UNIT 1 INFORMATION TECHNOLOGY: AN INTRODUCTION

Objectives

After studying this unit, you should be able to:

- Understand the concept of information technology
  Explain the basics of communications
  Describe the networks of local and wide area and standards in comlnunication
- Familiarize the technology based business issues discussed in other units of this course.

Structure

1.1 BASICS OF DATA COMMUNICATIONS

The distance over which data moves within a computer inay vary from a few thousandths of an inch, as is the case within a single Integrated Circuit chip, to as much as several feet along the back plane of the main circuit board. Over such smnll distances, digital data may be transmitted as direct, over siinple copper conductors. Frequently, however, data must be sent beyond the local circuitry that constitutes a computer. In many cases, the distances involved may be enormous. As the distance between the source of a message and its destination increases, accurate transmission becomes increasingly difficult, Data Communication concerns the transmission of digital messages to devices external to the message source. "External" devices are generally thought of as being independently powered circuitry that exists beyond the chassis of a computer or other digital message source.

Communication Channels

A communication channel is a pathway over which information can he conveyed. It may be defined by physical wire that connect communicating devices, or by a radio, laser, or other radiated energy source that has no obvious physical presence. Information sent through a communications channel has a source from which the information originates, and a destination to which the information is delivered. Although information originates from a single source, there may he more than one destination, depending upon how many receive stations are linked to the channel.

In a digital com~nunicationchannel, the information is represented hy individual data bits, which may be encapsulated into multibit message units. A byte, which consists of eight bits, is an example of a message unit that may be conveyed through a digital communications channel, Channels of Communication can be divided into three types as shown in Figure 1.1.

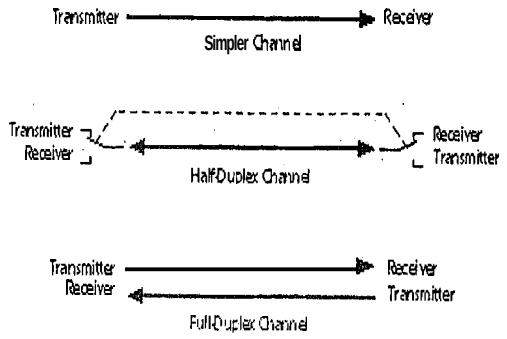


Fig 1.1 Channel Types

Any communication channel has a direction associated with it. The message source is the transmitter, and the destination is the receiver. A channel whose direction of transmission is unchanging is referred to as a simplex channel. For example, a radio station is a simplex channel because it always transmits the signal to its listeners and never allows them to transmit back.

A half-duplex channel is a single physical channel in which the direction may be reversed. Messages may flow in two directions, but never at the same time, in this system. In a telephone call, one party speaks while the other listens. After a pause, the other party speaks and the first party listens. Speaking simultaneously results in garbled sound that cannot be understood.

A full-duplex channel allows simultaneous message exchange in both directions. It really consists of two simplex channels, a forward channel and a reverse channel, linking the same points, as shown in figure 1.1.

Serial Communications: Most digital messages are vastly longer than just a few bits. Because it is neither practical nor economic to transfer all bits of a long message simultaneously, the message is broken into smaller parts and transmitted sequentially. Bit-serial transmission conveys a message one bit at a time through a channel. Each bit represents a part of the message. The individual bits are then reassembled at the destination to compose the message. In general, one channel will pass only one bit at a time. Thus, bit-serial transmission is necessary in data communications if only a single channel is available. Bit-serial transmission is normally just called serial transmission and is the chosen as a communication method in many computer peripherals.

Byte-serial transmission conveys eight bits at a time through eight parallel channels. Although the raw transfer rate is eight times faster than in bit-serial transmission, eight channels are needed, and the cost may be as much as eight times higher to transmit the message. When distances are short, it may nonetheless be both feasible and economic to use parallel channels in return for high data rates, as can be seen from figure 1.2. The popular printer interface is a case where byte-serial transmission is used. On the other hand, when communicating with a system over a modem, only a single channel is available, and bit-serial transmission is required.

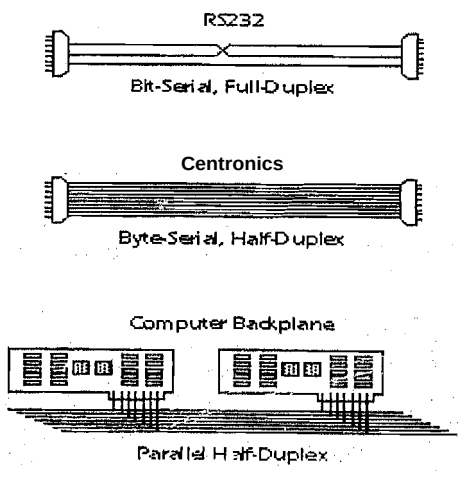


Fig 1.2 Transmission Types

The data rate of a channel is often specified by its bit rate. However, an equivalent measure channel capacity is bandwidth. A communications protocol is an agreed-upon convention that defines the order and meaning of bits in a serial transmission. It may also specify a procedure for exchanging messages. A protocol will detine how many data bits compose a message unit, the framing and formatting bits, any error-detecting bits that may be added, and other information that governs control of the communications hardware. Channel efficiency is determined by the protocol design rather than by digital hardware considerations.

Asynchronous vs. **Synchronous** Transmission: When two computers communicate, they must have a way to synchronize the flow of data so that the receiving computer can read at the same speed at which the sending computer transmits. There are two modes of transmission:

Asynchronous **Transmission:** The sending of one data character at a time, each preceded by a start bit and terminated by one or more stop bits.

Synchronous Transmission: The sending of dala in frames i.e., blocks of data preceded by synchronizing character.

Data Compression and Encryption

If a typical message is statistically analyzed, it would be found that certain characters are used much more frequently than others. By analyzing a message before it is transmitted, short binary codes may be assigned to frequently used characters and longer codes to rarely used characters. In doing so, it is possible to reduce the total number of charactcrs sent without altering the information in the message. Appropriate decoding at the receiver will restore the message to its original form. This procedure, known as data compression, may result in a 50 pcrccnt or greater savings in the amount of data transmitted. Even though time is necessary to analyze the message before it is transmitted, the savings may be great enough so that the total time for compression, transmission, and decompression will still be lower than it would be when sending an uncompressed incssage.

A compression method called Huffman coding is frequently used in data communications, and particularly in fax transmission, Clearly, most of the image data for a typical business letter represents white paper, and only about 5 percent of the surface represents black ink. It is possible to send a single code that, for example, represents a consecutive string of 1000 white pixels rather than a separate code for each white pixel. Consequently, data compression will significantly reduce the total message length for a faxed business letter. When the letter is made up of randomly distributed black ink covering 50 pcrcent of the white paper surface, data compression would hold no advantage.

Data Encryption : Privacy is a great concern in data communications. Faxed business letters can be intercepted at will through tapped phone lines or intercepted microwave transmissions without the knowledge of the sender or receiver. To increase the security of this and other data communications, including digitized telephone conversations, the binary codes representing data may be scrambled in such a way that unauthorized interception will produce an indecipherable sequence of characters. Authorized receive stations will bc equipped with a decoder that enables the message to be restored. The process of scrambling, transmitting, and dc-scrambling is known as encryption.

Data Transmission

Transmission over Short Distance: Computer peripherals such as a printer or scanner generally located within 20 feet of the computer. A relatively simple electronics may be added to make data transfer through a cable efficient and reliable. To accomplish this, a bus interface circuit is installed in the computer as can be seen in figure 1.3.

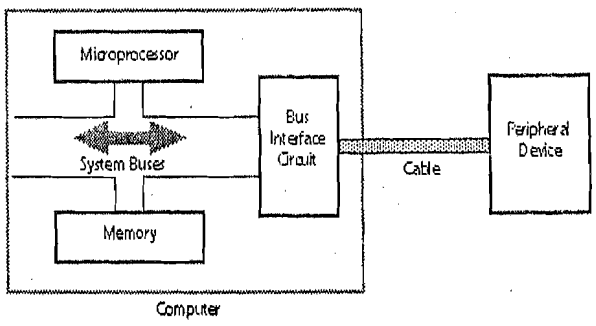


Fig 1.3 Transmission over short distance

It consists of a holding register for peripheral data, timing and formatting circuitry for external data transmission, and signal amplifiers to boost the signal sufficiently for transmission through a cable. When communication with the peripheral is necessary, data is first deposited in the holding register by the microprocessor. This data will then be reformatted, sent with enor-detecting codes, and transmitted at a relatively slow rate by digital hardware in the bus interface circuit. Data sent in this manner may be transmitted in byte-serial format if the cable has eight parallel channels (at least 10 conductors for half-duplex operation), or in bit-serial format if only a single channel is available.

Transmission over Long Distances: When relatively long distances (4000 feet) are involved in reaching a peripheral device, driver circuits must be inserted after the bus interface unit to compensate for the'electrical effects of long cables, as show in figure 1.4.

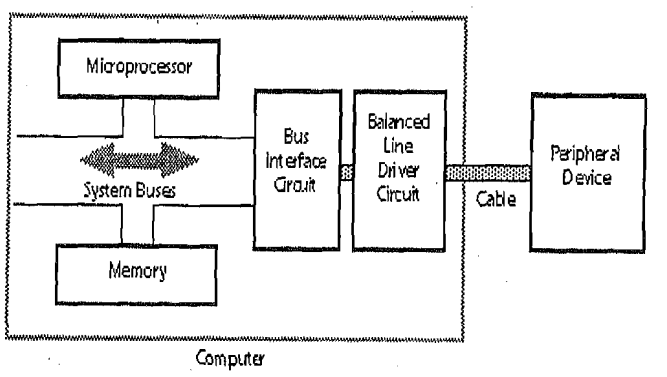


Fig 1.4 **Transmission** over long **distance**

This is the only change needed if a single peripheral is used. However, if many peripherals are connected, or if other, computer stations are to be linked, a local area network (LAN) is required.

A great deal of technology has been developed for LAN systems to minimize the amount of cable required and maximize the throughput. The costs of a LAN have been concentrated in the electrical interface card that would be installed in PCs or peripherals to drive the cable, and in the communications software, not in the cable itself. Thus, the cost and complexity of a LAN are not particularly affected by the distance between stations.

Transmission over Very Long **Distances:** Data communications through the telephone network can reach any point in the world. The volume of overseas fax transmissions is increasing constantly, and computer networks that link thousands of businesses, governments, and universities are pervasive. Transmissions over such distances are not generally accomplished with a direct-wire digital link, but rather with digitally-modulated analog carrier signals. This technique makes it possible to use existing analog telephone voice channels for digital data, although at considerably reduced data rates compared to a direct digital link.

Transmission of data from a personal computer to a timesharing service over phone lines requires that data signals be converted to audible tones by a modem. The receiver's modern accepts the modulated sine wave and extracts the digital data from it.

Electronic Mail

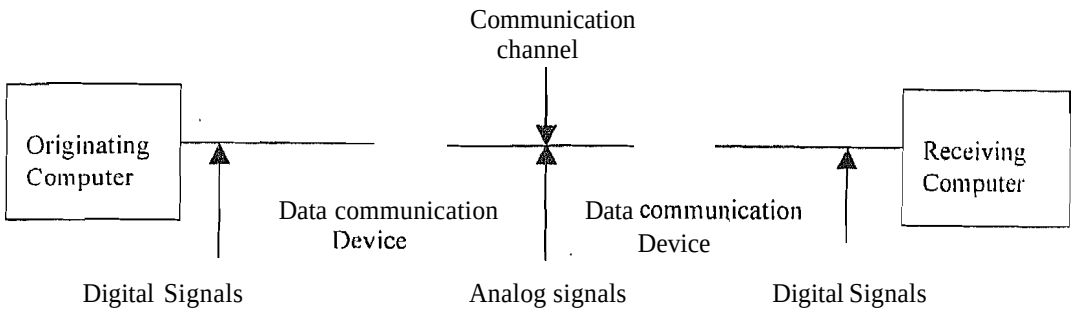
Electronic Mail (E-mail) is the transmission of textual material from one plnce lo other by electronic means. Electronic mail systems work on the principle of providing each user with a mail box located in a computer in which messages are stored and can bc accessed. In most cases, mail or messages are delivered on a store and forward basis and are not delivered directly to the recipient's computers.

E-mail set-up: An e-mail data communication system consists of the following components as presented in Fig.1.5.

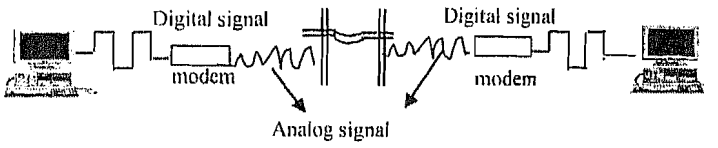
- Source/Destination (Computers)
- Data. communication devices (modems)
- A communication channel (cable)
- Data communication software

Specialised data communication software is required to set up a communication link between two computers and to transmit data.

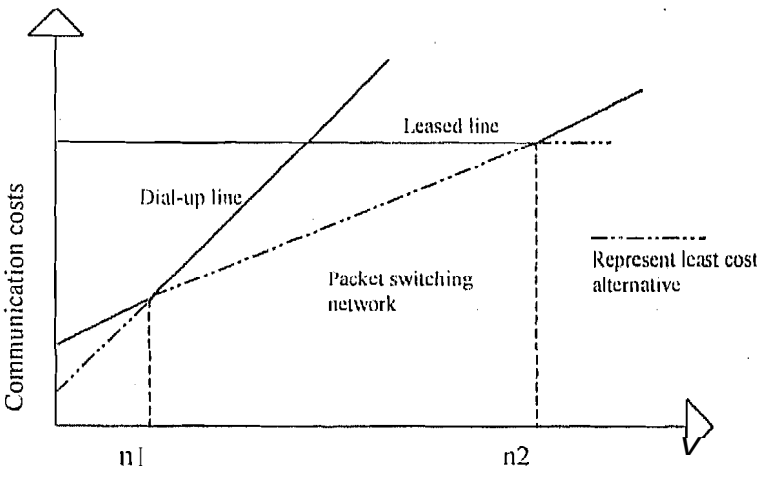
Dial-up Lines : The simplest method of connecting two geographical remote computer systems is to use a dial-up line with the two computers connected by modems. This connection method uses the telephone network's voice grade lines. The operation of the dial-up line depends upon the type of modem being used: with the basic models, a user at one location, telephones the other and when the connection is established, the respective computer systems are connected to the telephone handsets.



The components of a Data Communication system



Pig 1.5 The basic elements of conimunicution link between 2 computer systems



Data volume transmitted between two locations

Fig.1.6 Wide area communication cost

Leased Line: The leased line is a dedicated link between the source and destination, it is capable of meeting the highest performance requirements. The high performance is achieved because the line is permanently allocated by the telephone network, or a similar carrier, especially for a subscriber's data communication applications. Therefore, the line can be conditioned to provide a fast, error free service that would be uneconomical to design into the standard switched telephone lines. The drawbacks are the cost and the inflexibility: the subscriber has to pay for the line conditioning, also it may hnvc to bc leased for exclusive use only. Furthermore, the subscriber can only alter the connection by prior arrangement with the telephone network.

Packet Switching Networks: Packet switching networks (PSN)(i.e. shared networks) offer lower cost data transfer because their tariffs are based upon the amount of data a user sends across the network, plus a fixed subscription charge. The telephone companies, for example, charge customers connecting two computers a fixed rate for leased telephone line, or a time/ distance rate for a standard dial-up connection, regardless of the amount of information the user transmits across the telephone system; which means that for leased lines the same rate is charged whether or not the communication facility is being used and that for dial-up lines the charge will be directly proportional to the geographical distance between the two users and the time spent on the call. A cost comparison can be made by referring to Fig.l.6. it can be seen in this simplified graph that the dial-up line is the cheapest transfer medium until the volume increases to a value (nl). At this point the slow speed of the dial-up line makes larger data transfers uneconomical. Between volumes n1 and n2 the PSN provide the cheaper alternative to the dial-up and the leased line, but above a certain high volume (n2) the cost of leased line becomes less prohibitive. Thus, for the mid-volume range of data transfers PSN provides the most cost-effective solution. When the other advantages are also considered (reliability, flexibility and connectivity) the PSN may prove to be the best overall solution to any data communication requirement.

Advantages of E-mail are:

- messages can be sent at any time that suits the user
- messages will be in the recipient's mailbox within minutes
- delivery of messages can be confirmed
- copies can be sent automatically to every one, on a distribution list
- messages can be read at the user's convenience
- telex terminal can be replaced

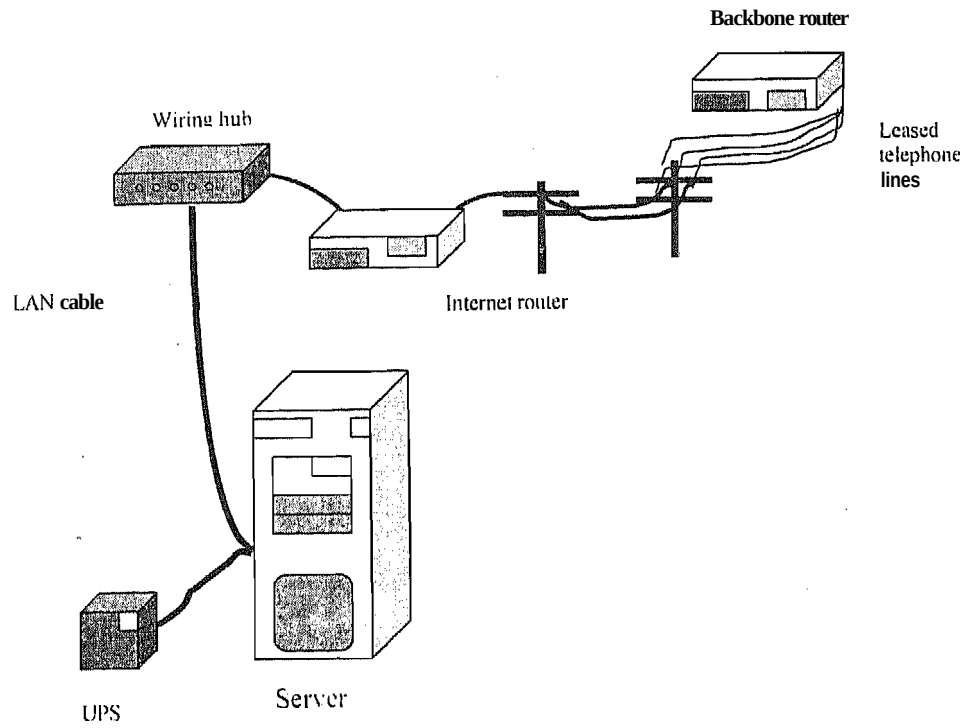
A survey conducted on use of e-mail has shown the following savings:

- 80% cut in time spent on the telephone
- 50% reduction in the amount of paper
- 94% reduction in the use of inter-office mail
- 61% drop in the number of copies being made.

Internet Connectivity

How does one get connected to Internet ? There are different ways to get connected to Internet depending on the availability of resources. The connections can be either wired or wireless. The wired connections use PSTN/PSDN terrestrial links. The wireless connection for wide area connectivity is through satellite communications. The user gets connected to Internet through an Internet server. Internet servers are provided by many organizations. Those are called Internet service providers. In India some of the service providers are: ERNET (Education & Research Network) of DoE; GIAS(Gateway Internet Access Service) of VSNL; NICNET (National Informatics Centre Network). These networks are managed by the government organization. In light of the privatisation of Telecommunication industry, private organizations are also providing E-mail and Internet services. There are mainly two ways of connection methods: On-line connectivity Off-line (Dial-up) connectivity

1) **On-line connectivity:** On-line connection provides dedicated Internet access that requires substantial initial investment in equipment. The main continuing cost is a flat annual fee for the use of the line; the annual fee varies from the line capacity. The line capacity is the factor that determines how many users can connect simultaneously.



Pig **1.7 Establishing a** dedicated Internet **connection**

On-line connection **through** Leased line: This is terrestrial link through PSTN of DoT in India. In this, the user's system gets connected to an Internet server by a dedicated telephone line. The leased line data circuits are available for different data transmission speeds viz., 9.6 Kbps, 19.2 Kbps, 2Mbps, etc. The generic configuration is shown in Fig 2 .7, in which leased lines are connected one end to the internet router of the customer premises and the other end to the ISPs backbone router. The local internet router and Internet server are connected through the wiring hub.

Requirements for leased line connection arc:

Hardware: A computer system with color monitor; A leased line; A leased line modem

Software: TCP/IP; Net browser viz. Netscapcl IE/ Hotjava

Others: IP address; An account on service provider system and A router (for local network connectivity)

On-line connection **through** VSAT : This is a wireless connection. In this user's computer system is connected to VSAT (very Small Aperture Terminal). VSAT communicates to the destination via a Satellite viz., INSAT-1A/INSAT-2A in India. The data transfer speed of the communication link is based on the capacity of the communication channel allocated to the individual user site by the Master Control Station.

Requirements of VSAT connection are:

Hardware:

- A computer system with color monitor; VSAT
- PES (Personnel Earth Station); TCP/IP
- Netbrowser viz., Netscape / IE / HotJava.

Others:

- IP address; An account on service provider system
- A router (for local network connectivity)

2. Off-line (Dial-up) connectivity: If you do not have a direct connection to the Internet or if you plan to use a stand-alone PC, you may use SLIP/PPP connection to the Internet. To establish connection, you must first find an Internet service provider that offers SLIP/ PPP account. Get telephone number and account from the service provider, then you can run windows-based Internet programs.

Requirements for dial-up connection are:

Hardware:
- PC with color monitor; **A** telephone line; **A** high speed modem

Software:
- TCP/IP; Netbrowser

Others:
- An account on an Internet server.

Intranet

There is no technical difference between the Internet and the intranet, except that not everybody is allowed to connect to an intranet. Intranet is an application of the Interr technology to a closed network. It provides a relatively cost efficient way to connect manage corporate networks and distributed information. Intranet uses Internet-derived communication protocols (TCP/IP), networking (IP network) and user interface (Web browsers, emails etc.).

The surprising speed by which intranets has grown among corporate users demonstrat the strength of the Intranet networking. Several surveys contend that corporate intrane expenditure far out-paces the level of spending on consumer-oriented Web businesses (Web stores). The compatibility of corporate intranets with the Internet will be a significant factor in the digital economy. In a sense, producer and seller information is readily accessible by outsiders, making it easy to manage and disseminate information consumers.

Intranet application : The key aspect of intranet in corporate application is in the easiness in process integration. For example, a company with a mobile sales force has manage continuous inputs and data coming in from the field and integrate them into supply management, and delivery services. Large corporations have implemented an elaborate IS technologies integrating information systems, supply logistics management sales and customer asset management, corporate finance and human resources management, etc.

Activity 1

1. Distinguish between:

a) Simplex and half-duplex channel.

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b) Distinguish between bit-serial and byte-serial communication.

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c) Distinguish between asynchronous and synchronous transmission.

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2. What is the use of data compression?

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3. Give the components required for dedicated Internet connectivity.

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4. List out the advantages and disadvantages of e-mail?

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1.2 LOCAL AREA NETWORKING

A Local Area Network (LAN) refers to a communication network with the following characteristics:

- The network is confined to a small area typically a single building or a cluster of buildings.
- The network consists of a shared transmission medium.
- The data rate on the network is high, anywhere from 1Mbps to 100Mbps.
- The devices on the network are peers. That is any device can initiate data exchange with any other device.

A LAN is an increasingly popular way for organizations large and small to get additional productivity gains from the use of personal computers. Large businesses, government agencies and universities have long realized the need for "collaborative, computing" or people using their computers as a group. Today, more and more small businesses, local governments and schools are using the power of LANs to increase productivily and efficiency.

LAN Hardware and Software: The most basic elements of workgroup LANs nre personal computers. They may either be used by individuals or connected as supporting hardware. LAN hardware and software is designed to connect all types of PCs.

One of the great benefits of a LAN is the ability to share computing devices that are used only occasionally. Devices that are commonly shared on a LAN include printers, modems, scanners and the like. One can save considerable computing expense by sharing these types of devices over a LAN as opposed to dedicating individual devices to individual users. All computing devices on a network, workstations, printers, etc., are referred to as nodes.

The next group of hardware to be considered is the hardware that is required for the physical network itself. For any node to be connected to the LAN, interface hardware is required. The interface hardware is referred to as an adapter. Networking adapters are also commonly referred to as Network Interface Cards or NICs. The LAN connection for a printer, however, is referred to as a print server and not a NIC.

Media: Media is a term that largely refers to the cable or wires connecting together the various computing devices that make up a LAN. There are many different media types in use today in LANs.

Twisted Pair is the most common type of LAN media. It consists of strnnds of copper wire twisted together to make up a single cable. Most typically eight wires make up a twisted pair cable. This twisted pair cable is then either Shielded (and referred to as Shielded Twisted Pair or STP) or unshielded and referred to as Unshielded Twisted Pair or UTP. Of the two, UTP is far more common and is similar to the type of wire that is

used for telephones in the United States and is therefore often referred to as telephone cable.

The next most common type of LAN media is coaxial cable or coax. Two different versions of coax are used in LANs: Thin coaxial and thick coaxial. Of the two, thin coax is far more popular and is similar in appearance to the cable used in cable television systems.

Other media types include Fiber Optic cable, which allows for high speed and long distance data transmission and is principally found in only larger LANs. Another type of media is not a cable at all. This type of media is either infrared light [like a television remote control) or radio waves. Networks that have no physical media are referred to as wireless and are typically found only in niche applications where stringing cable is impossible or impractical.

Hubs: A Hub is a generic term that is used for a device that acts as a central point for LAN cable. The most basic and popular types of hubs are devices that simply connect cables together and regenerate data thereby passing data from one device to another. These types of hubs are referred to as concentrators or repeaters. There are also hubs that provide additional functionality, including bridges, which connect network segments and routers, which connect different types of both local and wide area networks. The functionality of these types of hubs are highly specialized and closely related to the type of network they are used in. They are typically installed in very large, complex networks.

Bridge: When more devices are connected to the same network, more collision will happen, and therefore the average throughput will go down. One quick solution is simply to divide the network up into separate smaller networks (or segments). Within each segment, devices will continue to communicate with each other. In order to allow devices on different segments to communicate with each other, a device called bridge is often installed that connects to these networks.

Software: Software is required by the network to operate. This type of networking software is referred to as a Network Operating System or NOS. The various brands of NOSs divide into two types: those, which provide for a Peer to Peer architecture and those that provide for a Client/Server architecture. Additionally, a small software program is required for the adapters installed in LAN nodes to operate with the NOS. These programs are referred to a device drivers or simply drivers. Drivers for popular adapters are often included with the NOS itself. Custom drivers, which provide for better adapter performance or drivers for less popular adapters are included with the adapter itself and must be copied into the NOS when the adapter is installed.

Types of Networks

Given that the concept Local Area Networking has been established for well over twenty years and given that LANs serve the computing requirements of a wide range of organizations, it follows that different types of LANs have been standardized at various times to suit specific computing needs. The organization that is responsible for establishing these standards is the Institute of Electrical and Electronic Engineers [IEEE). This professional organization works with network product vendors and users to standardize product specifications so that hardware and software products from many different and competing vendors will work together on the LAN. Products that conform to these standardized specifications and therefore work together are considered to be Interoperable. Within the IEEE, various committees are set up to act as the standards setting bodies for different types of LANs. These LAN corninittees are designated by a number,

The two predominant types of standardized networking are Ethernet and Token Ring, Of the two, Ethernet networks are far more common than Token Ring networks. In general, Ethernet networks are designed for small and medium sized groups while Token Ring networks are best suited to larger groups. Amongst larger networks, it is not uncommon to have both types of networks, which are connected via a router or similar hardware device. Ethernet was standardized by the IEEE by the 802.3 committee.

Ethernet is predominately used as a baseband transmission network, where all the network nodes share access to the network media on an equal basis. Baseband transmission means that data sent over the media uses the entire bandwidth of the media as opposed to

broadband transmission where data takes only a segment of the media by dividing the media into electronic channels. Each Ethernet node has the capability to send data at the Ethernet standard speed of ten million bits (megabits) per second (10Mbps). Since the nodes are sharing the media, the actual data speed tends to be significantly less than 10Mbps in much the same way that the speed of a car on a crowded freeway tends to be significantly less than the posted speed limit.

When Ethernet was first standardized by the IEEE, the type of media specified was thick coaxial cable,, which allowed for a maximum cable length of 500 meters. Later, a second cable implementation of Ethernet was standardized based on thin coaxial cable that was less expensive and allowed segments of just under 200 meters. To differentiate between these two different cable implementations, the designations 10BASE5 and'10BASE2 were developed for thick and thin coaxial cable respectively. The "10" refers to the 10Mbps data transfer rate, "Base" refers to the fact that Ethernet is a baseband media access method and the "5" or the "2" refers to the maximum cable length between nodes.

With both 10BASE5 and 10BASE2, the nodes are arranged in a bus topology meaning that they are connected one after another with a terminator on the last node on the bus. While this is a fairly simple design, it does have a drawback in that if a nodc fails on the bus, it effectively terminates the bus making media access impossible for nodes further down. Trouble shooting a bus type topology to find the problem nde is time consuming. To address this issue as well as provide for even less expensive media, a third implementation was developed using twisted pair cable and allowing for nodes up to 100 meters from the hub. This implementation was designated as 10BASE-T. Unlike 10BASE5 and 10BASE2, the IOBASE-T physical network design is a star topology with each node connecting not to the next node but to a central hub. If a nodc fails, the hub partitions that node from the rest of the LAN leaving the remaining nodes unaffected.

Token Ring is a network architecture that is based on a far more structured media access method. Not surprisingly, Token Ring was developed by IBM for larger LANs. The Token Ring IEEE designation is 802.5. With Token Ring, the nclwork nodes are arranged in a ring pattern. LAN data, along with an electronic "token", circle around the ring. Unlike Ethernet, a Token Ring nodc cannot send data at any time: it must first capture the token, which is constantly circling the ring. The nodc then attaches the data to be sent to the single token and sends it to its destination. In this manner, only one node can send at a time. Historically, Token Ring hardware has been more expensive than Ethernet hardware and available from fewer vendors. Today Token Ring is found mostly in large corporate LANs.

While Ethernet and Token Ring promise to be the predominant types of networking for the rest of the decade, new, higher performance networking technologies are on the horizon. Fast Ethernet is a 100Mbps version of Ethernet based twisted pair cable. 100VGAnyLAN (another 100Mbps network type) is a sort of hybrid of Ethernet and Token Ring and uses twisted pair cable. Asynchronous Transfer Mode or ATM is a high performance network type (25 and 155Mbps data transfer) that can be used for both local and wide area networking. ATM is generally held to be the network of the future, showing a lot of promise but very little implementation at present.

1.3 WAN TECHNOLOGY

Frame Relay Overview

Frame relay is a Wide Area Network (WAN) technology for connecting devices across the wide area. It is a layer 2 protocol in the OSI model, and has been designed to be simple and effective. The frame relay network is a digital network.

The main advantage of using frame relay when compared to leased lines is its configuration flexibility and lower costs. To make four sites connect to each other through the frame relay network, for example, each site simply connects to the carrier's POP (Point of Presence) through one physical connection. This is as opposed to installing three physical connections at each site for the case of leased lines.

To subscribe to a frame relay service, the user also subscribes to a CIR (Committed Information Rate) from the service provider. CIK defines the minimum data rate

guaranteed to be delivered by the service provider. However, currently the user can often send data at a rate higher than the CIR until the network becomes congested, at which time the network will start discarding packets, and will indicate such tc the user device. Upon receiving such indication, the user device is expected to reduce the traffic rate accordingly (such as back to the CIR rate).

ISDN Overview

ISDN is a very mature technology that only recently found extensive use because of the market's dramatic changing needs. ISDN provides an end-to-end switched digital service that is designed to transport real-time voice and video, as well as non-real time data such as LAN data traffic. Setting up a connection is exactly the same as making a regular telephone call, except that an ISDN device can only communicate with another ISDN device, or with a non-ISDN device through an ISDN modem, or the so called ISDN Terminal Adapter (TA).

One of ISDN's advantage over the frame relay network is that frame relay does not currently support SVC (Switched Virtual Circuit), which means all connections are nailed, and can not be changed easily. Another is that there is a substantial fee associated with setting up a frame relay connection at this point (which will drop in time). However, since ISDN charge is based on distance and connection time like regular phone calls, it may be more costly, depending on the connection time and distance of the call. This is unlike frame relay, where you pay a fixed monthly charge, whether you use very little of it or 24 hours a day.

ISDN is based on a number of fundamental building blocks. First, there are two types of ISDN "channels" or communication paths:

- B-channel: The Bearer ("B") channel is a 64 kbps channel, which can be used for voice, video, data, or multimedia calls. B-channels can be aggregated together For even higher bandwidth applications.
- D-channel: The Delta ("D") channel can be either a 16 khps or 64 khps channel used primarily for communications (or "signaling") between switching equipment in the ISDN network and the ISDN equipment at your site.

These ISDN channels are delivered to the user in one of two pre-defined configurations:

- Basic Rate Interface (BRI): BRI is the ISDN service most people use to connect to the Internet. An ISDN BRI connection supports two 64 kbps B-channels and one 16 kbps D-channel over a standard phone line. BRI is often, called "2B+D" referring to its two B-channels and one D-channel.
- Primary Rate Interface (PRI): ISDN PRI service is used primarily hy large organizations with intensive communication needs. An ISDN PRI connection supports 23(64 kbps) B-channels and one 64 kbps D-channel (or 23B+D) over a high speed line.

BRI is the most common ISDN service for Internet access. A single BRI line can support up to three calls at the same time because it is comprised of three channels (2B+D). Two voice, fax or data "conversations," and one packet switched data "conversation" can take place at the same time. Multiple channels or even multiple BRI lines can be combined into a single faster connection depending on the ISDN equipment you have. Channels can be combined as needed for a specific application (a large multimedia file transfer, for example), then broken down and reassembled into individual channels for different applications (normal voice or data transmissions).'

ISDN offers the speed and quality that previously was only available to people who bought expensive, point-to-point digital leased lines. Combined with its flexibility as a dial-up service, ISDN has become the service of choice for many communications applications. Popular ISDN applications include:

- Internet access
- Telecommuting/remote access to corporate computing
- Video conferencing
- Small office/home office data networking

As the Internet becomes more and more information-intensive with graphics, sound, video and multimedia, the ability to take advantage of these new resources depends on the speed of Internet connection. With ISDN, Internet access is even faster and more efficient and economical.

ATM Overview

Asynchronous Transfer Mode (ATM) Forum was created in August 1991 by Adaptive, NT, Sprint, and Cisco with the goal of defining standards for ensuring the interoperability between public and private ATM implementations. ATM provides connection oriented network services, which means that before traffic can be sent, a connection has to be set up first. When communication is finished, the call is taken down, just like a regular phone call.

The main advantage of using the ATM network includes the following:

- It defines one set of protocols for both LAN and WAN networks.
- Because of its short cell (unit of transmission) size, high bandwidth, and low latency, it can be used to support almost all kinds of traffic including voice and real-time video.
- Eventually, ATM will be able to move data across the WAN at the lowest per bit cost.

The ATM operation is mainly defined in three layers: the ATM adaptation layer (that sets up a connection, and chops the data streams into 48-byte units); the ATM layer (that converts the 48-byte data units into 53-octet cells); and the physical layer (for physical connection to the network).

The ATM adaptation layer further defines 4 classes of traffic through quality of service (QOS) negotiation during the call set-up time: (1) AAL-1 (constant bit rate), for traffic sensitive to both cell delay and loss; (2) AAL-2 (variable bit rate), for time sensitive traffic such as digitized voice; (3) AAL-3/4 (variable bit rate but asynchronous traffic) handles bursty connection oriented traffic like LAN file transfers (traffic that can tolcratc delay but not loss); (4) AAL-5 (connectionless data traffic), for bursty LAN data traffic hut with less overhead compared to 314, also known as the Simple and Efficient Adaptation Layer (SEAL).

One key characteristic of the ATM network is the fixed size 53-octet cells transmitted over the network. Because of its small and fixed size, any traffic can occupy the network for one cell's worth of transmission time. This is as opposed to the LAN environment where once a variable size LAN packet starts to be transmitted, there is no telling when the transmission will complete to free the network up for other traffic.

Activity 2

1. What are the hardware requirements for LAN sct-up?

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2. Distinguish between Ethernet and Token Ring networks.

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3. Distinguish among 10base5, 10base2 and 10baseT.

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4. List out the advantages of ISDN

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5. Identify the key characteristic of ATM technology?

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1.4 VSAT NETWORK SYSTEM FOR BANKING

Satellite **Transmission:** A communications satellite is like a big microwave relay located in a geo-synchronous orbit 22300 miles above the earth. A satellite receives microwave signals in a given frequency band and retransmits them at a different frequency. It must use a different frequency for retransmission; otherwise, the powerful transmitted signal would interfere with the weak incoming signals. The different frequency bands are referred as to the uplink and downlink. The equipment that receives the signal, amplifies it, changes its frequency and retransmits, it is called a transponder. Signals sent are received by a satellite receiving antenna referred to as an earth station. The send and receive earth stations operate at different frequencies so as to avoid interference between up and down links, figure 1.8. The signal received from one earth station can be broadcasted back to earth to any number of receiving earth stations covering a wide geographic area.

At present, satellites operate at three pairs of frequencies for the uplink and downlink, respectively.

- C band : 416 GHz
- Kuband : 11/14 GHz
- Ka band : 20/30 GHz

For example, the *C* band operates with an uplink frequency of 4 GHz and a downlink frequency of 6 GHz.

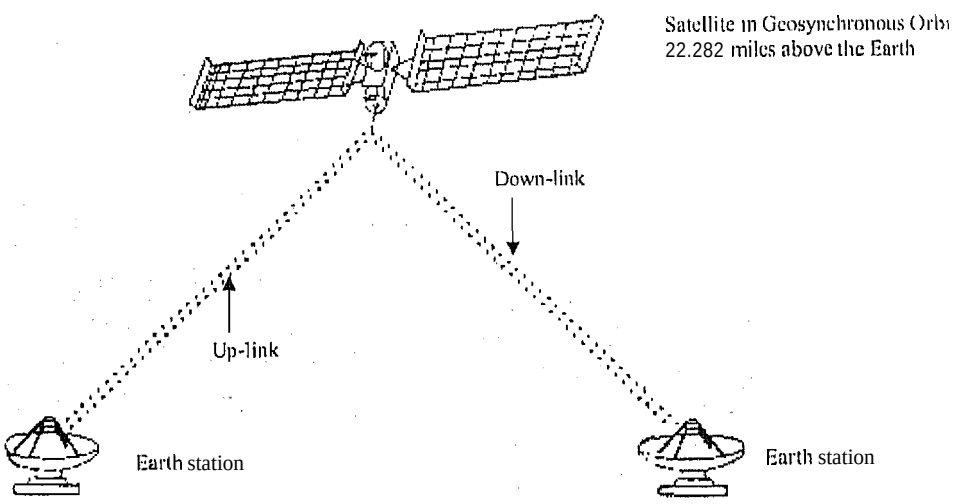

Fig. 1.8 VSAT Communication

Banking Application

The information age is changing the face of banking. Customers are discriminating, and expect the banks to keep up with fast-breaking changes in technology. The banks want to make sure that the customer gets what he want$, whenever he wants it, and that the staff can render good service to customers because good customer service translates into loyal customers. To stay ahead of the competition, the bank has to:

- Reduce costs
- Provide exciting new products in a timely manner

  Maintain well-trained, knowledgeable staff at all branches
- Process transactions quickly and reliably at all branches
- Proliferate ATM usage
- Offer unique services and partnerships

Banks and other financial institutions around the world have learned that very small aperture terminal (VSAT) Enterprise Networks improve the way they do business by providing an adaptable communications platform capable of handling both their current and emerging applications. VSAT nctworks are the economical way of implementing a centrally managed, geographically dispersed, enterprise nctwork. VSAT networks provide two-way transmission of data and voice as well as one-way video and audio broadcasts. In addition, VSAT technology provides high bandwidth directly into each branch For emerging data-intensive applications such as software updates, interactive kiosks, and applications based on World Wide Web technology.

Cost-efficient networking : VSAT nctworks provide the most economical front-office to back-office communications in a geographically dispersed banking network. By offering lower monthly communications costs and increasing the efficiency of operations staff, VSATs provide cost-effective online connectivity for all of branches, as well as standalone ATMs and other locations.

Improved customcr service : Whether the customcr is using an ATM or a teller, or investigating a loan, an VSAT network ensures a pleasant banking experience by processing transactions quickly and reliably. And an online VSAT nctwork gives access to valuable information about customer base lor more effective sales and marketing campaigns.

Secure communications : VSAT nctworks offer encryption plus conditional access control from a secure facility, thus ensuring that intentional or unintentional intcrccption of data is highly unlikely. The inherent security of VSAT networks has been examined and verified by many of the customers that serve, including financial institutions and other corporations that use these networks for their most sensitive and competitive communications.

Improved network manageability and availability : Locate network faults in minutes, not hours. Unlike complex terrestrial networks with multiple points of failure in cach link, VSAT nctworks offer a simple, easy-to-manage topology. And advanced network management system facilitates quick identification and resolution of faults.

Interactive distance learning : The customer's satislaction depends upon the competence of the branch staff, but maintaining well-trained staff at all branches becomes increasingly challenging and costly with cach new product introduction. VSAT networks with interactive distance learning platform, enable to bring products to market quickly and economically, with uniformly positive results across all branches.

Multicast applications : Satellite communications' unique ability to offer high-speed broadcast transmissions offers tremendous benefits for both the central data center and the branches. For example, the ability to automatically download software upgrades to branch banking platforms via the VSAT nctwork saves time and money. The branches are assured of timely, worry-free upgrades, and the central office can be confident that cveryonc is operating on the same platform at the same time.

Low-cost network growth: VSATs are easy to install, so as changing demographics demand movement of branches, or new branches, the network can quickly and economically accommodate those changes. VSAT networks arc flexible enough lo grow as business needs grow and evolve. Unlike many terrestrial solutions, a VSAT network

accommodates system expansion, network reconfiguration, and additional applications w very little increase in costs. VSAT networks maintain compatibility for all current and future enterprise applications through the use of standard protocols and Interfaces.

Hidden benefits: VSAT network can become a profit center, enabling to offer attractively priced enhanced services to your corporate clients. For example, if you are planning to install ATMs in locations such as convenience stores or petrol stations, an VSAT system enables to carry your retail partner's Electronic Funds Transfer/Point of Sale (EFT/POS) traffic as well as ATM traffic.

1.5 NETWORK STANDARDIZATION

Although there is no widely accepted and quoted definition of the term standard, the National Policy on Standards for the United States encompasses the essential concept : A prescribed set of rules, conditions, or requirements concerning definition of terms; classification of components; specification of materials, performance or operations; delineation of procedures; or measurement of quantity and quality in describing materials products, systems, service, or practices.

The key advantages of standardization are as follows:

- A standard assures that there will be a large market for a particular piece of equipmer of software. This encourages mass production and in some cases, the use of Very Large Scale Integration (VLSI) techniques, resulting in lower casts.
- The standard allows products from multiple vendors to communicate, giving the purchaser more flexibility in equipment selection and use.

The principle disadvantage of standards is that they tend to freeze technology. By the time a standard is developed, subjected to review and compromise and promulgated, mor efficient techniques may have been developed. Nevertheless, the advantages of standards' are so great that customers are willing to pay this price.

Standards and Regulation: There are three categories of standards:

1. Voluntary standards
2. Regulatory standards
3. Regulatory use of voluntary standards

Voluntary standards arc developed by standards-making organizations, such as CCITT (International Telegraph and Telephone Consultative Committee) and ISO (International Organization for Standardization), They are voluntary in that the existence of the standard does not compel its use. That is, manufacturers voluntarily implement a product' that conforms to a standard if they perceive a benefit to themselves; thcrc is no legal requirement to conform. Such standards are also voluntary in the sense that they are developed by volunteers who are not paid for their efforts by the standards-making organization that administers the process. These volunteers arc gcncrally employees of interested organizations, such as manufacturers and government agencies.

A regulatory standard is developed by a government regulatory agency to meet some public objective, such as economic, health and safety objectives. These standards have the force of the law behind them and must be complied with by providers in the context in which the regulations apply, Familiar examples of regulatory standards can be found in areas such as fire and health codes. But regulations can apply to a wide variety of products, including those related to computers and communications.

A relatively new, or at least newly prevalent, phenomenon is the ***regulatory use*** of ***voluntary standards. A*** typical example of this is a regulation requiring that the government's purchase of a product be limited to those that conform to some referenced set of voluntary standards. This approach has a number of benefits,

- It reduces the rule-making burden on government agencies.
- It encourages cooperation between government and standards organizations to produce standards of broad applicability.
- It reduces the variety of standards that providers must meet.

Standards Organizations

Various organizations have been involved in the development or promotion of communication standards. This section provides a brief description of two of the important standard organizations.

International Telegraph and Telephone Consultative Committee (CCITT): CCITT is a committee of the International Telecommunications Union (ITU), which is an United Nations treaty organization. Hence, the members of CCITT are governments. CCITTís primary objective is to standardize, to the extent necessary, techniques and operations in telecommunications to achieve end-to-end compatibility of international telecommunication connections, regardless of the countries of origin and destination.

CCITT is organized into 15 study groups that prepare standards, called recommendations by CCITT. Work within CCITT is conducted in Four year cycles. Every four years, a plenary assembly is held. The work program for the next four years is established at the assembly in the form of questions submitted by the various study groups or abolishes existing ones and allocates questions to them. Based on these questions, each study group prepares draft recommendations. Two procedures may be followed for the adoption of a new recommendation. The traditional technique is to submit all proposed recommendations to the next assembly, four years hence. A recommendation is approved if it obtains a majority of the votes. All approved recommendations are then published as' a package of 'books' once in every four years.

In addition to this four-year cycle, a new method for approving recomtnendations was adopted. The need for a change was dictated by two factors. First, the increasing volume of standards produced by CCITT has made the publication process increasingly cumbersome. Second, with fast-moving areas of technology and user demand, a four year gap is simply too long between updates. Accordingly, CCITT adopted a resolution allowing for the approval of recommendations outside the four year cycle. A study group may submit a proposed recommendation if its members unanimously approve. A vote of all members must be completed within four months. If 70 percent or more of the responding members approve, the recommendation is adopted.

International Organization **for Standardization (ISO):** ISO is an international agency for the development of standards on a wide range of subjects. It is a voluntary, non-treaty organization whose members are designated standards bodies of participating nations, plus nonvoting observer organizations. Although ISO is not a governmental body, more than 70 percent of ISO member boclics are governmental standards institutions or organizations incorporated by public law. The United States member body is thé American National Standards Institute (ANSI).

ISO was Sounded in 1946 and has issued more than 7000 standards on a broad range of areas. One important area of standardization deals with the open systems interconnection communications architecture and the standards at each layer of the Open Systems Intercommunication (OSI) architecture. The development of an ISO standard from first proposal to actual publication of the standard follows a seven step process. The objective is to ensure that the final result is acceptable to as many countries as possible. A brief description of the steps is follows:

1. A new work item is assigned to the appropriate technical committee and within that technical committee, to the appropriate working group. The working group prepares the technical specifications for the proposed standard and publishes these as a committee draft (CD). The CD is circulated among interested members for balloting and technical comment. At least three months arc allowed and there may be iterations. When there is substantial agreement, the CD is sent to the administrative are of ISO, known as the Central Secretariat.
2. The CD is registered at the Central Secretariat within two months of its final approval by the technical committee.
3. The Central Secretariat edits the document to ensure conformity with ISO practices; no technical changes are made. The edited document is then issued as a draft international standard (DIS),
4. The DIS is circulated for a six month balloting period. To be approved, the DIS must receive the votes of a majority of the technical committee rnemhcrs and 75

percent of all voting members. Revisions may occur to resolve any negative vote. more than two negative votes remain, it is unlikely that the DIS will be published a final standard.

5. The approved, possibly revised, DIS is returned within three months to the Centra Secretariat for submission to the IDO council, which acts as the board of directors ISO.
6. The DIS is accepted by the council as an international standard (IS).
7. The IS is published by ISO.

CCITT has primarily been concerned with data transmission and communication netwo issues. Roughly, these occupy the lower three layers of the OSI architecture. ISO has traditionally been concerned with computer communications and disturbed processing issues, which correspond roughly to layers 4 through 7.

Areas of Standardization

Even within the areas of telecommunications and information technology, the range of topics for standardization is very broad. In this section, we highlight three key areas of standardization.

Communications Architecture: A communications architecture is a structured set of software modules that implement the communications function. A standard for a communications architecture has been adopted jointly by ISO (ISO 7498) and CCITT (X200), referred to as the open systems interconnection (OSI) reference model. The OS model, which is a seven-layer structure, prove the following potential benefits:

- The model provides a framework within which standards at each layer can bc developed systematically and in parallel. Thus, the standards making process is mor efficient.
- Communications standards assure a large market and therefore promote lower costs through competition and mass production.
- Standards promote interoperability; that is, standards promote the ability for product from different vendors to work together. Interopcrability, in turn, gives purchasers m flexibility in equipment selection and promotes tlistributcd applications between and among different organizations.

Local Area Networks: One of the most successful areas of networking standardizatio has been that of local area networks (LANs). LAN standards have been adopted enthusiastically by the both vendors and customers; and standards-based LAN products have come to dominate the LAN marketplace.

In the forefront in the development of LAN standards has been the IEEE 802 committee, a standards-making body of the IEEE Computer Society. The 802 commi has been accredited by ANSI to develop draft standards that go on to become ANSI standards. The IEEE standards cover what may now be rcfcrrcd to as LANs of moderate data rates, up to about 20 Mbps. An equally successful set of standards for higher-speed LANs has been developed by an ANSI committee, the ANS X3T9.5 committee. The result is a set of standards referred to as the fiber distributed data interface (FDDI), also adopted by ISO.

Integrated Services Digital Network (ISDN): The acronym ISDN refers to a massive set of standards developed by CCITT that define the characteristics of a digital telecommunications network for voice and data. The focus of the standards is on the externals of the network interfaces and services. The ISDN standards fall into two categories:

1. **Narrowband ISDN:** The initial version of the ISDN specification is based on the use of a 64 Kbps digital channel as the building block for user scrviccs. Recommendations for narrowband ISDN were first issued in 1984, with a more complete set adopted in 1988.
2. **Broadband ISDN (B-ISDN):** The follow-on to narrowband ISDN, B-ISDN, provic data rates in the tens and hundreds of megabits per second. It is intended to suppo high-speed data applications plus image and video. A brief and preliminary functio

description of B-ISDN appeared in tlie 1988 set of approved recommendations appeared in 1990, using the new CCITT approval process.

The OSI Reference Model

In very general terms, communications can be said to involve three agents: applications, computers, and networks. The applications that we are concerned with here are distributed applications involving the exchange of data between two computer systems. These applications and others execute on computers that can often support multiple simultaneous applications. Computers are connected to networks and the data to be exchanged are transferred by the network from one computer to another. Thus, the transfer of data from one application to another involves first getting the data to the computer in which the application resides and then getting it to tlie intended application within that computer.

With these concepts in mind, the communication task is organized into three relatively independent layers:

- Network access layer
- Transport layer
- Application layer

The network access layer is concerned with the cxchangc of data between a computer and the network to which it is attachcd. The sending computer must provide the network with tlie address of the destination computer, so that the network may route the data to the appropriate destination. The sending computer may wish to invoke certain services, such as priority, that might be provided by the network. The specific software used at this layer depends on the type of network to bc used; different standards have been developed for local area networks and others. Thus, it makes sense to separate those functions having to do with network access into a separate layer. By doing this, the remainder of the communications software, above tlie network access layer, need not be concerned about the specifics of the network to be used. The same higher-layer software should function properly regardless of the particular network to which the computer is attached.

Regardless of the nature of the applications that are exchanging data, there is usually a requirement that data be exchanged reliably. That is, it should be assured that all the data arrive at the destination application and that they arrive in the same order in which they were sent. The mechanisms for providing reliability are essentially independent of the nature of the applications. Thus, it makes sense to collect those mechanisms in a common layer shared by all applications, which is referred to as the transport layer.

Finally, the application layer contains the logic needed to support tlie various user applications. For each different type of application, such as file transfer, a separate module is needed that is peculiar to that application.

Fig. 1.9 and 1.10 illustrate this simple architecture. Fig. 1.9 shows three computers connected to a network, Each computer contains software at the network access and transport layers, as well as software at the application layer for one or more applications. For successful communication, every entity in tlie overall system must have a unique address. Actually, two levels of addressing are needed. Each computer on the network must have a unique network address; this allows the network to deliver data to the proper computer. Each application on a computer must have an address that is unique within that computer; this allows the transport layer to deliver data to the proper application. These latter addresses are know as service access points (SAPS), connoting the fact that each application is individually accessing the services of the transport layer.

Fig 1.10 indicates the way in which modules at the same level on different computers communication with each other; by means of a protocol. A protocol is the set of rules or conventions governing the way in which two entities cooperate to exchange data. A protocol specification details Uie control functions that may be performed, the formats and control codes used to cominunicate those functions and the procedures that the two entities must follow.

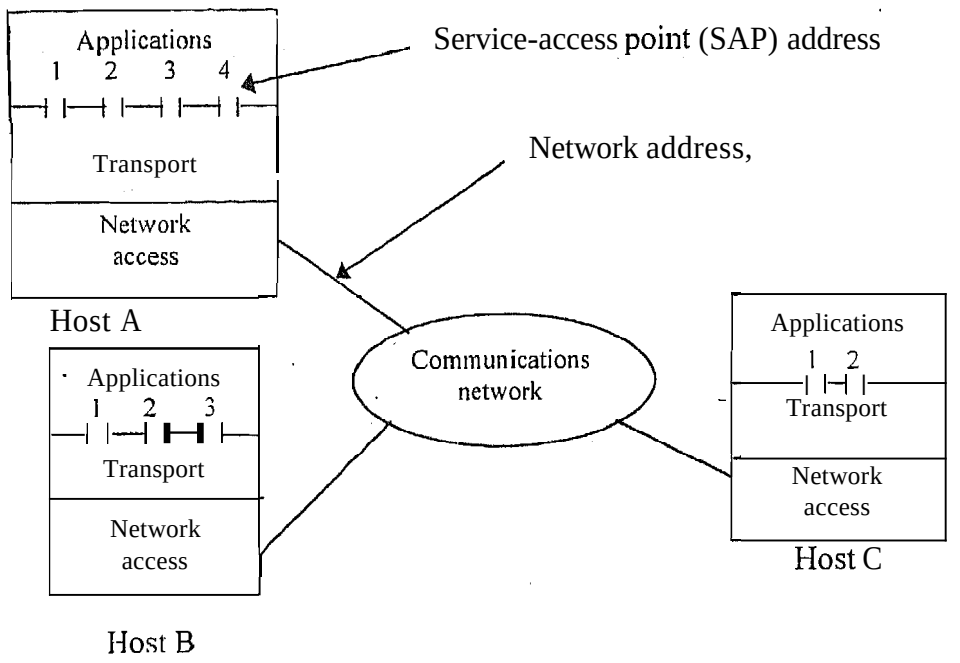

Fig. 1.9 Communication Architectures and Networks

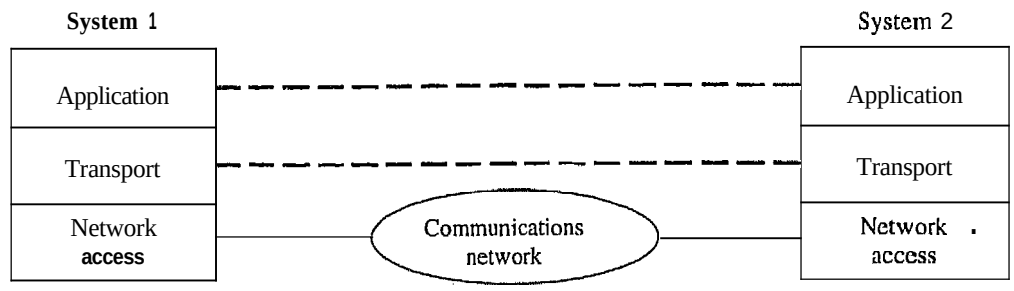

Fig. 1.10 Protocols in a Simplified **Architecture**

Activity 3

1. Role of CCITT

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2. ISDN **standards**

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3. Prolocol

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1.6 SUMMARY

Communication channel types can be either of simplex, half-duplex, or full duplex. There are three types of communication: bit serial, byte serial and parallel. For faster communication data compression techniques are used. For secure transmission data encryption techniques are used.

E-mail is used for transmission of material from one place to other place. E-mail can be used over dial-up line or a dedicated line. Internet connection can be obtained from an Internet service provider with dial-up connectivity or leased line connectivity. The leased line can be terrestrial link or satellite link.

For networking different components are used, Viz., Cables, hubs, bridges, software etc. Based on the type of cables used the network is named as 10base5, 10base2, or 10baseT network. Frame relay, ISDN and ATM technologics are used for wide area connectivity. VSAT networks are in use across banking industry for many on-line applications. Various organizations like CCITT and ISO are involved in standardization of communication networks.

1.7 SELF ASSESSMENT QUESTIONS

1) Discuss different Internet connectivity options.
2) Explain different types of networks. .
3) What are the advantages of VSAT technology for Banks?
4) Briefly describe ISDN technology.
5) Explain OSI reference model.
6) What is an intranet, and its application?

1.8 KEYWORDS

1. Communication channels are pathways through which information is conveyed from the source to the receiver(s). A channel whose direction of transmission cannot be changed is a simplex channel. A channel which allows transmission in both directions but not at the same time is a half-duplex channel. A channel which allows simultaneous exchange is both directions is a full-duplex channel.
2. Integrated services Digital Network (ISDN) is a network designed to transport real-time voice and video as well as non-real titne data such as LAN data traffic.
3. Local Area Network (LAN) is a network confined to a small area consisting of a shared transmission medium with an ability to share cotnputing devices, and **a** high data rate.
4. Very small aperture terminal (VSAT) networks provide economical centerally managed, geographically dispersed, two-way transmission of data and voice as woll as one wya video and audio broadcasts.

1.9 FURTHER READINGS

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