UNIT-1

Introduction: History and development of computer networks, Basic Network Architectures: OSI reference model, TCP/IP reference model, and Networks topologies, types of networks (LAN, MAN, WAN, circuit switched, packet switched, message switched, extranet, intranet, Internet, wired, wireless)

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Introduction to Computer Networks

COMPUTER NETWORK:

- A computer network is a system in which multiple computers are connected to each other to share information and resources.
- The physical connection between networked computing devices is established using either cable media or wireless media.
- The best-known computer network is the Internet.

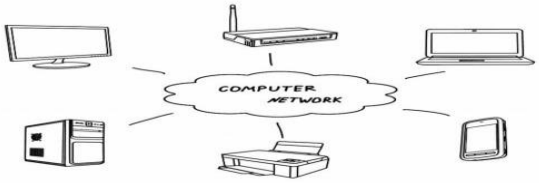


Fig: Computer Network

Advantages of Computer Networks

1. **File sharing:** The major advantage of a computer network is that is allows file sharing and remote file access. **Resource sharing:** All computers in the network can share resources such as printers, fax machines, modems, and scanners.
2. **Better connectivity and communications:** It allows users to connect and communicate with each other easily.
3. **Internet access:** Computer networks provide internet service over the entire network. Every single computer attached to the network can experience the high speed internet.
4. **Entertainment:** Many games and other means of entertainment are easily available on the internet.

Disadvantages of Computer Networks

1. **Lack of data security and privacy:** Because there would be a huge number of people who would be using a computer network to get and share some of their files and resources, a certain user's security would be always at risk.
2. **Presence of computer viruses and malwares:** If even one computer on a network gets affected by a virus, there is a possible threat for the other systems getting affected too.
3. **Lack of Independence:** Since most networks have a centralized server and dependent clients, the client users lack any freedom whatsoever. Centralized decision making can sometimes hinder how a client user wants to use his own computer.
4. **Lack of Robustness:** As previously stated, if a computer network's main server breaks down, the entire system would become useless. Also, if it has a bridging device or a central linking server that fails, the entire network would also come to a standstill.

History and development of computer network

Year	Event
1961	In this year, Leonard Kleinrock proposed the earliest computer networks, which was the idea of ARPANET.
1965	In 1965, Donald Davies coined the term "packet" to describe how to send data between computers on a network.
1969	Although In 1966, the development of ARPANET began, officially started ARPANET in 1969. It was considered one of the first computer networks in which first two nodes, UCLA and SRI (Stanford Research Institute) were connected, and to use packet switching. To provide and define information about network protocols, procedures, and computer communications, the first RFC surfaced as a document in April 1969.
1969	On 29 August 1969, the first IMP and network switch were sent to UCLA. On ARPANET, the first data transmission was sent by using it.
1970	NCP, stands for NetWare Core Protocol, released by Steve Crocker and a team at UCLA for use with NetWare.
1971	In 1971, the first e-mail was sent to across a network to other users by Ray Tomlinson.
1973	While working at Xerox PARC, Robert Metcalfe developed the Ethernet in 1973. In the same year, ARPA deployed the first international network connection, known as SATNET. In 1973, VoIP technology and capabilities were officially introduced, which made a VoIP call. However, until 1995, the software was not available for users that could make VoIP calls.
1974	In this year, the use of first router was began, but they were not considered true IP routers.
1976	Originally called a gateway, Ginny Strazisar develop the first true IP router.
1978	In 1978, the TCP/IP protocol was developed and invented by Bob Kahn for networks; it was developed with help from Vint Cerf.
1981	In the United States, between IBM mainframe systems, BITNET was created in 1981 as a network. The U.S. National Science Foundation developed the CSNET (Computer Science Network) in the same year 1981.
1983	For using TCP/IP, ARPANET finished the transition. The first DNS implement by Jon Postel and Paul Mockapetris in 1983.
1986	This is the year in which a backbone for ARPANET, the National Science Foundation Network was came online, which finally took the place of ARPANET in 1990s. In the same year, with the original BITNET, BITNET II was introduced to deal with bandwidth issues.
1988	In 1988, the first T1 backbone was included with ARPANET. AT&T, Lucent, and NCR introduced the WaveLAN network technology in 1988.
1990	The first network switch was developed and introduced by a U.S. network hardware company named Kalpana in 1990.

1996	In 1996, an IPv6 was introduced as an improvement over IPv4, as well as embedded encryption, improved routing.
1997	In June 1997, the 802.11 standards, containing transmission speeds up to 2 Mbps, for Wi-Fi were introduced.
1999	The 802.11a standard, containing transmission speeds up to 25 Mbps to use the 5 GHz band, was officially made in 1999. Another standard 802.11b was available to use for the public in mid-1999, which offered transmission speeds up to 11 Mbps. In September 1999, for use with 802.11b, the WEP encryption protocol was released.
2003	802.11g devices, contained transmission speeds up to 20 Mbps, were available to the public in January 2003. In the same year, for use with 802.11g, the WPA encryption protocol is released.
2004	In 2004, as a replacement for WPA, the WPA2 encryption protocol was introduced. By 2006, WPA2 certification was compulsory for all Wi-Fi devices.
2009	The 802.11n standard can operate on the 2.4 GHz and 5 GHz bandwidths and offers higher transfer speeds over 802.11a and 802.11g. Officially, it was made in 2009.
2018	In January 2018, WPA3 encryption was released by the Wi-Fi Alliance, which comprises security enhancements over WPA2.

THE INTERNET

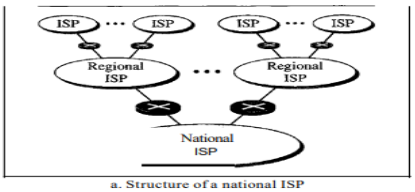
Internet is a global network that connects billions of computers across the world with each other and to the World Wide Web. It uses standard internet protocol suite (TCP/IP) to connect billions of computer users worldwide. It is set up by using cables such as optical fibers and other wireless and networking technologies. At present, internet is the fastest mean of sending or exchanging information and data between computers across the world.

A Brief History

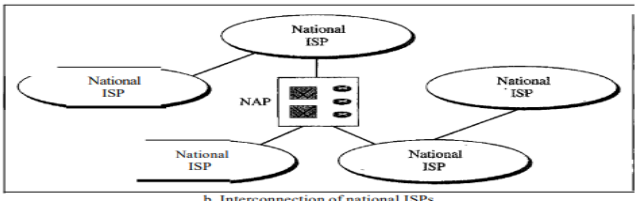
- Millions of people are users. Yet this extraordinary communication system only came into being in 1969
- In the mid-1960s, mainframe computers in research organizations were standalone devices.
- In 1967, at an Association for Computing Machinery (ACM) meeting, ARPA presented its ideas for ARPANET, a small network of connected computers.
- 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.
- In 1972, Vint Cerf and Bob Kahn, both of whom were part of the core ARPANET group, collaborated on what they called the Interknitting Projec1. Cerf and Kahn's landmark 1973 paper outlined the protocols to achieve end-to-end delivery of packets. This paper on Transmission Control Protocol (TCP) included concepts such as encapsulation, the datagram, and the functions of a gateway.

The Internet Today : The Internet has come a long way since the 1960s. The Internet today is not a simple hierarchical structure. It is made up of many wide- and local-area networks joined by connecting devices and switching stations.

- Today most end users who want Internet connection use the services of Internet service providers (lSPs). There are international service providers, nation service providers, regional service providers, and local service providers. The Internet today is run by private companies, not the government. Figure 1.13 shows a conceptual (not geographic) view of the Internet



a. Structure of a national ISP



b. Interconnection of national ISPs

International Internet Service Providers: At the top of the hierarchy are the international service providers that connect nations together

National Internet Service Providers

To provide connectivity between the end users, these backbone networks are connected by complex switching stations (normally run by a third party) called network access points (NAPs). Some national ISP networks are also connected to one another by private switching stations called peering points. These normally operate at a high data rate (up to 600 Mbps).

Regional Internet Service Providers Regional internet service providers or regional ISPs are smaller ISPs that are connected to one or more national ISPs. They are at the third level of the hierarchy with a smaller data rate.

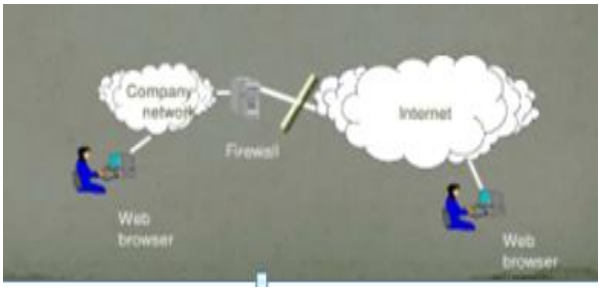
Local Internet Service Providers : Local Internet service providers provide direct service to the end users.

Advantages of the Internet:

- **Instant Messaging:** You can send messages or communicate to anyone using internet, such as email, voice chat, video conferencing, etc.
- **Get directions:** Using GPS technology, you can get directions to almost every place in a city, country, etc. You can find restaurants, malls, or any other service near your location.
- **Online Shopping:** It allows you to shop online such as you can be clothes, shoes, book movie tickets, railway tickets, flight tickets, and more.
- **Pay Bills:** You can pay your bills online, such as electricity bills, gas bills, college fees, etc.
- **Online Banking:** It allows you to use internet banking in which you can check your balance, receive or transfer money, get a statement, request cheque-book, etc.
- **Online Selling:** You can sell your products or services online. It helps you reach more customers and thus increases your sales and profit.
- **Work from Home:** In case you need to work from home, you can do it using a system with internet access. Today, many companies allow their employees to work from home.
- **Entertainment:** You can listen to online music, watch videos or movies, play online games.
- **Cloud computing:** It enables you to connect your computers and internet-enabled devices to cloud services such as cloud storage, cloud computing, etc.
- **Career building:** You can search for jobs online on different job portals and send you CV through email if required.

INTRANET

Private and secure information system which uses internet technology to collect and disseminate information of interest to all staff .

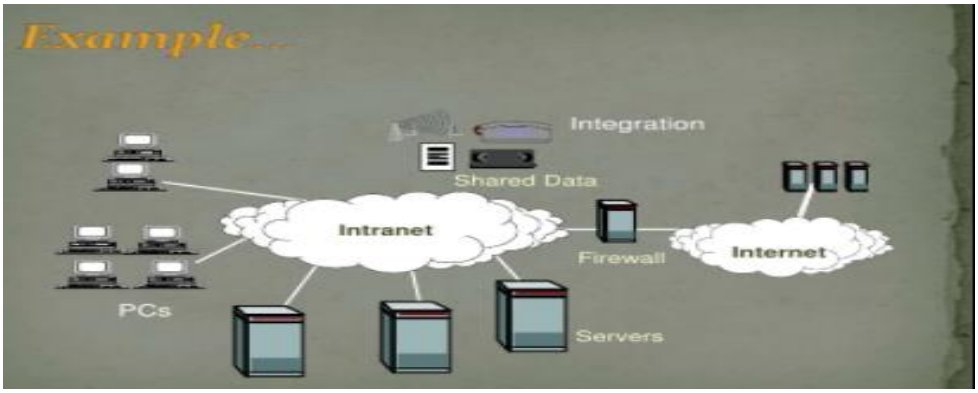


Why intranets

- Improved internal communication
- Improved access to information
- Improved productivity
- Promote user participation
- Improved management

Technology behind intranets

- One or more inter connected TCP/IP networks
- Internet connectivity with firewall protection
- Servers:WEB,E-Mail,Proxy,DNS
- Browsers,plug-ins,authoring tools
- Databases,search engines
- Website administration tools



Advantages

- Platform independent
- Ease of publishing
- Easier to setup
- Ease of use
- Maintenance is very easy
- Cost effective
- Information retrieval is timely manner

Disadvantages

- Security Concerns
- Intranetmay cause information overload

Extranet

Extranet is a part of an organization's intranet. It is a communication network that is based on internet protocols (TCP/IP). It provides controlled access to firm's intranet to its trading partners, customers, and other businesses. So, it is a private network that securely shares internal information and operations of a firm with authorized people outside the firm without giving access to the company's entire network. The users are required to have IDs, passwords, and other authentication mechanisms to access this network

Some of the benefits of extranet:

- It acts as a single interface between the company and its trading partners.
- It automates the firm's processes like automatically places an order with suppliers when inventory drops.
- It improves customer service by providing customers a platform to resolve their queries and complaints.

How is Extranet Established?

It is set up in the form of a Virtual Private Network as it is prone to security threats due to the use of the internet to connect outsiders to an organization's intranet. VPN can assure you a safe network in a public network such as the internet. The transmission control protocol (TCP) and internet protocol (IP) are used for the data transfer.

VPN assures secure transactions based on Internet Protocol Security Architecture (IPSEC) protocol as it provides an extra security layer to TCP/IP protocol, which is used for data transfer in the extranet. In this layer, the IP packet is encapsulated to form a new IP packet, as shown below:

Furthermore, to provide more security to Intranet, the following two measures are also taken by an organization:

- **Firewall:** It prevents unauthorized users from accessing the extranet.
- **Passwords:** It also prevents unauthorized users, including the company's employees from accessing the data stored on its server.

Limitations of Extranet:

- **Hosting:** If you host extranet pages on your own server, it requires a high bandwidth internet connection, which is may be very expensive.
- **Security:** You need extra firewall security if you host it on your own server. It increases the workload and makes security mechanism very complex.
- **Dependency:** It is dependent on the internet as outsiders cannot access information without using the internet.

Difference between internet, Intranet and Extranet

BASIS OF COMPARISON	INTERNET	INTRANET	EXTRANET
Description	Internet can be described as a global system of interconnected computer network.	Intranet can be described as a network of computers or a private network designed for a specific group of users (organization).	Extranet can be described as a private network that uses public network to share information with clients (suppliers and vendors).
Size Of The Network	Internet is the largest network in as far as the number of connected devices is concerned.	It is a small network with a few number of connected devices.	It is a small network with a few number of connected devices.
Purpose	Internet is a means of sharing information throughout the world.	Intranet is a means of sharing sensitive or confidential information throughout the organization.	Extranet is a means of conveying information between members of the organization and external members.
Content On The Network	Content in the network is readily accessible by everyone who is connected.	The content in the network is accessible only to members of the organization.	The content on the network is accessible to members of the organization and external members with access to the network.
Ownership	Internet has no known ownership.	Ownership of intranet is by a single organization.	Ownership of extranet is by a single or multiple organizations.
Access	Users have unrestricted access and can access internet anonymously.	An intranet may be accessible from the internet, but it is protected by a password and accessible only to authorized users.	An intranet may be accessible from the internet, but it is protected by a password and accessible only to authorized users.
Security	Security is dependent of the user of the device connected to network.	Security of the network is enforced through a firewall.	Security of the network is enforced through a firewall that separates internet and extranet.
User Training	Users need no training on how to work with the network.	Time is required to train users on how to work with the network.	Time is required to train users on how to work with the network.
Example	An example of internet is the network you use to google words with.	An example intranet is a company like ExxonMobil using internal network for its business operations.	Example of extranet is when companies like HP, Intel and Lenovo decide to use the same network for related

NETWORK TOPOLOGIES

Topology is the arrangement of network by including nodes and connecting lines. (or) A physical or logical arrangement of nodes in a network is called network topology.

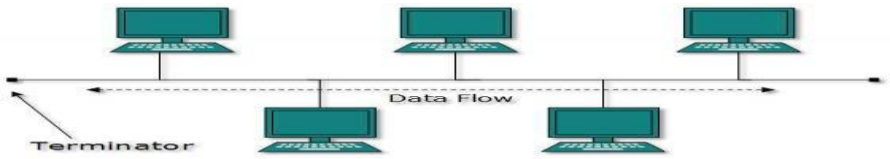
Different types of Network topologies are

- Bus topology
- Ring topology
- Star topology
- Mesh topology
- Tree topology

Bus Topology

In bus topology devices or nodes are connected to the same line or single cable and each computer system is connected to a single cable of bus

At any time, any computer can send the data over the bus. When more than one computer wants to send data at a same time a bus arbitration mechanism will decide which computer has to send.



Advantages:

- Works well for small networks.
- Cost of network is low.
- Easy to add new nodes.
- Less cable is required because of backbone.

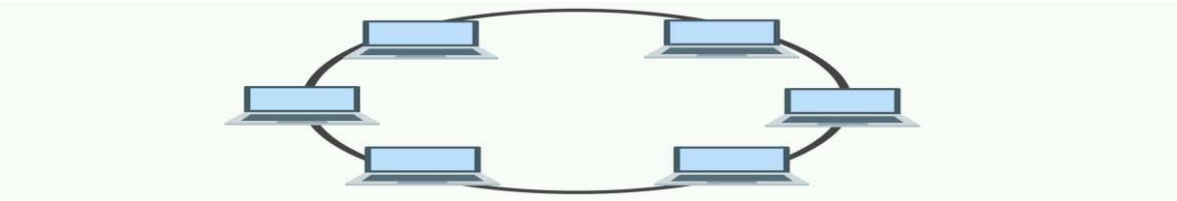
Disadvantages:

- Heavy n/w traffic can slow a bus.
- Management cost may be high.
- Failure of backbone affects failure of all devices on the n/w.

Ring Topology

In ring topology each device is connected by a dedicated point-to-point connection to its adjacent devices forms a ring structure and any node has exactly two branches connected to it.

Data is transmitted around the ring in a particular direction to reach its destination. In between the signal is regenerated by the repeater in the ring. So it is an active n/w and termination is not required.



Advantages

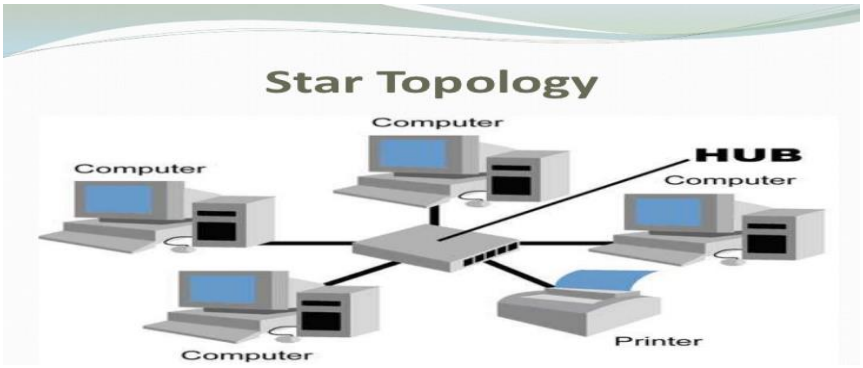
- Easy to install
- Link failure can be easily found as each device is connected to its immediate neighbours only.
- Because every node is given equal chance to access the n/w by giving tokens to each node.

Disadvantages

- Maximum ring length and number of devices is limited.
- Failure of one node can affect the entire n/w.

Star Topology

In Star topology all the devices/nodes are connected to a central computer or server in a point-to-point connection stream. In star topology every node is connected to a central node, which is called Hub/Switch via cables. Hub connects different nodes which are present in the star network and it can manage or control whole network.



Advantages

- Less expensive than mesh since each device is connected only to the hub.
- Installation and configuration are easy.
- Less cable is need then mesh.
- Easy to fault identification and to remove parts.
- No disruptions to the network when connecting (or) removing devices.

Disadvantages

- If the central hub fails, the whole network fails to operate.

Mesh Topology

Each node is directly connected to all other nodes, which are present in the entire network. In this each node not only send its own data but also can broadcast the data from other nodes.

This topology is very expensive just because of there are many needless connections and is mainly used in wireless connections.

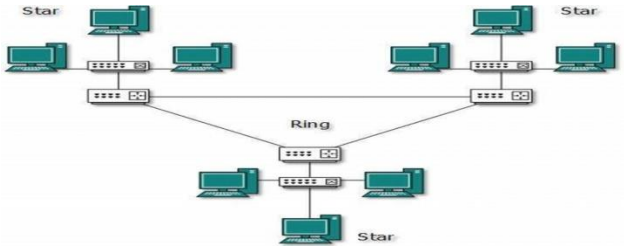
Advantages

- Dedicated link between nodes ensures optimum data rate and eliminate traffic problem.
- Better privacy and security.
- Failure of any link will not cause failure of entire network.

Disadvantages

- Large amount of cabling and i/o paths are required.
- Hardware required for each link and redundant link increases cost.
- It is Expensive.
- Difficulty in installation.
- Difficult to recognize.

Hybrid Topology: A network structure whose design contains more than one topology is said to be hybrid topology. For example if in an office in one department ring topology is used and in another star topology is used, connecting these topologies will result in Hybrid Topology (ring topology and star topology).



Advantages:

- Reliable as error detecting and trouble shooting is easy.
- Scalable as size can be increased easily.
- Flexible.

Disadvantages:

- Complex in design.
- Costly.

TYPES OF NETWORKS

Local Area Network(L.A.N):-

- A LAN is system composed of computer hardware and transmission media and software.
- The standard of LAN is IEEE -802, which is popularly used shared media for peer-to-peer communications that broadcasts information for all stations to receive.
- The LAN enables stations to communicate directly using a common physical medium on a Point to point basis without any intermediate switching node.
- It generally use only one type of transmission media.
- LAN'S are privately owned networks within a single building (or) campus of upto kms in range.
- Depends on application and cost, various topology used in LAN(star,bus,ring).
- LAN transmits data amongst user stations.
- LAN transmission capacity is more than 1 mbps.
- LAN is limited to areas less than 5 sq.kms.

Fig.1: Two broadcast networks . (a) Bus. (b) Ring.

LAN can provide users

- Flexibility and speed
- Adapatability and reliability
- Security and transparent interface
- Centralised mgt and private ownership

Metropolitan Area Network(M.A.N):-

- A MAN is larger than LAN which is limited to cities (or) group of nearby corporate offices.
- It uses similar technology as LAN.
- MAN standards are sponsored by IEEE. The Man standards is organized around a topology and technique called distributed queue dual bus (DQDB).
- MAN provides the transfer rates from 34 to150 mbps.
- MAN is designed with two unidirectional busses.
- Each bus is independent of the other in the transfer of traffic.
- The topology can be designed as an open bus (or) a closed configuration.

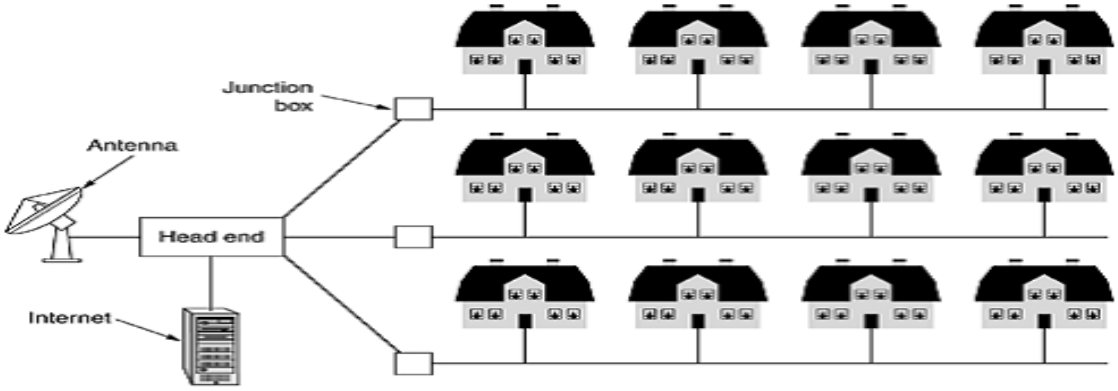
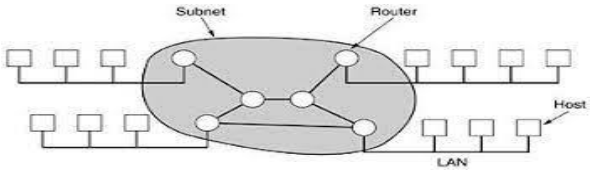


Fig: A Metropolitan area networks based on cable TV.

- MAN are based on fiber optic transmission technology and provides high speed interconnections between sites. It supports both data and voice.
- MAN as a special category is that standard has been adopted for them and implemented which is called IEEE 802.6

Wide Area Network(W.A.N):-

- A WAN is within the limit of country (or) continent.
- Machines are connected for running user applications (or) programs. These machines are called “hosts”.
- All the hosts are connected by each other through communication subnet.
- Subnet carries messages from host to host.
- Subnet contains transmission lines and switching elements.
- Transmission line is used for data transfer between two machines.
- Switching elements are used for connecting two transmission lines.
- Switching elements are basically computers and they are called packets switching nodes,intetrmediate sustems and data switching exchanges.



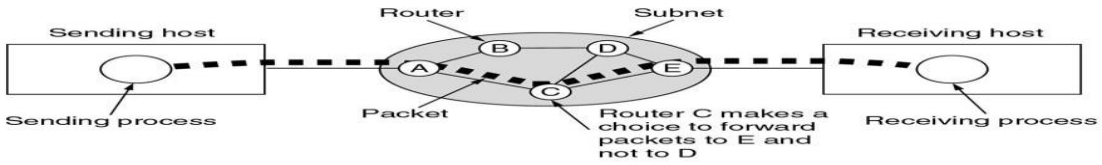
Relation between hosts on LANS and ther subnet.

- The above fig. shows the relation between hosts,subnet and routers in WAN. Each host is connected to a LAN on which a router is present.
- In the WAN a subnet is organized according to the principle,

Which a packet is sent from one router to another via one (or) more intermediate routers the packet is received to each intermediate router and stored until the required output line is free and then forwarded.

This is called “store and forward” (or) “packet switched subnet”.

Wide Area Networks (2)



A stream of packets from sender to receiver.

Comparision between LAN,MAN,WAN:

BASIS OF COMPARISION	LAN	MAN	WAN
Expands to	Local Area Network	Metropolitan Area Network	Wide Area Network
Meaning	A network that connects a group of computers in a small geographical area.	It covers relatively large region such as cities, towns.	It spans large locality and connects countries together. Example Internet.
Ownership of Network	Private	Private or Public	Private or Public
Design and Maintenance	Easy	Difficult	Difficult
Propagation Delay	Short	Moderate	Long
Speed	High	Moderate	Low
Fault Tolerance	More Tolerant	Less Tolerant	Less Tolerant
Congestion	Less	More	More
Used for	College,School,Hospital.	Small towns,City.	Country/Continent.