Chapter 8 : Introductions to Computer Networks

Computer Networks –AN Introduction

A computer network is a collection of interconnected autonomous computing devices so as

to exchange information or share resources .

- Two or more autonomous computing devices connected to one another in order to exchange information or share resources, form a computer network.

- Eg in home we can connect our smartphone, our laptop with our smart TV, gaming console and a printer simultaneously either using cables or through WiFi, it will be termed as a computer Network

  .
- Advantages and disadvantages

Advantages of Networks	Disadvantages of Networks
Share resources	The systems are more sophisticated and complex to run. This can add to costs and we may need specialist staff to run the network.
Share storage	If networks are badly managed, services can become unusable and productivity falls
Can share software	If software and files are held centrally, it may be impossible to carry out any work if the central server fails. People become reliant on the communications, if these fail, it can cause havoc.
Improve communications Messages can be sent (eg internal email)	Files security is more important especially if connected to WANs e.g., protection from viruses.

COMPONENTS OF A COMPUTER NETWORK

- Two computers with a cable won't form a network, in fact there are many components that together
  make a network.
- The major components of a computer network.
  (a) Hosts/Nodes (Such as PC, Laptops, smartphones etc)
  (b) Servers
  (c) Client
  (d) Network hardware(Such as NIC, router, switch, hub etc.)
  (e) Communication channel(such as cables , radio-links etc.)
  (f) Software(Such as protocols, network operating system etc.)
  (g) Network services(Such as BNS, File-sharing etc)

Types of Networks

- A computer network means a group of 'Networked' Computers i.e Computers that are linked by means of a communication system.
- A network can mean a small group of linked computers to a chain of a few hundred computers of different types(eg PCs, minis, mainframes etc)spread around the world
  .
- Network vary in size , complexity and geographical spread.

Types of Network

(i)   LAN(Local Area Network

(ii) WAN(Wide Area Network)

(iii) PAN(Personal Area Network)

(iv) MAN(Metropolitan Area Network)

Local Area Network(LAN)

- Small computer networks that are confined to a localised area(eg. An office, a building or a factory) are known as Local Area Networks(LANs).
- Traditionally, LANs are said to have geographical spread of upto 1 km.
- The key purpose of a LAN is to serve its users in resource sharing .
- The hardware as well as software resources are shared through LANs.
- LAN users can share data, information , programs, printers, hard-disks, modems etc.

- In a typical LAN configuration, one computer is designatedas the **File server**.
  - ➢ File server—It stores all of the software that controls the network, as well as the software
    that can be shared by the computers attached to the network.
  - ➢ File server:- A server is a computer that just serves the requests of doing some tasks, made by other computers in its network.
  - ➢ Afile server serves the request related to file sharing , storing etc.
  - ➢ Aprint serves the printer related requests and so on.
  - ➢ Computers connected to the server are called workstations.
- On most LANs, cables are used to connect the network interface cards in each computer.
  - ➢ network interface cards provides the physical connection between the network and the computer workstation.

Widel Area Network(LAN)

- The Networks spread acrosscountries or on a very big geographical area are known as WANs.
- A wide Area Network(WAN) is a group of computers that are separated by large distances and tied together.

- It can even be a group of LANs that are spread across serveral locations and connected together to look like one big LAN. The WANs link computers to facilitate fast and efficient exchange of information at lesser costs and higher speeds.
- Computers connected to a wide-area network are often connected through public networks such
  As the telephone system and sometimes they can be connected through leased lines or satellites.
- The largest WAN in existence is the Internet.

Sl no	LAN	WAN
a	It is spread over a small area	It is spread over a very large area
b	It usually costs less to set it up	It costs higher to set it up.
c	It is usually a single network	It is usually a network of many networks

METROPOLITAN AREA NETWORK (MAN)

- <u>MAN</u> , which refers to a network that is spread over an area as big as a city. But these days, this term has become redundant.

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PERSONAL AREA NETWORK (PAN)

- A personal area network is the iterconnection of information technology devices within the range of an individual person, typically with a range of 10 meters.
- Example, a person travelling with a laptop , a personal digital assistant (PDA), and a portable printer could interconnect them without having to plug anything in, using some form of wireless technology such as Wifi.
- This kind of PAN could also be interconnected without wires to the Internet or other networks.
- We can use PAN networks to transfer files including email and calendar appointments, digital photos and music etc from our portable devices such as phones and tables toPC and vice versa.

Network topologies

- The pattern of interconnection of nodes in a network is called the topology.
- The selection of a topology for a network can not be done in isolation as it affects the choice of media and the access method used.
- There are a number of factors to consider in making this choice, the most important of which are set out below:
  - ➤ **Cost**:--
    - ▪ For a network to be cost effective , one would try to minimize installation cost.
    - ▪ **This may be achieved by using welllunderstood   mediaand also , to a lesser extent by minimizing the distancesinvolved**
  - ➤ Flexibility:-
    - ▪ Because the arrangement of furniture, internal walls etc. in offices is often subject to change, the topology should allow for easy reconfiguration of the network.
    - ▪ In this moving of existing nodes and adding new ones.
  - ➤ Reliability:-
    - ▪ Failure in a network can take two forms.
      (i)1st an individual node can malfunction.
      (ii)2nd network fails to operate.

The topology chosen for the network can help by allowing the location of the fault to be detected and to provide some of isolating it.

<u>Point –to-Point Link</u>

- It basically relies upon two function ---transmit and receive.
- The main characteristics of P-P network is that each station receives exactly from one transmitter, and each transmitter transmits to exactly one receiver.
- The transmit and receive operations can occur over separate wires9 for better performance) or they can take turns over the same wire using a variety of techniques.
- Point –to point networks can grow in several ways.
- One method is simply to install a P-P link between each pair of computersin the network.
  called Mesh.

- Many toplogies have been developed, but major ones are :-
  - The STAR topology
  - The BUS topology
  - The RING topology
  - The TREE topology
  - The Mesh topology
  - The fully connected

<u>The STAR Topology</u>

- This topology consists of a central nodeto which all other nodes are connected by a single path.
- It is the topology used in most existing information networks involving data processing or voice communications.
- The most common example of this is IBM 370 installations, in which multiple 3270 terminals are connected to either a host system or a terminal controller.

<u>Advantage:-</u>

(i) Ease of service:- the star topology has a number of concentration points(where connections

   are joined)

(ii) One device per connection:-

- Connnection points in any network are inherently prone to failure.
- In star topology, failure of a single connection typically involves disconnecting one node from an otherwise fully functional network.

(i) Centralized control/problem diagnosis:-

- The fact that the central node is connected directly to everyother node in the network means that faults are easily detected and isolated.
- It is a simple matter to disconnect failing nodes from the system.

(ii)   Simple access protocols:-

- Any given connection in a star network involves only the central node.
- In this situation, contention for who has control of the mediumfor the transmission purposes is easily solved.
- Thus in a star network, access protocols are very simple.

Disadvantage of the Star Topology

- **Long cable: -**
  - **Because each node is directly connected to the center, the star topology necessitates a large quantity of cable.**
  - **Whilst the cost of cable is often small, congestion in cable ducts and maintenance and installation problems can increase cost considerably.**
- **Difficult to expand :- The addition of a new node to a star network involves a connection all the way to the central node.**
- **Central node dependency :-**
  - **If the central node in a star network fails, the entire network is rendered inoperable.**
  - **This introduces heavy reliability and redundancy constraints on this node.**

The star topology has found extensive application in areas where intelligence in the network is concentrated at the central node.

BUS TOPOLOGY

- Another topology for data networks is the linear.
- This consists of a single length of the transmission medium (normaly coaxial cable) onto which the various nodes are attached .
- The topology is used in traditional data communication network where the host at one end of the
  Bus communicates with several terminals attached along its length.
- The transmission from any station travels the length of the bus, in both directions and can be received by all other stations.
- The bus has terminators at either end which absorb the signal, removing it from the bus .
- Data is transmission
  - in small blocks, known as packets.
  - Each ach packet has some data bits, plus a header containing its destination address.
  - A station wanting to trans-mit some data sends it in packets along the bus.

- The destination device, on identifying the address on the packets, copies the data onto its Its disk.
- Advantages
  - Short cable length and simple wiring layout.
  - Resilient Architecture
  - Easy to extend

- Disadvantages
  - Fault diagnosis is difficult
  - Fault isolation is difficult
  - Repeater configuration
  - Nodes must be intelligent

The Ring Topology

- In this case, each node is connected to two and only two neighbouring nodes.
- Data is accepted from one of the neighbouring nodes and is transmitted onwards to another.
- Data travels in one direction only, from node to node around the ring.
- After passing through each node, it returns to the sending node, which removes it.
- In this it is important to note that data 'passed through' rather than 'travels past' each node.
- This means that the signal may be amplified before being 'repeated' on the outward channel .

Advantage:-

  - Short cable length
  - No wiring closet space required
  - Suitable for optical fibers

Disadvantage

  - **Node failure causes network failure.**
  - **Difficult to diagonose faults.**
  - **Network reconfiguration is difficult**

TREE TOPOLOGY

- ➤ **A variation of bus topology is the tree topology is the tree topology.**
- ➤ **The shape of the network is that of an inverted tree with the central root branching and**
  Sub branching to the extremities of the network.
- ➤ Transmission in this topology takes place in the same way as in the bus topology. In
  this there is no need to remove packets from the medium because when a signal reaches the end of the medium, it is absorbed by the terminators.
- ➤ Tree topology is best suited for applications which have a hierarchical flow of data and control.
- ➤ Since the tree topology is a modification of a 'pure' network topology, bus topology, it is hybrid topology.

- ▪ **Advantages**

  - ➤ It uses point-to-point wiring for individual segments.
  - ➤ It is supported by several hardware and software venders.

- ▪ **Disadvantages**
  - ➤ **Overall length of each segment is limited by the type of cabling used.**
  - ➤ **If the backbone line breaks, the entire segment goes down.**
  - ➤ **It is more difficult to configure and wire than other topologies.**

The Mesh Topology Topology

- ➤ In this topology, each node is connected to more than one node to provide an alternative route in the case the host is either down or too busy.
- ➤ It is an extension to P-P network.
- ➤ It is excellent for long distance networking because it provides extensive back-up, rerouting and pass-throughcapabilities.
- ➤ Communication is possible between any two nodes on the network either directly or by passing through. This function is needed in the event of a line or node failure elsewhere in the network.
- ➤ The mesh topology is commonly used in large internetworking environ-ments with stars, rings and busses attached to each node.
- ➤ This is ideal for distributed networks.

<u>Advantage:-</u>

- Each connection can carry its own data load.
- It is robust and provides security and privacy.
- In this topology, fault diagnosis is easy.

Disadvantage

- **Its installation and configuration is difficult.**
- **Cabling cost is more for mesh topology.**
- **Bulk wiring is required for mesh topology.**

Factors to Consider for Topology Selection

- **Cruciality of work**

- **Cost**

- **Length of cable needed**

- **Future growth**

- **Communication Media**

MODEM

- A modem is computer peripheral that allows us to connect and communicates with other computers via telephone lines.
- Modem is a device which allows a computer to send and receive data over teleophone lines or cable connections.
- As we know that ordinary telephone lines cannot carry digital information, a modem changes the digital data from our computer into analog data, a format that can be carried by telephone lines. In a similar manner, the modem receiving the call then changes the analog signal back into digital data that the computer can digest. This shift of digital data into analog data and back again, allows 02 computers to "speak" with one another called modulation/demodulation.
- Modulation is the process of sending data on a wave, 3 types of modulation tech-niques are used: AM(Amplitude Modulation),FM(Frequency Modulation),PM(Phase Modulation)

HUB

- A hub is a hardware device used to connect several computers together.
- A hub contains multiple independent but connected modules of network and inter-networked
  Equipment. A similar term is concentrator.
- A concentrator is a device that provides a central connnection point for cables from workstations, servers and peripherals.
- Basically, hubs are multi-slot concentrators into which a number of multi-port cards can be plugged to provide additional access as the network grows in zize.
- Hubs can be either passive or active.

Switch

- A switch is a device that is used to segment networks into different subnetworks called subnets or LAN segments.
- Segmenting the network into smaller subnets,prevents traffic overloading network.
- A switch is responsible for filtering i,e transforming data in a specific way and for forwarding packets(a piece of message being transmitted) between LAN segments.
- Switch can support any packet protocal.
- LANs that are segmented through switches are called Switched LANs.

REPEATER

- A repeater is a device that amplifies a signal being transmitted on the network .It is used in long network lines, which exceed the maximum rated destance for a single run.
- Over distance, the cables connecting a network lose the signal trasmitted.
- If the signal degrades too much, it fails to reach the destination or if it does arrive, the degradation
  Of the message makes it useless.
- Repeaters can be installed along the way to ensure that data packets reach their destination.
- Repeaters are of two kinds: amplifier and signal repeater. The firstly merely amplifies all incoming signals over the network. But signal repeater collects the inbound packet and then retransmits the packet as if it were starting from the sorce station.

BRIDGE

- A brdge is a device that lets us link two networks together.
- Bridges are smart enough to know which computers are on which side of the bridge, so they only allow those message that need to get to the other side. To cross the bridge.
- Bridges can handle networks that follow same protocols

ROUTER

- **A device that works like a bridge but can handle different protocols, is known as a router.**
  Eg a router can link Ethernet to a mainframe.
- **The router is responsible for forwarding data from one network to a different network.**
- **If the destination is unknown to a router it sends the traffic(bound to unknown destination) to another router(using logical addresses) which knows the destination.**
- **Based on a network road map called a routing table, routers can help ensure that packets are travelling the most efficient paths to their destinations.**
- **If a link between two routers fails, the sending router can determine an alternate route to keep traffic moving.**
- **Router differes from a bridge in a way that former uses logical addresses and the latter uses physical addressses.**

GATEWAY

- **A gateway is a device that connects dissimilar networks.**
- **A gateway is actually a node on a network that serves as an entrance to another network.**
- **In enterprises, the gateway is the computer that routes the traffic from a workstation to the outside network that is serving the Web pages. In homes, the gateway is the ISP that connects the user to the Internet.**
- **In enterprises, the gateway node often acts as a proxy server(a machine that is not actually a**