____ ensures that data are transmitted without any error.

(vii) Data transmission through a medium can be either synchronous or _____.

(viii) WAN stand for_____.

(ix) A _____ is a microwave station placed in outer space.

(x) A router is also used as a _____ device used for interconnecting different types of networks together.

2. Choose the correct option:

(i) A LAN is a combination of

(a) Network adapter cards (b) LAN cables

(c) LAN application software (d) All of above

(ii) What layer of OSI model does data compression

(a) Network (b) Presentation (c) Data Link (d) Physical

(iii) Cabling on a linear bus topology can be extended using which of following?

(a) Terminator (b) Barrel connector

(c) Network adapter card (d) Medium attachment

(iv) The Media Access Control sub layer resides in which layer?

(a) Physical (b) Data link (c) Network (d) Transport

(v) FDDI is a

(a) Ring network (b) Star network (c) Mesh network (d) Bus network

(vi) How many pairs of computers can simultaneously communicate on Ethernet LAN?

(a) 1 (b) 2 (c) 3 (d) Multiple

(vii) One or more computers connected to a hub computer is a

(a) Ring network (b) Node (c) Information utility (d) Star network

(viii) Project 802 defines standards for which layers of the OSI model?

(a) Application and presentation layers (b) Physical and Data Link layers

(c) Transport and Network layers (d) Network and Data Link layers

(ix) Terminal is a
(a) Device to give power supply to computer
(b) Point at which data enters or leaves the computer
(c) The last instruction in a program (d) Any input/output device

(x) Software to peruse the internet
(a) Gateway (b) EFT (c) Browser (d) Teleconferencing

3. Write T for true and F for false statement:

(i) E-mail is short for electronic mail.
(ii) Teleprocessing allows a user to make queries of a computer 1000 miles away.
(iii) An Ethernet system (IEEE 802.3 protocol) uses packet switching technique.
(iv) ISDN modems can communicate only with other ISDN modems.
(v) 16 bit and 32 bit are currently the two most popular bus width.
(vi) FTP, short for File Transfer Protocol is a tool that lets users transfer files across the internet.
(vii) DSL modem uses the cable TV network for data transmission.
(viii) A WAN is usually limited to one office building.
(ix) A gateway connects two similar computers.
(x) A bus network uses a central computer as the server.

4. What is the difference between LAN and WAN?

5. What method does an Ethernet network use to control access to the network?

6. What is Topology? Describe the types of topology. **7.** What is www?

8. Describe the OSI Model and types of layers of OSI Model.

9. Difference between Intranet and Extranet.

10. Difference between FTP and HTTP. **11.** Define the gateway and router.

12. Define the term "Operating System" in your own words?

13. Describe the function of (i) Dedicated Server Network (ii) Peer – to - Peer

Answers

1. (i) Data (ii) Sink (iii) Serial, Parallel
(iv) Transmission Control Protocol / Internet Protocol (v) Half Duplex Mode (vi) Data Link Layer
(vii) Asynchronous (viii) Wide Area Network (ix) Satellite (x) Intermediate

2. (i) d (ii) b (iii) b (iv) b (v) a
(vi) d (vii) d (viii) b (ix) d (x) c

3. (i) T (ii) F (iii) F (iv) F (v) F
(vi) T (vii) F (viii) F (ix) F (x) F