UNIT 3 NETWORKING CONCEPTS

Structure

3.1 INTRODUCTION

Two computers are said to be interconnected if they are able to exchange information by any means. Basically in this chapter, computer networks to mean an interconnected connection of autonomous computers. If one computer can forcibly start, stop or control another one, the computers are not autonomous, system with one control unit and many slaves is not a network; nor is a large computer with remote printers and terminals.

When the concept of network comes to mind before that we have to understand the confusion between computer networks and Distributed system. In a network, each system treated as a node or terminal and each terminal must have an unique identification on the network. A node can share its own resources like file system or its own resources like printer using network spooling. It is also possible to define multiple subnet networks under main network under one or multiple domain. Parent domain normally use to control the user access or authentication and sub domain can have fine grain authentication. It is also possible to create a virtual network under a network, where other people can access or utilize the resources of virtual network under certain rule and access rights. In computer network each node or participant agreed to communicate with certain rules and protocols layer like TCP/IP , IPX or netBois.

Users must explicitly log onto one machine, can submit jobs remotely, or move files around and generally handle all the network management personally. With a distributed system, nothing has to be done explicitly; it is all automatically done by the system without the user's knowledge.

A network is a set of devices (often referred to as nodes) connected by the media links. Node can be a computer, printer, or any other device capable of sending and/ or receiving data generated by other nodes on the network. The links connecting the devices are often called communication channels.

Data communication is the exchange of data (in the form of 0s and 1s) between two devices via some form of transmission medium (such as a wire cable). The effectiveness of a data communication system depends on three fundamental characters:

- Delivery
- Accuracy
- Timeliness

3.2 OBJECTIVES

After studying this unit, you should be able to:

- describe different types of networks, viz. local, metropolitan and wide networks;
- explain the topologies on which networks work;
- list the difference between OSI and TCP Reference Model;
- describe protocols used for networks; and
- list organizations dedicated for establishing standards for controlling the Internet.

3.3 TYPES OF NETWORKS

The computer networks can be classified into three broad categories:

Local Area Networks (LAN)

Metropolitan Area Networks (MAN)

Wide Area networks (WAN)

All the three above networks are briefly discussed below:

Local Area Networks (LAN)

Local Area Networks, generally called LANs, are high speed, fault-tolerant data networks that cover a relatively small geographic area. They are widely used to connect personal computers and work stations in company offices and factories to share resources (e.g. files) and exchange information. LAN offers computer users many advantages including shared access to devices and applications, file exchanges, file exchange between connected users, and communication between the users via electronic mail and other applications.

LANs are restricted in size, which means that the worst case transmission time is bounded and known in advance. Knowing this time bound makes it possible to use certain kinds of designs that would not otherwise be possible. It also simplifies the network management.

General Characteristics of LAN:

- Cost of setting up network is usually low.
- Data transfer rates are in- between 10 to 100 Mbps.
- Each device connected in the network can either operate standalone or in the Network.
- Area covered is small.
- All the connected devices in the network share the transmission media.

Metropolitan Area Networks (MAN)

The Metropolitan Area Networks or MAN is basically a bigger version of LANs and normally uses the same technology. It might cover a group of near by corporate offices or a city and might be either private or public. A MAN can support both data and voice and might even be related to the local cable television network. A MAN just has one or two cables and does not contain switching elements, which shunt packets over one of the several potential output lines. Not having to switch simplifies the design.

The main reason for even distinguishing MANs as a special category is that a standard is now being implemented. It is called DQDB (Distributed Queue Dual Bus) or for people who prefer numbers to letters, 802.6(the number of the IEEE standard that defines it). DQDB consists of two unidirectional buses (cables) to which all the computers are connected. A key aspect of MAN is that there is a broadcast medium (for 802.6, two cables) to which all the computers are attached. This greatly simplifies the design compared to other kinds of networks.

Wide Area Networks (WAN)

A wide Area Network or WAN covers large geographical area, often a country or continent. Suppose a company having its head office at Delhi and branch office at USA and Italy wants to be in a single network then WAN is the only solution here. WAN contains a collections inter for running users (i.e. applications) programs.

Please answer the following Self Assessment Question.

Self Assessment Question 1 *Spend 3 Min.*

What do you mean by Network? Discuss about types of Networks?

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3.4 NETWORK TOPOLOGY

The term topology refers to the way a network is laid out, either physically or logically. The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to each other. Though there are various topologies for broadcasting LANs, some of them are briefly highlighted here:

- Bus
- Ring
- Star
- Tree
- Mesh

1) A Bus Topology is a linear LAN artitecture in which all the stations are connected to a single communication line, transmission from the network stations propagate the length of the medium and are received by all other stations. The arbitration mechanism may be centralized or distributed. IEEE 802.3, popularly called EATHERNET, for example, is a bus based broadcast network with decentralized control, operating at 10 or 100 Mbps.

2) A Ring topology is a LAN Architecture that consists of a series of devices connected to one another by unidirectional transmission links to form a single form loop, i.e. local area networks that have each station attached to an adjacent station using point-to-point link from a physical ring. Each station attached and active to the ring regenerated the information frame, and then retransmits the information frame on the ring. The ring itself is logically circular and the information travels in one direction.

   Failure of a station in ring topology disrupts the ring because the information frame is not generated. Additions or deletions of stations to the ring can be disruptive, if the change is not managed properly. Both token ring and FDDI (Fiber Distributed data Interface) networks implement a ring topology.

3) A Star topology is a LAN architecture in which the ends points of one network are connected to a common central hub, or switch, by dedicated links. Logical bus and ring topologies are often implemented physically in star topology. Communications on the connecting links between the stations and the central station of a star topology cab are bi-directional and point-to-point. A station on this type of network passes an information frame to the central controller, which then forwards the information to the destination station. The central controller manages and controls all communications between the stations on the network.

   Failure of station on a star network is easy to detect and can be removed from the network. However failure of the central controller will disable the communication throughout the whole network.

4) A Tree Topology is a LAN architecture that is identical to the bus topology, except those branches with multiple nodes are possible in this case.

5) In a Mesh topology, every device has a dedicated point-to-point link to every other device. The term dedicated means that the link carries traffic only between the two devices it connects. A fully connected mesh network therefore has n (n – 1)/2 physical channels to link n devices. To accommodate that many links, every device on the network must have (n – 1) input/output (I/O) ports.

Advantages of this network are:

a) The use of the dedicated links guarantees that each connection can carry its own data load, thus eliminating the traffic problems that can occur when the links must be shared by multiple devices;

b) Privacy or security is good enough here; and

c) A mesh topology is robust.

The main disadvantages are related to the amount of cabling and the number of I/O ports needed.

Devices commonly used in LANs include repeaters, hubs, LAN extenders, bridges, LAN switches and routers.

Please answer the following Self Assessment Question.

Self Assessment Question 2 *Spend 3 Min.*

Define the term Topology?

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3.5 REFERENCE MODELS

The two most important reference models are OSI (Open System Interconnection) and TCP/IP model.

THE OSI Reference Model: This model is based on a proposal developed by the International Standards Organizations (ISO). It deals with connecting open systems that are open for communication with the other systems. The OSI model has seven layers:

- The physical layer
- The data link layer
- The transport layer
- The network layer

- The session layer
- The presentation layer
- The application layer

The physical layer is concerned with transmitting raw bits over a communication channel. The design issues have to do with making sure that when one side sends a 1 bit, the other side as a 1 bit, not as a 0 bit receives it.

The main task of data link layer is to take a raw transmission facility and transform it into a line that appears free of undetected transmission errors to the network layer. It accomplishes this task by having the sender break the input data up into data frames, transmit the frames sequentially and in the process the acknowledgement frames are sent back by the receiver.

The network layer is concerned with controlling the operation of the subnet. A key design issue is to determine how packets are routed from the source to destination. Routes can be based on static tables that are "wired into" the network and rarely changed.

The basic function of the transport layer is to accept the data from the session layer, split it up into smaller units if need be, pass these to the network layer and ensure that the pieces all arrive correctly at the other end.

The session layer allows users on different machines to establish sessions between them. A session allows ordinary data transport, as does the transport layer, but it also provides enhanced services useful in some applications. A related session service is TOKEN Management.

The presentation layer performs certain functions that are requested sufficiently often to warrant finding a general solution for them, rather than letting each user solve the problems. The presentation layer manages abstract data structures and converts from the representation used inside the computer to the network standard representation and back.

The application layer contains a variety of protocols that are commonly needed. All the virtual terminal software is in the application layer. Another application layer function is file transfer.

The TCP/IP Reference Model: This model has been created from ARPANET. TCP stands for Transmission controls protocol and the Internet protocol. There are four layers:

- Host-to-network
- Internet
- Transport
- Application

TCP is a reliable connection-oriented protocol that allows a byte stream originating on one machine to be delivered without error on any other machine in the Internet. The second protocol in this layer is UDP (User Datagram Protocol) is an unreliable, connectionless protocol.

The OSI and TCP/IP have much in common. Both are based on the concept of a stack of independent protocols. Also the functionality of the layers is roughly similar.

Despite these fundamental similarities, the two models also have many differences in the following ways:

- Provisions of service
- Interfaces
- Protocols

3.6 NETWORKING PROTOCOLS

In computer networks, communication occurs between entities in different systems. For communication to occur, the entities must agree on a protocol which is a set of rules that govern data communication. A protocol defines what is communicated, how it is communicated, and when it is communicated. The key elements of a protocol are syntax, semantics, and timing.

The TCP/IP protocol suite is most important for the Internet. This was developed prior to OSI model, so this suite does not match exactly with those in the OSI model. The TCP/IP protocol suite is made of five layers: physical, data link, network, transport and application. The first four layers provide physical standards, network interface, internetworking, and transport functions that correspond to the first four layers of the OSI model. The three topmost layers in the OSI model, however, are represented in TCP/IP by a single layer called the application layer.

At the Transport Layer, TCP/IP defines two protocols: Transmission Control Protocol (TCP) and User Datagram Protocol (UDP). At the network layer, the main protocol is IP (Internet Protocol).

In addition to the Internet Protocol (IP), which is used for data transfer, the Internet has several control protocols used in the network layer, including Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP) and BOOTP. Every host and router on the Internet has an IP address, which encodes its network and host number. The combination is unique: no two machines have the same IP address. All IP addresses are 32 bits long.

Network addresses are usually written in dotted decimal notation. Network numbers are assigned by the Network Information Center (NIC).

Internet Control Message Protocol (ICMP): When something unexpected occurs, the event is reported by it. About a dozen types of ICMP messages are defined. Each ICMP message type is encapsulated in an IP packet.

Address Resolution Protocol (ARP): Although every machine on the Internet has one (or more) IP addresses, these cannot actually be used for sending packets because the data link layer hardware does not understand the Internet address. ARP will resolve the address confusion.

Reverse Address Resolution Protocol (RARP): ARP solves the problem of finding out, which Ethernet address corresponds to a given IP address. But sometimes how can we find IP address when Ethernet addresses are given? This solution is being solved by RARP protocol.

These above protocols are very much vital when the concept of network stands. But in case of the Internet, Domain Name System (DNS) is a very important aspect by which Uniform Resource Locator (URL) address is being maintained globally.

DNS is a protocol that can be used in different platforms in the Internet. The domain name space (tree) is divided into three different sections: generic domains, country domains and inverse domains.

Generic Domains define registered hosts according to the generic behavior. These are com, edu, gov, int, mil, net, and org.

The Country Domain system follows the same format as the generic domains but uses two-character country abbreviations (e.g. in for India). But at present the country domain can be like www.mtnl.in (for Example).

Inverse Domain is used to map an address to a name. This may happen, for example, when a server has received a request from a client to do a task. Where the server has a file that contains a list of authorized clients, the server lists only the IP address of the client (extracted from the received IP packet).

3.6.1 TELNET

It is a general-purpose client-server application program. It is an abbreviation of Terminal Network. It enables the establishment of a connection to a remote system in such a way that the local terminal appears to be a terminal at the remote system. Both local login and remote login are quite possible through TELNET. It solves the remote login problem by defining a universal interface called the network virtual terminal (NVT) character set. Through this interface, the client TELNET translates characters (data and commands) that come from the local terminal into NVT form and delivers them to the network. The server TELNET, on the other hand, translates data and the commands from NVT form into the form acceptable by the remote computer.

File Transfer Protocol (FTP) is the standard mechanism provided by TCP/IP for copying a file from one host to another. Transferring files from one computer to another is one of the most common tasks expected from networking or internetworking environment. These problems can be solved by FTP: two systems may use different file name conventions. Again two systems may have different ways to represent text and data. Two systems may have different directory structure. All the above problems are solved by FTP in a very simple and elegant approach.

The actual mail transfer is done through mail transfer agents(MTAs). To send a mail, a system must have a client MTA, and to receive a mail, a system must have a server MTA. Although Simple Mail Transfer Protocol (SMTP) does not define a specific MTA, send mail is commonly used by the UNIX system MTA.

The post office protocol (POP) is used for retrieving a message. POP3 version is very popular to download messages from server.

The Simple Network Management Protocol (SNMP) is a framework for managing devices in an Internet using TCP/IP protocol suite. It provides a set of fundamentals operations for monitoring and maintaining the Internet.

The Hypertext Transfer protocol (HTTP) is a protocol used mainly to access data on the World Wide Web. The protocol transfers data in the form of plain text,

hypertext, audio, video, and so on. It functions like a combination of FTP and SMTP. It is similar to FTP because it transfers files and uses the services of TCP.

The World Wide Web (WWW) is a repository of information spread all over the world and linked together. It has a unique combination of flexibility, portability, and user-friendly features that distinguish it from other services provided by the Internet. It is a subset of the Internet. It must be clear that the term Internet and World Wide Web are not similar.

Please answer the following Self Assessment Question.

Self Assessment Question 3 *Spend 3 Min.*

Define Protocol and list key elements of Protocol?

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3.7 AUTHORITIES TO CONTROL INTERNET

Day by day hundreds of stations are being connected to the Internet. So it is very difficult to control the naming system worldwide. To solve this problem, Domain Name System (DNS) was invented previously. The essence of DNS is the invention of a hierarchical, domain-based naming scheme and a distributed database system for implementing this name scheme. It is primarily used for mapping host names and email destinations to IP addresses but can be also used for other purposes. DNS is defined in RFCs 1034 and 1035.

Scenario is quite different as Internet Corporations for Assigned Names and Numbers (ICANN), controls how to assign the IP addresses. Though India is a member country of ICANN, it is not satisfied with the functionality of this organization as it supports the USA directly.

Standards are developed by cooperation among standard creation committees, forums, and government regulatory authorities. While many organizations are dedicated to the establishment of standards, some of the reputed ones are described below:

International Standard Organizations (ISO): It is a multinational body whose membership is drawn mainly from the standards creation committees of various Governments through the world. Created in 1947, the ISO is an entirely voluntary organization dedicated to worldwide agreement on the international standards.

Institute of Electrical and Electronics Engineers(IEEE): It is the largest professional engineering society in the world. It aims to advance theory, creativity, and product quality in the fields of electrical engineering, electronics and radio as well as all the related branches of engineering. The IEEE oversees the development and adoption of international standards for computing and communication. The IEEE has a special committee for local area networks (LANs), out of which has come project 802 (the 802.3, 802.4 and 802.5 standards.)

International Telecommunication Union-Telecommunication Std. Sector (ITU-T):

On March 1993, it was formed. It is divided into two study groups, each devoted to a different aspect of the industry. A national committee such as CEPT in Europe and ANSI in the USA submits proposals to these study groups. If the study group agrees, the proposal is ratified and becomes part of the ITU-T standard, issued every four years. The best known ITU-T standards are the V series (V.32, V.33, and V.42) which define transmissions over public phone lines: the X series (X.25, X.400, and X.500), which defines transmission over public digital networks. Information Highway is one of the successful projects of it.

Internet Corporation for Assigned Names and Numbers (ICANN) : It is a co-ordinate private sector non-profit organization, which was set up by the United States in1998 to take over the activities performed for thirty years, amazingly by a single pony tailed professor in California. India is a member country of ICANN. But its private-sector approach favours the United States, so the other member countries have no real power in case of any decision. All domain names are maintained by this organization.

With the rapid growth of high-speed technology, the basic concept of networking is going to face a tremendous change. Nowadays, network and telecommunication have already been merged into a single entity. Therefore, network security is becoming more and more crucial as the volume of data being exchanged on the Internet increases largely. Though at present lot of attentions are been given to network security, still a review is needed for further strengthening the universal cryptological background.

Please answer the following Self Assessment Question.

Self Assessment Question 4 *Spend 3 Min.*

What is Domain Name System? Write about the role of ICANN.

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Let us now summarize the points covered in this unit.

3.8 SUMMARY

- A network is a set of device (often referred to as nodes) connected by media links.
- Three types of networks are LAN, MAN and WAN.
- The Internet is the bigger version of WAN.
- Network topology is the way in which network is laid out either physically or logically.

- Some important topologies are bus, star, ring, tree and mesh.
- TCP/IP and OSI are two basic reference models.
- OSI has seven layers where as TCP/IP has four layers.
- TCP/IP is the main protocol suite on which the Internet is based.
- TELNET is a general purpose client-server application program.
- Through TELNET both local login and remote login are possible.
- To control the naming system worldwide, previously domain name system (DNS) was invented. It is primarily used for mapping host names and e-mail destinations to IP addresses.
- ICANN is a non-profit private organization that controls the domain name system in the Internet.

3.9 TERMINALQUESTIONS

1) What is the basic difference between OSI and TCP/IP models?
2) Write about TELNET and FTP.
3) What are the advantages of LAN?
4) Discuss various Network Topologies.

3.10 ANSWERS AND HINTS

Self Assessment Questions

1) A network is set of devices (often referred to as nodes) connected by media links. Node can be a computer, printer, or any other device capable of sending and/or receiving data generated by other nodes on the network. The links connecting the devices are often called communication channels. The computer networks can be classified into three broad categories: Local Area Network (LAN), Metropolitan Area Networks (MAN) and Wide Area networks (WAN).
2) The term topology refers to the way a network is laid out, either physically or logically. The topology of a network is the geometric representation of the relationship of all the links and linking devices (usually called nodes) to each other.
3) A protocol defines what is communicated, how it is communicated, and when it is communicated. The key elements of a protocol are syntax, semantics, and timing.
4) The Domain Name System (DNS) helps the users find their way around the Internet. Every computer on the Internet has a unique address called its "IP address" (Internet Protocol address). Because IP addresses (which are strings of numbers) are hard to remember, the DNS allows a familiar string of letters (the "domain name") to be used instead. So rather than typing "192.0.34.163", you can type "www.icann.org". ICANN is responsible for coordinating the management of the technical elements of the DNS to ensure universal

resolvability so that all the users of the Internet can find all valid addresses. It does this by overseeing the distribution of unique technical identifiers used in the Internet's operations, and the delegation of Top-Level Domain names (such as .com, .info, etc.).

Terminal Questions

1) Refer to section 3.5 of the unit.

2) Refer to section 3.6 of the unit.

3) Refer to section 3.3 of the unit.

4) Refer to section 3.4 of the unit.

3.11 REFERENCES AND SUGGESTED READINGS

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