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Introduction

Lesson 1

Introduction and Course Outline

Specific Instructional Objective

On Completion of this lesson, the students will be able to:

- Define Computer Networks
- State the evolution of Computer Networks
- Categorize different types of Computer Networks
- Specify some of the application of Computer Networks

1.1.1 Introduction

The concept of Network is not new. In simple terms it means an interconnected set of some objects. For decades we are familiar with the Radio, Television, railway, Highway, Bank and other types of networks. In recent years, the network that is making significant impact in our day-to-day life is the **Computer network**. By computer network we mean an interconnected set of autonomous computers. The term autonomous implies that the computers can function independent of others. However, these computers can exchange information with each other through the communication network system. Computer networks have emerged as a result of the convergence of two technologies of this century- Computer and Communication as shown in Fig. 1.1.1. The consequence of this revolutionary merger is the emergence of a integrated system that transmit all types of data and information. There is no fundamental difference between data communications and data processing and there are no fundamental differences among data, voice and video communications. After a brief historical background in Section 1.1.2, Section 1.1.2 introduces different network categories. A brief overview of the applications of computer networks is presented in Section 1.1.3. Finally an outline of the entire course is given in Section 1.1.4.

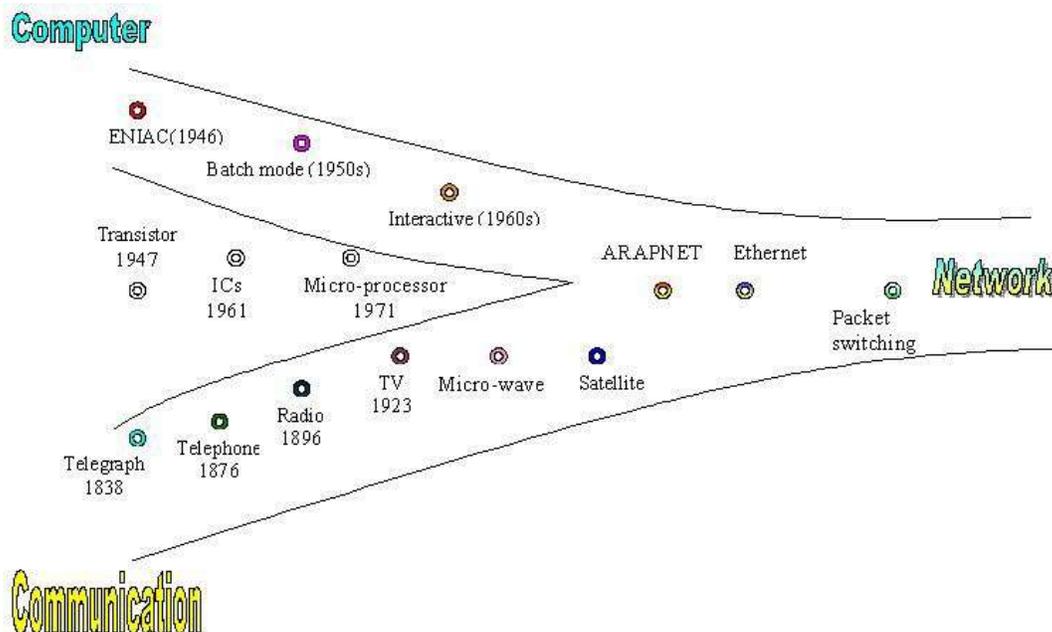


Figure 1.1.1 Evolution of computer networks

1.1.2 Historical Background

The history of electronic computers is not very old. It came into existence in the early 1950s and during the first two decades of its existence it remained as a centralized system housed in a single large room. In those days the computers were large in size and were operated by trained personnel. To the users it was a remote and mysterious object having no direct communication with the users. Jobs were submitted in the form of punched cards or paper tape and outputs were collected in the form of computer printouts. The submitted jobs were executed by the computer one after the other, which is referred to as batch mode of data processing. In this scenario, there was long delay between the submission of jobs and receipt of the results.

In the 1960s, computer systems were still centralizing, but users provided with direct access through interactive terminals connected by point-to-point low-speed data links with the computer. In this situation, a large number of users, some of them located in remote locations could simultaneously access the centralized computer in time-division multiplexed mode. The users could now get immediate interactive feedback from the computer and correct errors immediately. Following the introduction of on-line terminals and time-sharing operating systems, remote terminals were used to use the central computer.

With the advancement of VLSI technology, and particularly, after the invention of microprocessors in the early 1970s, the computers became smaller in size and less expensive, but with significant increase in processing power. New breed of low-cost computers known as mini and personal computers were introduced. Instead of having a single central computer, an organization could now afford to own a number of computers located in different departments and sections.

Side-by-side, riding on the same VLSI technology the communication technology also advanced leading to the worldwide deployment of telephone network, developed primarily for voice communication. An organization having computers located geographically dispersed locations wanted to have data communications for diverse applications. Communication was required among the machines of the same kind for collaboration, for the use of common software or data or for sharing of some costly resources. This led to the development of computer networks by successful integration and cross-fertilization of communications and geographically dispersed computing facilities. One significant development was the APPANET (Advanced Research Projects Agency Network). Starting with four-node experimental network in 1969, it has subsequently grown into a network several thousand computers spanning half of the globe, from Hawaii to Sweden. Most of the present-day concepts such as packet switching evolved from the ARPANET project. The low bandwidth (3KHz on a voice grade line) telephone network was the only generally available communication system available for this type of network.

The bandwidth was clearly a problem, and in the late 1970s and early 80s another new communication technique known as Local Area Networks (LANs) evolved, which helped computers to communicate at high speed over a small geographical area. In the later years use of optical fiber and satellite communication allowed high-speed data communications over long distances.

1.1.3 Network Technologies

There is no generally accepted taxonomy into which all computer networks fit, but two dimensions stand out as important: **Transmission Technology** and **Scale**. The classifications based on these two basic approaches are considered in this section.

1.1.3.1 Classification Based on Transmission Technology

Computer networks can be broadly categorized into two types based on transmission technologies:

- Broadcast networks
- Point-to-point networks

1.2.3.1.1 Broadcast Networks

Broadcast network have a single communication channel that is shared by all the machines on the network as shown in Figs.1.1.2 and 1.1.3. All the machines on the network receive short messages, called packets in certain contexts, sent by any machine. An address field within the packet specifies the intended recipient. Upon receiving a packet, machine checks the address field. If packet is intended for itself, it processes the packet; if packet is not intended for itself it is simply ignored.

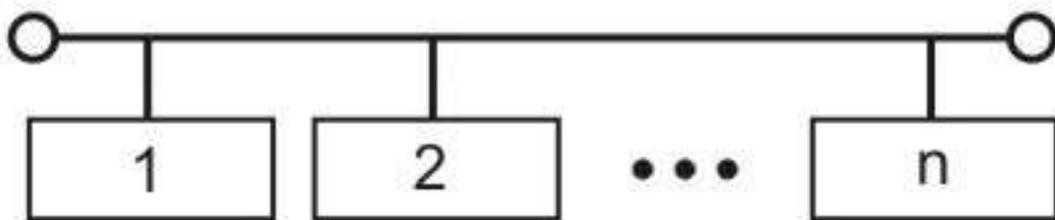


Figure 1.1.2 Example of a broadcast network based on shared bus

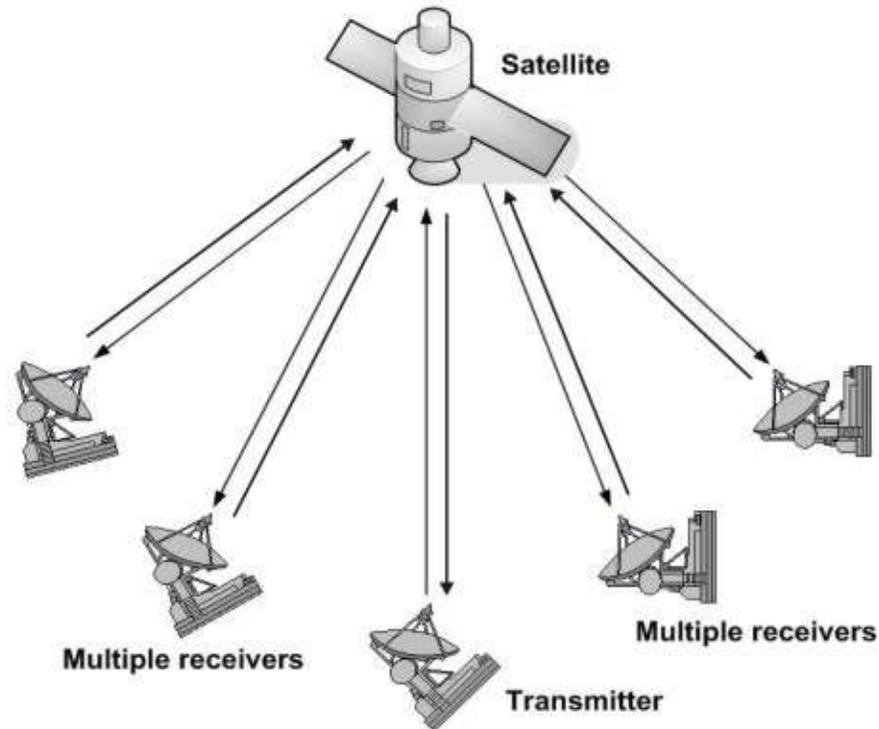


Figure 1.1.3 Example of a broadcast network based on satellite communication

This system generally also allows possibility of addressing the packet to all destinations (all nodes on the network). When such a packet is transmitted and received by all the machines on the network. This mode of operation is known as *Broadcast Mode*. Some Broadcast systems also supports transmission to a sub-set of machines, something known as *Multicasting*.

1.2.3.1.2 Point-to-Point Networks

A network based on point-to-point communication is shown in Fig. 1.1.4. The end devices that wish to communicate are called *stations*. The switching devices are called *nodes*. Some Nodes connect to other nodes and some to attached stations. It uses FDM or TDM for node-to-node communication. There may exist multiple paths between a source-destination pair for better network reliability. The switching nodes are not concerned with the contents of data. Their purpose is to provide a switching facility that will move data from node to node until they reach the destination.

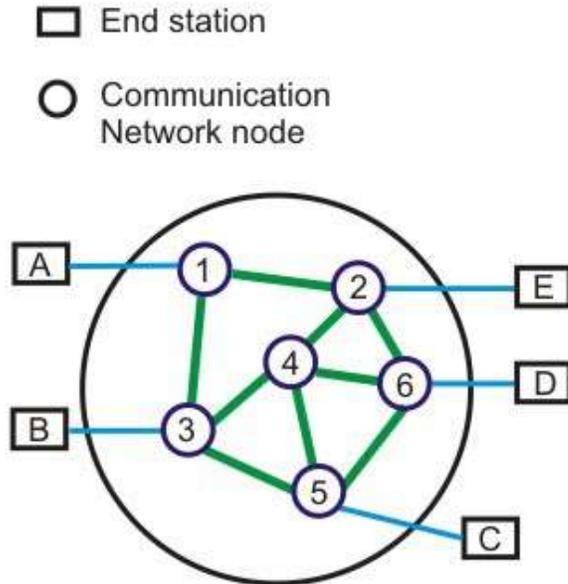


Figure 1.1.4 *Communication network based on point-to-point communication*

As a general rule (although there are many exceptions), smaller, geographically localized networks tend to use broadcasting, whereas larger networks normally use are point-to-point communication.

1.1.3.2 Classification based on Scale

Alternative criteria for classifying networks are their scale. They are divided into Local Area (LAN), Metropolitan Area Network (MAN) and Wide Area Networks (WAN).

1.1.3.2.1 Local Area Network (LAN)

LAN is usually privately owned and links the devices in a single office, building or campus of up to few kilometers in size. These are used to share resources (may be hardware or software resources) and to exchange information. LANs are distinguished from other kinds of networks by three categories: their size, transmission technology and topology.

LANs are restricted in size, which means that their worst-case transmission time is bounded and known in advance. Hence this is more reliable as compared to MAN and WAN. Knowing this bound makes it possible to use certain kinds of design that would not otherwise be possible. It also simplifies network management.

Corporate Local Area Network

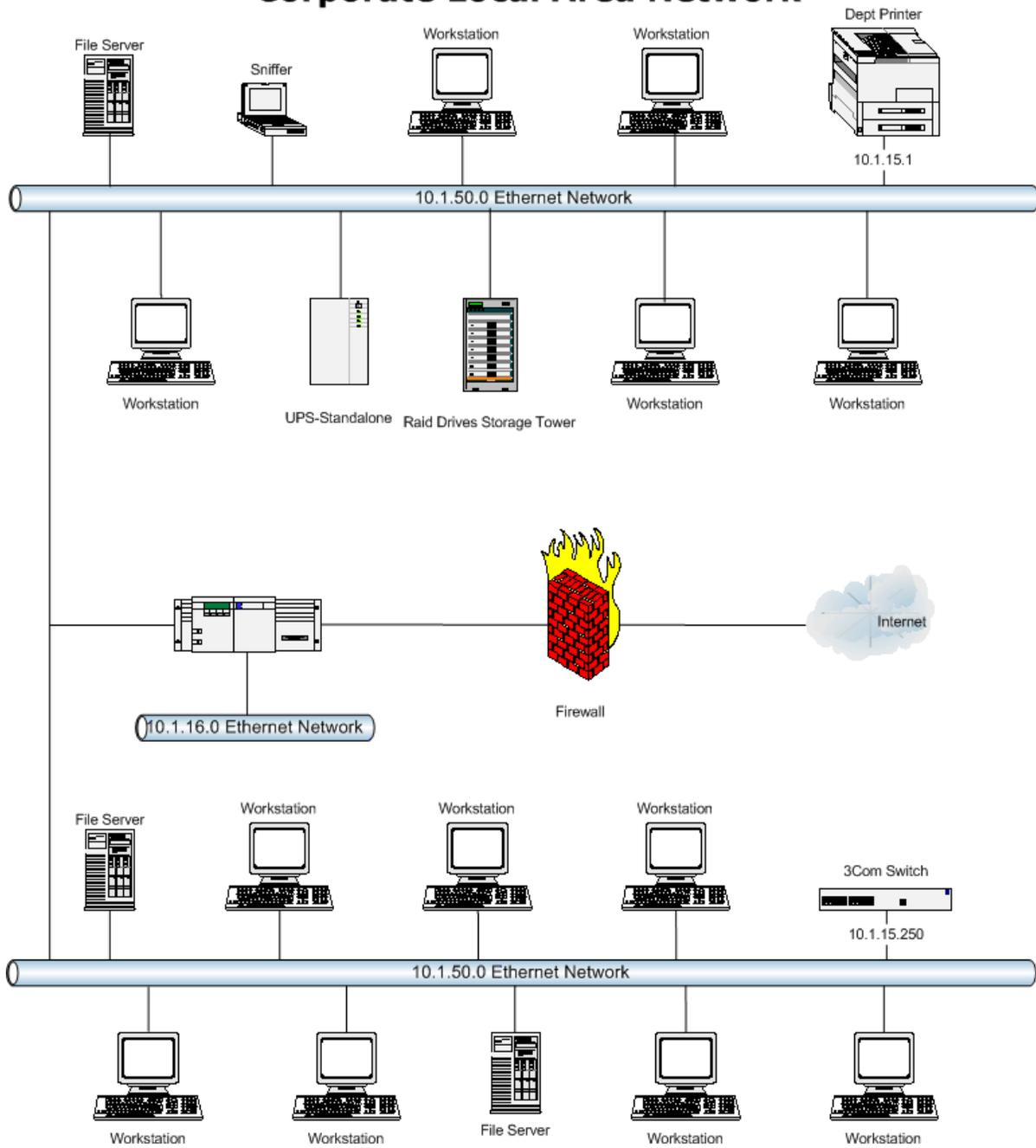


Figure 1.1.5 Local Area Network

LAN typically used transmission technology consisting of single cable to which all machines are connected. Traditional LANs run at speeds of 10 to 100 Mbps (but now much higher speeds can be achieved). The most common LAN topologies are bus, ring and star. A typical LAN is shown in Fig. 1.1.5.

1.1.3.2.2 Metropolitan Area Networks (MAN)

MAN is designed to extend over the entire city. It may be a single network as a cable TV network or it may be means of connecting a number of LANs into a larger network so that resources may be shared as shown in Fig. 1.1.6. For example, a company can use a MAN to connect the LANs in all its offices in a city. MAN is wholly owned and operated by a private company or may be a service provided by a public company.

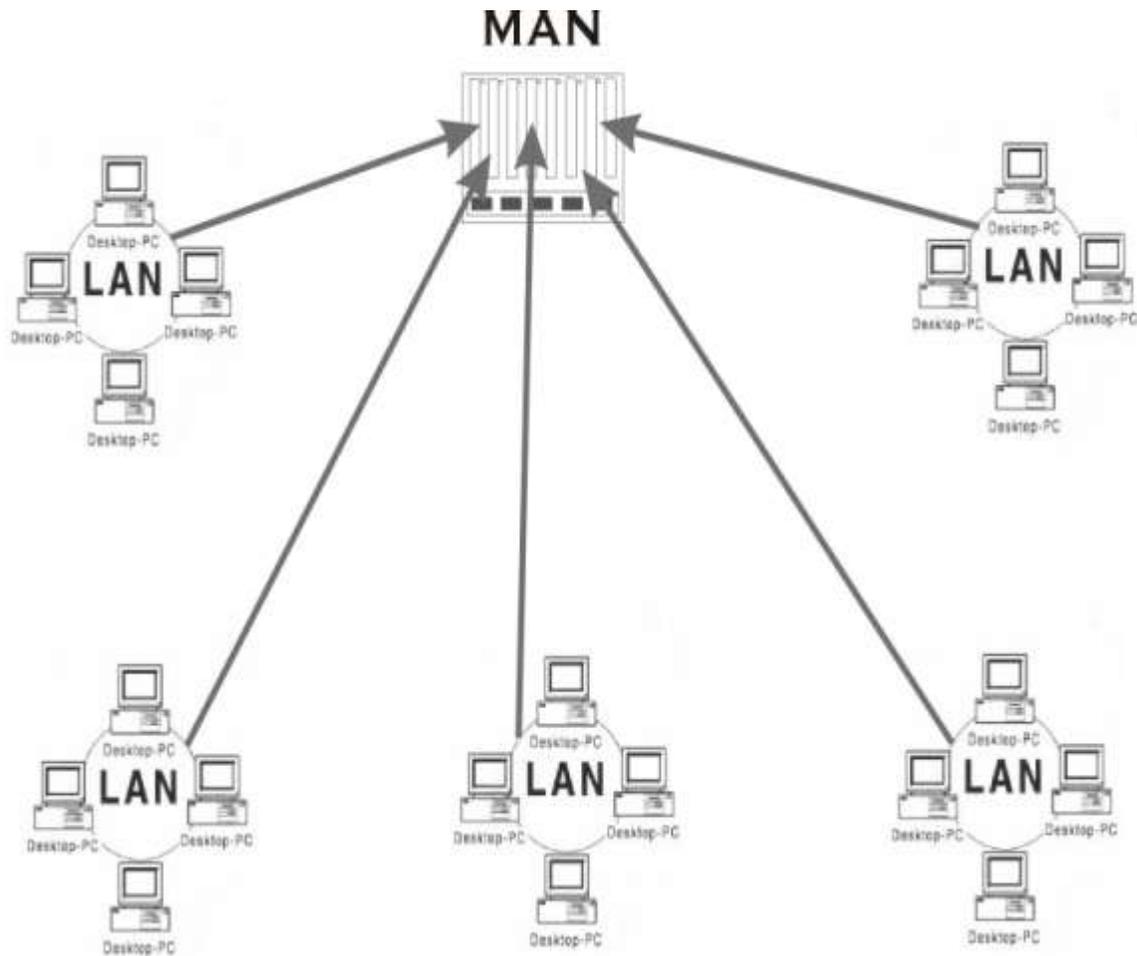


Figure 1.1.6 Metropolitan Area Networks (MAN)

The main reason for distinguishing MANs as a special category is that a standard has been adopted for them. It is **DQDB** (Distributed Queue Dual Bus) or IEEE 802.6.

1.1.3.2.3 Wide Area Network (WAN)

WAN provides long-distance transmission of data, voice, image and information over large geographical areas that may comprise a country, continent or even the whole world. In contrast to LANs, WANs may utilize public, leased or private communication devices, usually in combinations, and can therefore span an unlimited number of miles as shown

in Fig. 1.1.7. A WAN that is wholly owned and used by a single company is often referred to as *enterprise network*.

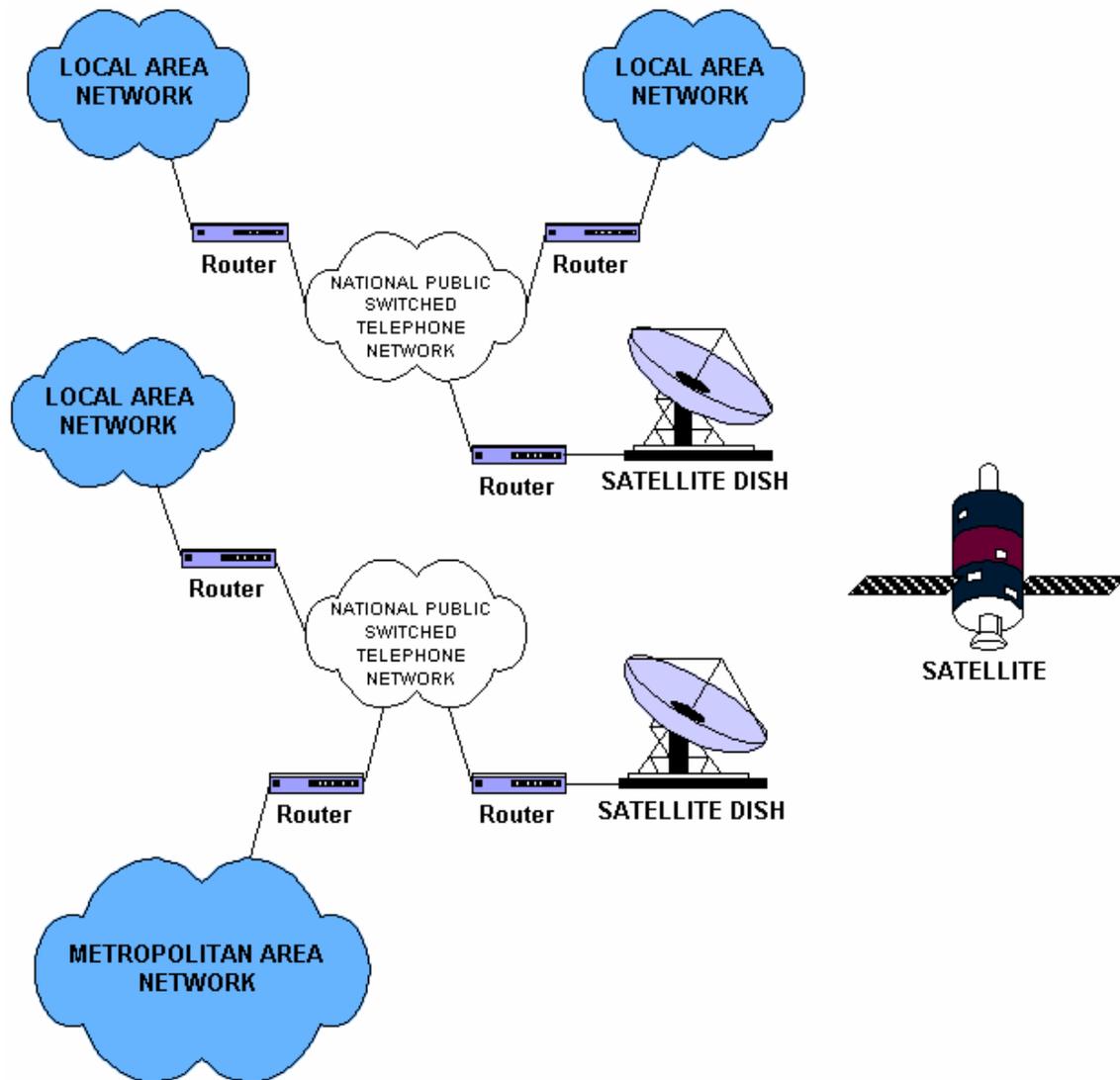


Figure 1.1.7 Wide Area Network

1.1.3.2.4 The Internet

Internet is a collection of networks or network of networks. Various networks such as LAN and WAN connected through suitable hardware and software to work in a seamless manner. Schematic diagram of the Internet is shown in Fig. 1.1.8. It allows various applications such as e-mail, file transfer, remote log-in, World Wide Web, Multimedia, etc run across the internet. The basic difference between WAN and Internet is that WAN is owned by a single organization while internet is not so. But with the time the line between WAN and Internet is shrinking, and these terms are sometimes used interchangeably.

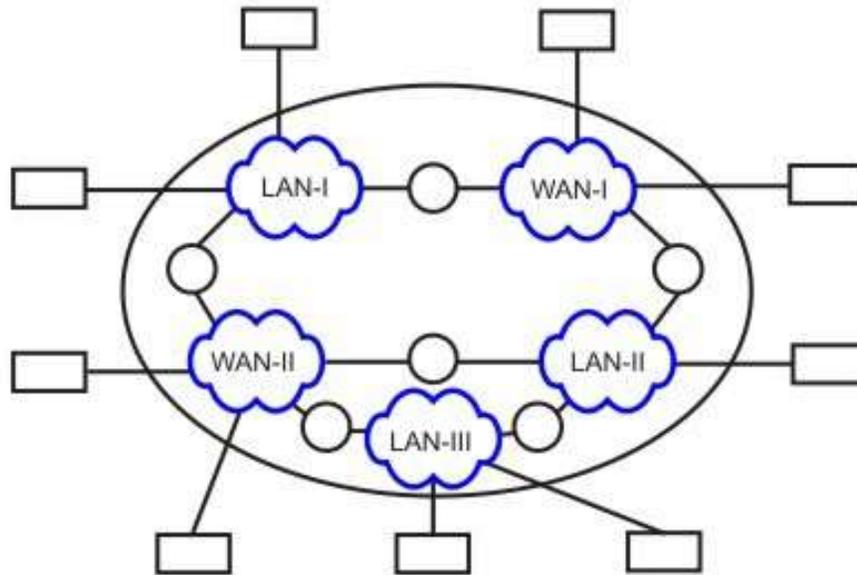


Figure 1.1.8 *Internet – network of networks*

1.1.4 Applications

In a short period of time computer networks have become an indispensable part of business, industry, entertainment as well as a common-man's life. These applications have changed tremendously from time and the motivation for building these networks are all essentially economic and technological.

Initially, computer network was developed for defense purpose, to have a secure communication network that can even withstand a nuclear attack. After a decade or so, companies, in various fields, started using computer networks for keeping track of inventories, monitor productivity, communication between their different branch offices located at different locations. For example, Railways started using computer networks by connecting their nationwide reservation counters to provide the facility of reservation and enquiry from any where across the country.

And now after almost two decades, computer networks have entered a new dimension; they are now an integral part of the society and people. In 1990s, computer network started delivering services to private individuals at home. These services and motivation for using them are quite different. Some of the services are access to remote information, person-person communication, and interactive entertainment. So, some of the applications of computer networks that we can see around us today are as follows:

Marketing and sales: Computer networks are used extensively in both marketing and sales organizations. Marketing professionals use them to collect, exchange, and analyze data related to customer needs and product development cycles. Sales application

includes teleshopping, which uses order-entry computers or telephones connected to order processing network, and online-reservation services for hotels, airlines and so on.

Financial services: Today's financial services are totally depended on computer networks. Application includes credit history searches, foreign exchange and investment services, and electronic fund transfer, which allow user to transfer money without going into a bank (an automated teller machine is an example of electronic fund transfer, automatic pay-check is another).

Manufacturing: Computer networks are used in many aspects of manufacturing including manufacturing process itself. Two of them that use network to provide essential services are computer-aided design (CAD) and computer-assisted manufacturing (CAM), both of which allow multiple users to work on a project simultaneously.

Directory services: Directory services allow list of files to be stored in central location to speed worldwide search operations.

Information services: A Network information service includes bulletin boards and data banks. A World Wide Web site offering technical specification for a new product is an information service.

Electronic data interchange (EDI): EDI allows business information, including documents such as purchase orders and invoices, to be transferred without using paper.

Electronic mail: probably it's the most widely used computer network application.

Teleconferencing: Teleconferencing allows conference to occur without the participants being in the same place. Applications include simple text conferencing (where participants communicate through their normal keyboards and monitor) and video conferencing where participants can even see as well as talk to other fellow participants. Different types of equipments are used for video conferencing depending on what quality of the motion you want to capture (whether you want just to see the face of other fellow participants or do you want to see the exact facial expression).

Voice over IP: Computer networks are also used to provide voice communication. This kind of voice communication is pretty cheap as compared to the normal telephonic conversation.

Video on demand: Future services provided by the cable television networks may include video on request where a person can request for a particular movie or any clip at anytime he wish to see.

Summary: The main area of applications can be broadly classified into following categories:

Scientific and Technical Computing

- Client Server Model, Distributed Processing
- Parallel Processing, Communication Media

Commercial

- Advertisement, Telemarketing, Teleconferencing
- Worldwide Financial Services
-

Network for the People (this is the most widely used application nowadays)

- Telemedicine, Distance Education, Access to Remote Information, Person-to-Person Communication, Interactive Entertainment

Review Questions

Fill in the blanks

1. A computer network interconnects a number of _____ computers.
2. Computer network emerges due to the development between two fields, namely _____ and _____.
3. Three main categories of networks are _____, _____ and _____.
4. _____ are privately owned while _____ are usually owned by government
5. LAN operates at a _____ speed with _____ error rate than WANs.
6. Internet is _____ of networks.
7. Initially, computer network was developed for _____.

Short answers

Q-1. Which Technologies of this age had led to the emergence of computer network?

Ans: The technologies are Computer technology and Communication technology with the support of VLSI Technology.

Q-2. What are the two broad classifications under which Networks can be divided?

Ans: All computer networks fit in one of the two dimensions namely,

a). **Transmission Technology**, this focuses on the basic underlying physical network, for e.g. whether the nodes share a communication media or each pair of node has a separate dedicated link.

b). **Scale**, it focuses on the scale of network how large is your network.

Q-3. Mention different categories of computer networks (on the basis of scale) and distinguish one from the other.

Ans: Local Area Network (LAN): It is privately owned communication systems that cover a small area, say a building or a complex of buildings. Length is about 10 meters to few kilometers and operates at a high speed like 10 MBPS to 1000 MBPS. It has very low error rate ($1:10^{11}$).

Metropolitan Area Network (MAN): It is public or privately owned communication system that typically covers a complete city. Speed is about 10 MBPS and follows DQDB (Distributed Queue Double Bus) standard. Its reliability is moderate.

Wide Area Network (WAN): It covers a large geographical area and usually owned by a state. Data transfer rate is low (few KBPS to 10 MBPS) and error rate is much higher.

Q-4. What are the two types of Transmission technologies, basis on which computer networks can be categorized?

Ans: Broadly there are two types of transmission technology:

1. **Broadcast networks:** a single communication channel that is shared by all the machines on the network

2. **Point-to-point networks:** This network consists of many connections between individual pairs of machines. To go from the source to destination a message (or packet) may have to visit one or more intermediate machines

Q-5. What is Internet?

Ans: Internet is a collection of networks or network of networks. Various networks such as LAN and WAN connected through suitable hardware and software to work in a seamless manner. It allows various applications such as e-mail; file transfer, remote log-in, World Wide Web, Multimedia, etc run across the internet.

Q-6. How do you account for higher reliability and scalability of computer network?

Ans: Computer network can have a large number of computers, which can share software, database and other resources. In the event of failure of one computer, its workload can be taken over by other computers. So, it provides higher reliability than centralized computing system.

Requirement of software, hardware, database etc. increases gradually. In centralized computing system, if one computer is not able to serve the purpose, we have to replace it by new one. Replacement of new computer requires lot of investment and effort, which can be avoided in computer network system. If there is need for more, one can buy another powerful computer, add it to computer network and use it. The various resources like computers, peripherals, etc. can be added in a scalable manner.

Q-7. Mention important benefits of computer network.

Ans: Important benefits of computer networks are:

- i) Resource sharing
- ii) Powerful communication medium
- iii) Higher reliability
- iv) Higher flexibility
- v) Lower cost
- vi) Incremental expansion

Q-8. What are the main categories based on which applications of computer network can be categorized?

Ans: The main areas under which the applications for computer network can be categorized are as follows:

Scientific and Technical Computing

- Client Server Model, Distributed Processing
- Parallel Processing, Communication Media

Commercial

- Advertisement, Telemarketing, Teleconferencing
- Worldwide Financial Services

Network for the People (this is the most widely used application nowadays)

- Telemedicine, Distance Education, Access to Remote Information, Person-to-Person Communication, Interactive Entertainment

Q-9 How is computer networks used in marketing and sales, financial services, teleconferencing?

Ans: Computer network have led to a new age of all of these services. They have helped in the following way to individual sector:

Marketing and sales: Computer networks are used extensively in both marketing and sales organizations. Marketing professionals use them to collect, exchange, and analyze data related to customer needs and product development cycles. Sales application includes teleshopping, which uses order-entry computers or telephones connected to order processing network, and online-reservation services for hotels, airlines and so on.

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