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## Concepts of network and internet

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**Objectives :** At the end of this lesson you shall be able to

- **define computer network and its advantages and disadvantages**
- **name and explain the types of network and their characteristics**
- **explain the types of topologies**
- **state about the cables used for network system**
- **name and state about the various connectors used in network system**
- **explain about the hub, modem and internet**
- **describe about the internet protocols connection sharing (ICS) using windows.**

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### Define computer network

A computer network is an interconnection of various computer systems located at different places. In computer network two or more computers are linked together with a medium and data communication devices for the purpose of communicating data and sharing resources. The computer that provides resources to other computers on a network is known as server. In the network the individual computers, which access shared network resources, are known as workstations or nodes.

### Advantages of Computer Networks

The following are some of the advantages of computer networks.

- **File Sharing:** Networks offer a quick and easy way to share files directly. Instead of using a disk or USB key to carry files from one computer or office to another, you can share files directly using a network.
- **Security:** Specific directories can be password protected to limit access to authorized users. Also, files and programs on a network can be designated as "copy inhibit" so you don't have to worry about the illegal copying of programs.
- **Resource Sharing:** All computers in the network can share resources such as printers, fax machines, modems, and scanners.
- **Communication:** Even outside of the internet, those on the network can communicate with each other via electronic mail over the network system. When connected to the internet, network users can communicate with people around the world via the network.
- **Flexible Access:** Networks allow their users to access files from computers throughout the network. This means that a user can begin work on a project on one computer and finish up on another. Multiple users can also collaborate on the same project through the network.

- **Workgroup Computing:** Workgroup software like Microsoft BackOffice enables many users to contribute to a document concurrently. This allows for interactive teamwork.
- **Error reduction and improve consistency:** One can reduce errors and improve consistency by having all staff work from a single source of information, so that standard versions of manuals and directories can be made available, and data can be backed up from a single point on a scheduled basis, ensuring consistency.

### Network Application Areas

There is a long list of application areas, which can be benefited by establishing Computer Networks. Few of the potential applications of Computer Networks are:

- 1 Information retrieval systems which search for books, technical reports, papers and articles on particular topics
- 2 News access machines, which can search past news, stories or abstracts with given search criteria.
- 3 Airline reservation, hotel booking, railway-reservation, car-rental, etc.
- 4 A writer's aid: a dictionary, thesaurus, phrase generator, indexed dictionary of quotations, and encyclopaedias.
- 5 Stock market information systems which allow searches for stocks that meet certain criteria, performance comparisons, moving averages, and various forecasting techniques.
- 6 Electronic Fund Transfer (EFT) between banks and via cheque clearing house.
- 7 Games of the types that grow or change with various enthusiasts adding to the complexity or diversity.
- 8 Electronic Mail Messages Systems (EMMS).

- 9 Corporate information systems such as marketing information system, customer information system, product information system, personnel information system, etc.
- 10 Corporate systems of different systems such as Order-Entry System, Centralized Purchasing, Distributed Inventory Control, etc.
- 11 On-line systems for Investment Advice and Management, Tax Minimization, etc.
- 12 Resources of interest to a home user.
- 13 Sports results.
- 14 Theatre, movies, and community events information.
- 15 Shopping information, prices, and advertisements.
- 16 Restaurants; good food guide.
- 17 Household magazine, recipes, book reviews, film reviews.
- 18 Holidays, hotels, travel booking.
- 19 Radio and TV programmes.
- 20 Medical assistance service.
- 21 Insurance information.
- 22 Computer Assisted Instruction (CAI).
- 23 School homework, quizzes, tests.
- 24 Message sending service.
- 25 Directories.
- 26 Consumer reports.
- 27 Employment directories and Job opportunities.
- 28 Tax information and Tax assistance.
- 29 Journey planning assistance viz. Train, bus, plane etc.
- 30 Catalogue of Open University and Virtual University courses.

Computer Networks may be classified on the basis of geographical area in two broad categories.

- 1 Local Area Network (LAN)
- 2 Wide Area Network (WAN)
- 3 Metropolitan Area Network (MAN)

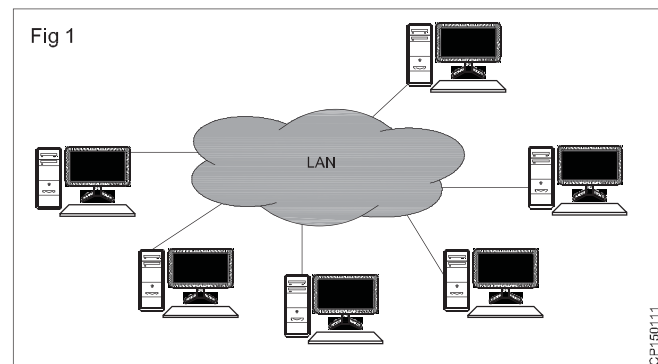
A classification of computer networks can be done to distance as in the table.

Interprocess (or) Distance	Network Type
0 to 1 Km	Local Area Network (LAN)
1 Km to 10 Km	Metropolitan Area Network (MAN)
10 Km to 1000 Km	Wide Area Network (WAN)
Above 1000 Km	Internet

### Local Area Network (LAN)

Networks used to interconnect computers in a single room, rooms within a building or buildings on one site are called Local Area Network (LAN). LAN transmits data with a speed of several megabits per second (106 bits per second). The transmission medium is normally coaxial cables.

LAN (Fig 1) links computers, i.e., software and hardware, in the same area for the purpose of sharing information. Usually LAN links computers within a limited geographical area because they must be connected by a cable, which is quite expensive. People working in LAN get more capabilities in data processing, work processing and other information exchange compared to stand-alone computers. Because of this information exchange most of the business and government organisations are using LAN.



### Major Characteristics of LAN

- every computer has the potential to communicate with any other computers of the network
- high degree of interconnection between computers
- easy physical connection of computers in a network
- inexpensive medium of data transmission
- high data transmission rate

### Types of Connection

**Peer to Peer:** Peer to peer is an approach to computer networking where all computers share equivalent responsibility for processing data. Peer-to-peer

networking (also known simply as peer networking) differs from client-server networking, where certain devices have responsibility for providing or "serving" data and other devices consume or otherwise act as "clients" of those servers.

**Client server:** The term client-server refers to a popular model for computer networking that utilizes client and server devices each designed for specific purposes. The client-server model can be used on the Internet as well as LAN.

**Advantages of LAN**

- The reliability of network is high because the failure of one computer in the network does not affect the functioning for other computers.
- Addition of new computer to network is easy.
- High rate of data transmission is possible.
- Peripheral devices like magnetic disk and printer can be shared by other computers.

**Disadvantages of LAN**

If the communication line fails, the entire network system breaks down.

**Use of LAN**

Followings are the major areas where LAN is normally used

- File transfers and Access
- Word and text processing
- Electronic message handling
- Remote database access
- Personal computing
- Digital voice transmission and storage

**Metropolitan Area Network (MAN)**

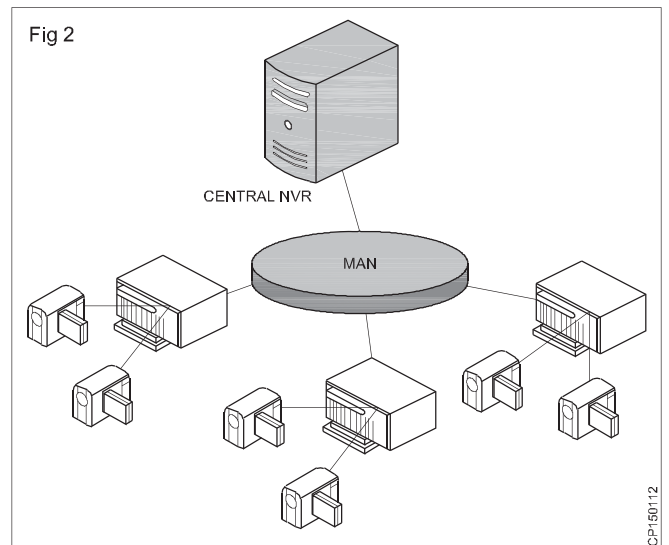
A Data network designed for a town or city. In terms of geographic breadth, MANs are larger than, but smaller than. LANs. MANs (Fig 2) are usually characterized by very high-speed connections using or other digital media.

**Characteristic of MAN**

- 1 The network size falls intermediate between LANs and WANs. A MAN typically covers an area of between 5 and 50 km range. Many MANs cover an area the size of a city, although in some cases MANs may be as small as a group of buildings.
- 2 A MAN (like a WAN) is not generally owned by a single organisation. The MAN, its communications links and equipment are generally owned by either a consortium of users or by a network service provider

who sells the service to the users.

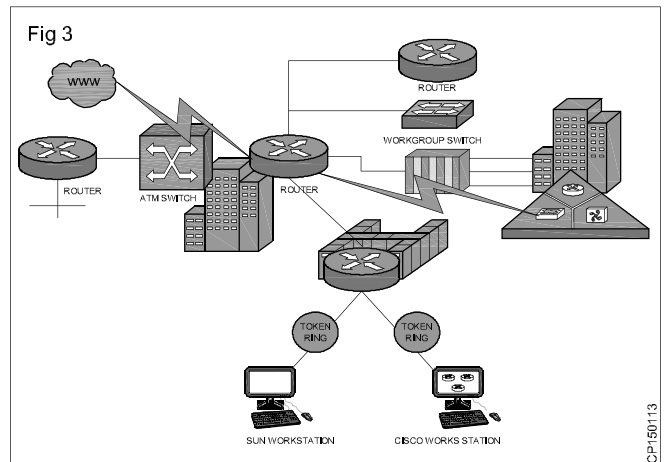
- 3 A MAN often acts as a high speed network to allow sharing of regional resources. It is also frequently used



to provide a shared connection to other networks using a link to a WAN.

**Campus Area Network (CAN)**

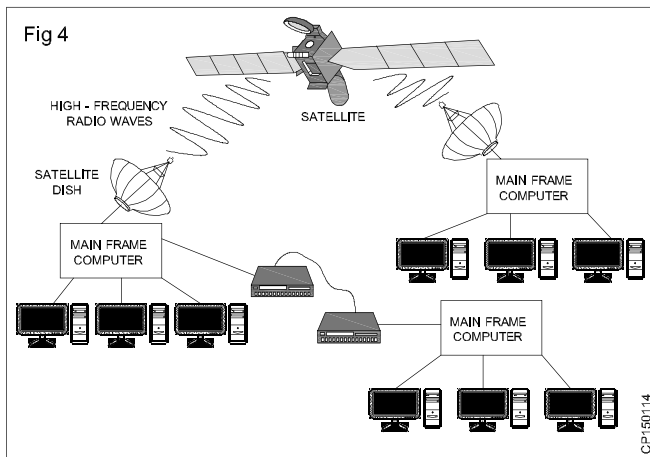
A Campus Area Network or Corporate Area Network (CAN) is a network is made up of an interconnection of local area network within a limited geographical area. A



CAN (Fig 3) is larger than a local area network but smaller than a Wide area Network

**Wide Area Network (WAN)**

The term Wide Area Network (Fig 4) is used to describe a computer network spanning a regional, national or global area. For example, for a large company the head quarters might be at Delhi and regional branches at Bombay, Madras, Bangalore and Calcutta. Here regional centres are connected to head quarters through WAN. The distance



between computers connected to WAN is larger. Therefore the transmission mediums used are normally telephone lines, microwaves and satellite links.

### Characteristics of WAN

Followings are the major characteristics of WAN.

- 1 **Communication Facility:** For a big company spanning over different parts of the country the employees can save long distance phone calls and it overcomes the time lag in overseas communications. Computer conferencing is another use of WAN where users communicate with each other through their computer system.
- 2 **Remote Data Entry:** Remote data entry is possible in WAN. It means sitting at any location you can enter data, update data and query other information of any computer attached to the WAN but located in other cities.
- 3 **Centralised Information:** In modern computerised environment you will find that big organisations go for centralised data storage. This means if the organisation is spread over many cities, they keep their important business data in a single place. As the data are generated at different sites, WAN permits collection of this data from different sites and save at a single site.

### Examples of WAN

- 1 **Ethernet:** Ethernet developed by Xerox Corporation is a famous example of WAN. This network uses coaxial cables for data transmission. Special integrated circuit chips called controllers are used to connect equipment to the cable.
- 2 **Arpanet:** The Arpanet is another example of WAN. It was developed at Advanced Research Projects Agency of U. S. Department. This Network connects more than 40 universities and institutions throughout USA and Europe.

### Difference between LAN and WAN

- LAN is restricted to limited geographical area of few kilometers. But WAN covers great distance and op-

erate nationwide or even worldwide.

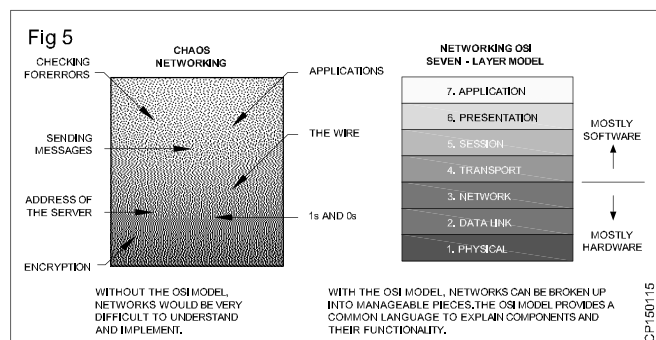
- In LAN, the computer terminals and peripheral devices are connected with wires and coaxial cables. In WAN there is no physical connection. Communication is done through telephone lines and satellite links.
- Cost of data transmission in LAN is less because the transmission medium is owned by a single organisation. In case of WAN the cost of data transmission is very high because the transmission medium used is hired either telephone lines or satellite links.
- The speed of data transmission is much higher in LAN than in WAN. The transmission speed in LAN varies from 0.1 to 100 megabits per second. In case of WAN the speed ranges from 1800 to 9600 bits per second (bps).
- Few data transmission errors occur in LAN compared to WAN. It is because in LAN the distance covered is negligible.

### Open Systems Interconnection (OSI)

The **Open Systems Interconnection (OSI)** model is a reference tool for understanding data communications between any two networked systems. It divides the communications processes into seven layers. Each layer both performs specific functions to support the layers above it and offers services to the layers below it. The three lowest layers focus on passing traffic through the network to an end system. The top four layers come into play in the end system to complete the process.

#### An Overview of the OSI Model (Fig 5)

**Application Layer (Layer 7):** This layer interfaces directly to and performs common application services for the application processes. The common application services provide semantic conversion between associated application processes. Examples of common applica-



tion services include the virtual file, virtual terminal (for example, Telnet), and "Job transfer and Manipulation protocol" (JTM, standard ISO/IEC 8832)

**Presentation Layer (Layer 6):** The Presentation layer relieves the Application layer of concern regarding syntactical differences in data representation within the end-user systems. MIME encoding, encryption and similar manipulation of the presentation of data are done at this layer. An example of a presentation service would be

the conversion of an EBCDIC-coded text file to an ASCII-coded file.

**Session Layer (Layer 5):** The Session layer provides the mechanism for managing the dialogue between end-user application processes. It provides for either duplex or half-duplex operation and establishes check pointing, adjournment, termination, and restart procedures. This layer is responsible for setting up and tearing down TCP/IP sessions.

**Transport Layer (Layer 4):** The purpose of the Transport layer is to provide transparent transfer of data between end users, thus relieving the upper layers from any concern with providing reliable and cost-effective data transfer. The transport layer controls the reliability of a given link. Some protocols are stateful and connection oriented. This means that the transport layer can keep track of the packets and retransmit those that fail. The best known example of a layer 4 protocol is TCP.

**Network Layer (Layer 3):** The Network layer provides the functional and procedural means of transferring variable length data sequences from a source to a destination via one or more networks while maintaining the quality of service requested by the Transport layer. The Network layer performs network routing, flow control, segmentation/desegmentation, and error control functions. The router operates at this layer - sending data throughout the extended network and making the Internet possible, although there are layer 3 (or IP) switches. This is a logical addressing scheme - values are chosen by the network engineer. The addressing scheme is hierarchical.

**Data Link Layer (Layer 2):** The Data link layer provides the functional and procedural means to transfer data between network entities and to detect and possibly correct errors that may occur in the Physical layer. The addressing scheme is physical which means that the addresses (MAC) are hard-coded into the network cards at the time of manufacture. The addressing scheme is flat.

**Physical Layer (Layer 1):** The physical layer defines all electrical and physical specifications for devices. This includes the layout of pins, voltages, and cable specifications. Hubs and repeaters are physical-layer devices. The major functions and services performed by the physical layer are:

- Establishment and termination of a connection to a communications medium.
- Participation in the process whereby the communication resources are effectively shared among multiple users. For example, contention resolution and flow control.
- Modulation or conversion between the representation of digital data in user equipment and the corresponding signals transmitted over a communications

channel. These are signals operating over the physical cabling - copper and fiber optic, for example. SCSI operates at this level.

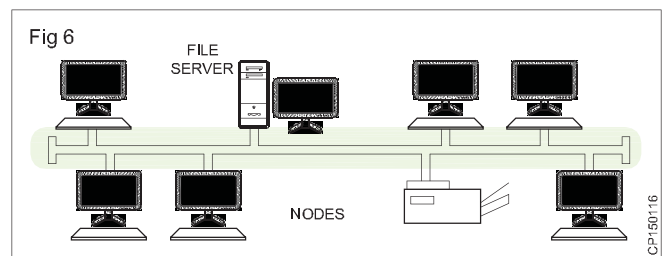
## Network Topology

The physical topology of a network refers to the configuration of cables, computers, and other peripherals. Physical topology should not be confused with logical topology which is the method used to pass information between workstations.

Main Types of Physical Topologies

- LINEAR BUS
- STAR
- RING
- TREE
- MESH

### Linear Bus Topology



A linear bus topology (Fig 6) consists of a main run of cable with a terminator at each end. All nodes (file server, workstations, and peripherals) are connected to the linear cable.

### 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.

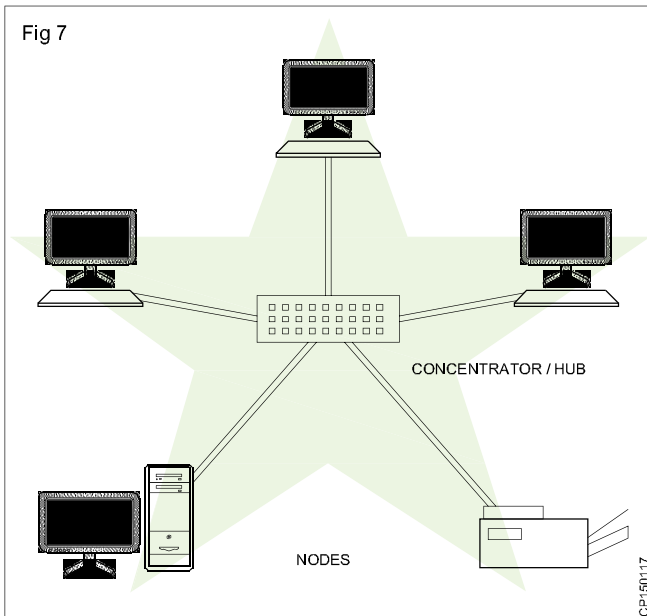
### Disadvantages of a Linear Bus Topology

- 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 Topology

A star topology (Fig 7) is designed with each node (file server, workstations, and peripherals) connected directly to a central network hub, switch, or concentrator





Data on a star network passes through the hub, switch, or concentrator before continuing to its destination. The hub, switch, or concentrator manages and controls all functions of the network. It also acts as a repeater for the data flow.

This configuration is common with twisted pair cable; however, it can also be used with coaxial cable or fiber optic cable.

#### 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

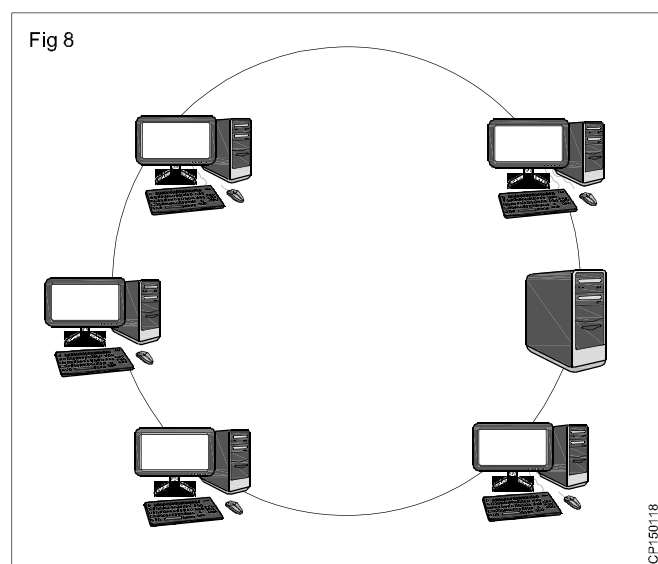
- Requires more cable length than a linear topology.
- If the hub, switch, or concentrator fails, nodes attached are disabled.
- More expensive than linear bus topologies because of the cost of the hubs, etc.

#### Ring Topology

The ring topology (Fig 8) is one which the network is a loop where data is passed from one workstation to another.

#### Advantages of Ring Topology

- This is very organized. Each node gets to send the data when it receives an empty token. This helps to reduce chances of collision. Also in ring topology all the traffic flows in only one direction at very high speed.



- There is no need for network server to control the connectivity between workstations.
- Additional components do not affect the performance of network.
- Each computer has equal access to resources.

#### Disadvantages of Ring Topology

- Each packet of data must pass through all the computers between source and destination.
- If one workstation or port goes down, the entire network gets affected.
- Network is highly dependent on the wire which connects different components.
- MAU's and network cards are expensive as compared to Ethernet cards and hubs.

#### Tree or Expanded Star

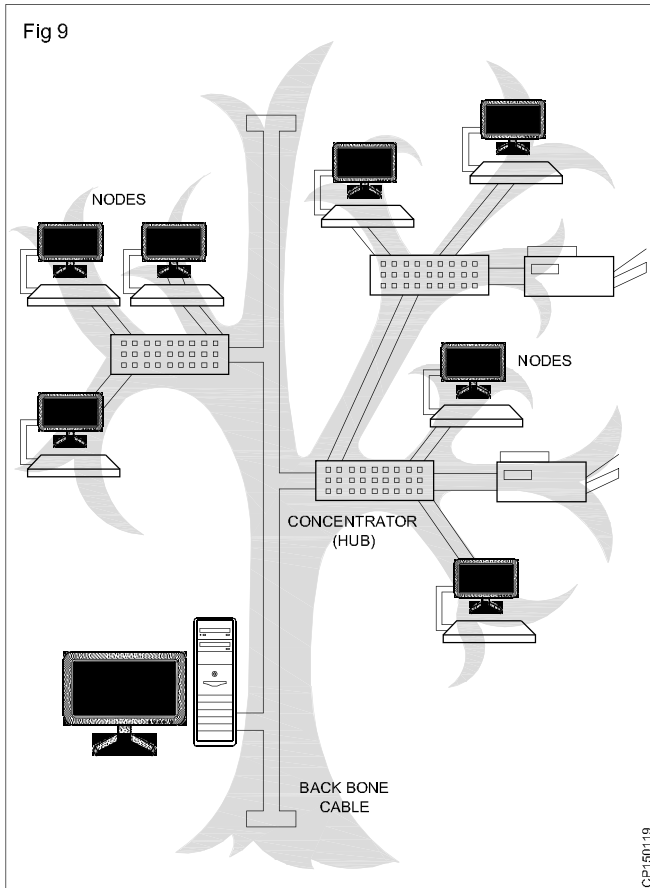
A tree topology (Fig 9) combines characteristics of linear bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable. Tree topologies allow for the expansion of an existing network, and enable schools to configure a network to meet their needs.

#### Advantages of a Tree Topology

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

#### Disadvantages of a Tree Topology

- Overall length of each segment is limited by the type



of cabling used.

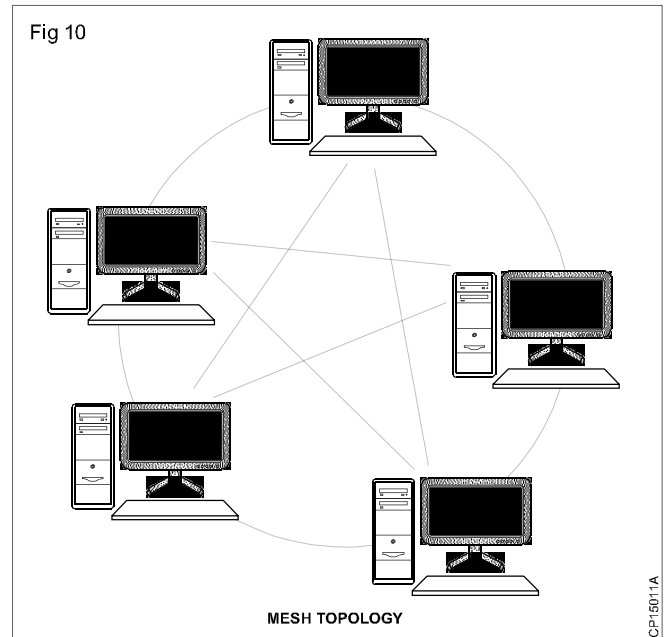
- If the backbone line breaks, the entire segment goes down.
- More difficult to configure and wire than other topologies.

### Mesh Topology

A network setup where each of the computers and network devices are interconnected with one another, allowing for most transmissions to be distributed, even if one of the connections go down. This topology is not commonly used for most computer networks as it is difficult and expensive to have redundant connection to every computer. However, this topology is commonly used for wireless networks (Fig 10).

### Advantages of Mesh topology

- Data can be transmitted from different devices simultaneously. This topology can with stand high traffic.
- Even if one of the components fails there is always an alternative present. So data transfer doesn't get affected.
- Expansion and modification in topology can be done without disrupting other nodes.



### Disadvantages of Mesh topology

- There are high chances of redundancy in many of the network connections.
- Overall cost of this network is way too high as compared to other network topologies.
- Set-up and maintenance of this topology is very difficult. Even administration of the network is tough.

## PROTOCOLS

### Network Protocol

A **network protocol** defines rules and conventions for communication between network devices. Protocols for computer networking all generally use packet switch techniques to send and receive messages in the form of packets. Network protocols include mechanisms for devices to identify and make connections with each other, as well as formatting rules that specify how data is packaged into messages sent and received. Some protocols also support message acknowledgement and data compression designed for reliable and/or high-performance network communication. Hundreds of different computer network protocols have been developed each designed for specific purposes and environments.

### Parameters of Protocol

- 1 Physical cable or transmission media.
- 2 Number of bits transmitted on the media.
- 3 When to transmit the data on the network.
- 4 Volume of data to be transmitted.
- 5 Interact with a network with different cable type or topology.
- 6 Ensure that the message has been delivered intact

Network Topology Comparison						
Topology	Information Transfer	Setup	Expansion	Troubleshooting	Cost	Cabling Concerns
<p><b>Star Bus</b></p> <p>Each computer connects to a central connection device.</p>	<p>All information passes through the central network connection.</p>	<p>Each computer must be close to the central device.</p> <p>100 meters maximum cable length.</p> <p>Up to 24 computers per network.</p>	<p>Add a new computer by plugging in a new cable from the computer to the connection device.</p>	<p>When one computer goes down, the rest of the network is unaffected. If the connection device goes down, then the network is down.</p>	<p>More expensive of the simple topologies, it requires costly connection device. Usually cheaper than a hybrid network.</p>	<p>Uses twisted pair cable.</p> <p>Requires large amounts of cable. No more than 100 meters from the computer to the connection device.</p>
<p><b>Bus</b></p> <p>Single cable connects everything.</p>	<p>One computer at a time sends information. Information goes along the cable and the computer accesses the information off the cable.</p>	<p>Connect the cable from one computer to the next and so on to the end.</p> <p>A terminator is placed at each end of the network.</p>	<p>To add a computer, you must shut down the network and disconnect the cable from the existing computers.</p>	<p>If one computer malfunctions, the entire network goes down.</p>	<p>A cheaper network since there is usually one continuous copper cable.</p>	<p>Single continuous cable connects the devices.</p> <p>Terminator is required at each end of the cable.</p> <p>Uses coaxial or twisted pair cabling.</p>
<p><b>Ring</b></p> <p>Single cable configured in a ring.</p>	<p>Information goes in one direction around the ring and passes along the ring until it reaches the correct computer.</p>	<p>Computers are located close to each other.</p> <p>Setup is easy. There is no connector.</p> <p>The ring has no beginning and no end.</p>	<p>Cable between the computers must be broken to add a new computer, so the network is down until the new device is back online.</p>	<p>If there's a break in the cable or an error in the network, information continues to transfer through the rest of the ring until reaching the point of the break. This makes troubleshooting easy.</p>	<p>One of the more expensive topologies due to high cable costs.</p>	<p>Requires more cabling than other topologies.</p> <p>Uses twisted pair.</p>



Network Topology Comparison						
Topology	Information Transfer	Setup	Expansion	Troubleshooting	Cost	Cabling Concerns
<b>Hybrid Mesh</b>  Combines two or more different structures.	Often used across long distances. Information transfer can happen in different ways, depending on the other topologies.	Often created when expanding an existing network. Can use a variety of connection devices.	Connection devices make combining different networks and different topologies easy.	Troubleshooting is most difficult in this topology because of the variety of technologies.	Expensive, large, and usually complicated.	Cabling depends on the types of networks.  Can use twisted pair and coaxial cable.  Also incorporates fiber optic cabling over long distances.

and in a proper manner.

### List of Network Protocols

**1 TCP/IP:** Transmission Control Protocol / Internet Protocol is an industry standard protocol widely used. It is used for inter operating among different types of computers. Almost all types of networks support TCP/IP. It is the protocol used by the Internet. It uses a 32 - bit addressing scheme.

#### IP Address

IP defines an addressing scheme that is independent of the underlying physical address (e.g. 48-bit MAC address). IP specifies a unique 32-bit number for each host on a network.

This number is known as the **Internet Protocol Address**, the **IP Address** or the **Internet Address**. These terms are interchangeable. Each packet sent across the internet contains the IP address of the source of the packet and the IP address of its destination.

**2 UDP - User Datagram Protocol** - is a simple OSI transport layer protocol for client/server network applications based on Internet Protocol (IP). UDP is the main alternative to TCP and one of the oldest network protocols in existence, introduced in 1980. UDP is often used in videoconferencing applications or computer games specially tuned for real-time performance.

**3 FTP: File Transfer Protocol (FTP)** is a standard network protocol used to transfer files from one host or to another host over a TCP-based network, such as the Internet.

FTP is built on a client-server architecture and uses separate control and data connections between the client and the server. FTP users may authenticate themselves using a clear-text sign-in protocol, normally in the form of a username and password, but can connect anonymously if the server is configured to allow it.

For secure transmission that hides (encrypts) the username and password, and encrypts the content, FTP is often secured with SSL/TLS ("FTPS"). **SSH File Transfer Protocol (SFTP)** is sometimes also used instead.

#### 4 SMTP

**Simple Mail Transfer Protocol (SMTP)** is an Internet standard for electronic mail (e-mail) transmission across Internet Protocol (IP) networks.

While electronic mail servers and other mail transfer agents use SMTP to send and receive mail messages, user-level client mail applications typically only use SMTP for sending messages to a mail server for relaying.

For receiving messages, client applications usually use either the **Post Office Protocol (POP)** or the **Internet Message Access Protocol (IMAP)** or a proprietary system (such as Microsoft Exchange or Lotus Notes/Domino) to access their mail box accounts on a mail server.

#### 5 Telnet

Telnet is a network protocol used on the Internet or local area networks to provide a bidirectional interactive text-oriented communication facility using a virtual terminal

connection. User data is interspersed in-band with Telnet control information in an 8-bit byte oriented data connection over the **Transmission Control Protocol (TCP)**.

Telnet provided access to a command-line interface (usually, of an operating system) on a remote host. Most network equipment and operating systems with a TCP/IP stack support a Telnet service for remote configuration (including systems based on Windows NT). Because of security issues with Telnet, its use for this purpose has waned in favour of SSH.

## 6 HTTP

The **Hypertext Transfer Protocol (HTTP)** is an application protocol for distributed, collaborative, hypermedia information systems. HTTP is the foundation of data communication for the World Wide Web.

Hypertext is a multi-linear set of objects, building a network by using logical links (the so-called hyperlinks) between the nodes (e.g. text or words). HTTP is the protocol to exchange or transfer hypertext.

## 7 SSH File Transfer Protocol

In computing, the **SSH File Transfer Protocol** (also **Secure File Transfer Protocol**, **Secure FTP**, or **SFTP**) is a network protocol that provides file access, file transfer, and file management functionalities over any reliable data stream.

It was designed by the Internet **Engineering Task Force (IETF)** as an extension of the **Secure Shell Protocol (SSH)** version 2.0 to provide secure file transfer capability, but is also intended to be usable with other protocols.

The IETF of the Internet Draft states that even though this protocol is described in the context of the SSH-2 protocol, it could be used in a number of different applications, such as secure file transfer over **Transport Layer Security (TLS)** and transfer of management information in VPN applications.

This protocol assumes that it is run over a secure channel, such as SSH, that the server has already authenticated the client, and that the identity of the client user is available to the protocol.

## 8 Post Office Protocol

In computing, the **Post Office Protocol (POP)** is an application-layer Internet standard protocol used by local e-mail clients to retrieve e-mail from a remote server over a TCP/IP connection. POP and IMAP (Internet Message Access Protocol) are the two most prevalent Internet standard protocols for e-mail retrieval.

Virtually all modern e-mail clients and servers support both. The POP protocol has been developed through several versions, with version 3 (POP3) being the current standard. Most webmail service providers such as Hotmail, Gmail and Yahoo! Mail also provide IMAP and POP3 service.

## Networking Components

- **Gateway:** A device sitting at a network node for interfacing with another network that uses different protocols. Works on OSI layers 4 to 7.
- **Router:** A specialized network device that determines the next network point to which it can forward a data packet towards the destination of the packet. Unlike a gateway, it cannot interface different protocols. Works on OSI layer 3.
- **Switch:** A device that allocates traffic from one network segment to certain lines (intended destination(s)) which connect the segment to another network segment. So unlike a hub a switch splits the network traffic and sends it to different destinations rather than to all systems on the network. Works on OSI layer 2.
- **Bridge:** A device that connects multiple network segments along the data link layer. Works on OSI layer 2.
- **Hub:** It connects multiple Ethernet segments together making them act as a single segment. When using a hub, every attached device shares the same broadcast domain and the same collision domain. Therefore, only one computer connected to the hub is able to transmit at a time.

Depending on the network topology, the hub provides a basic level 1 OSI model connection among the network objects (workstations, servers, etc.). It provides bandwidth which is shared among all the objects, compared to switches, which provide a connection between individual nodes.

- **Repeater:** A device to amplify or regenerate digital signals received while sending them from one part of a network into another. Works on OSI layer 1.
- **Modem (MoDem):** A device that **modulates** an analog "carrier" signal (such as sound), to encode digital information, and that also **demodulates** such a carrier signal to decode the transmitted information, as a computer communicating with another computer over the telephone network

### Types of MODEM

**External Modem:** This is a modem separated from the system unit in the computer case. It is connected to the serial port of the computer by means of a cable. It is connected to the telephone wall jack by another cable.

**Internal Modem:** An internal modem is a circuit board (a modem card) that can be added to the system unit of the computer. It takes one of the expansion slots.

### Wired Modem / Standard Modem

Most modem's used today are called standard modems. These modems are usually operated by commands entered from a microcomputer keyboard. Users control the functions (dialling, etc.) of a modem through the keyboard. Modems may use different command languages to control their functions,