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ABSTRACT

The computing field, networking is the practice of linking computer devices together, using hardware and software to support data communications among them.Computer network is believed as a promising social infrastructure, consisting of a wide variety of datalink networks, switches and routers, network servers, application servers and the end computers. We can expect the evolutional improvement in business, education, life-style and academic area. However, because of the complicated network componemts and its complex and dynamic topology, it is difficult for general users to effectively use, for network administrators to manage and control, and for programmers to describe network appliations.

The concept and aim of new networkinggroups who are working on networks are that network should be more self-reliant and intelligent for eliminating the difficulties. The researchs and developments are made for user-friendly media authoring, intelligent network resource navigation, and intelligent network management.

The computing field, networking is the practice of linking computer devices together, using hardware and software to support data communications among them

Most future graduates in technology, business or computer information systems will be required to have a solid understanding of computer networking and optimization of computer networks.

The strong, and other developing countries around the world tries to develop their networking technology to optimize it, for its speed and efficiency.Increasing communication speed helps us to earn time and money.

As we all know networking is taking an essential part of our career, entertainment and many other roles in our life. But why? It can be the question to be asked, and we could find the answer after reading this project. Network provides us many things such as transfer of information, resource sharing, sharing of information, economy by sharing expensive hardware and software applications and increased reliability.

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INTRODUCTION

We live in a world, where the most important thing is information and communication. The information is kept and used mostly by the computers around the world. And the technology that connects the computers to each other is network.So can we say that networking is one of the most important science in our century ?

The optimization of network provides us more quick communication between the computers, so we may say that the information will be able to pass the path more quickly and the communication of information will be more quick, cheaper and safe.

This project explains the most important general principles that are used in most forms of computer networks, including the general principles and purposes of network,the network toptolgies, the algorithms for optimization of network traffic, and also topological optimization of networks.

This project will consist of four main chapters as shown in below

1) General principles and purposes of network,
2) Network topologies,
3) Optimization algorithms
4) Topological optimization of networks

At the first chapter of this project ,general principles and purposes of networks will be explained by showing general types of networks LANs, MANs and WANs with figures and tables.This chapter of the project will also include network structures, user requirements,network control and performance,data transmission,network protocols,,wireless connection, and also includes the ISDN technologies.

At the second part of the project the network topologies will be represented suh as linear bus,star,ring,tree and mesh topologies.This chapter will also include some of the advantages and disadvantages of network topologies.

In third part ,the algorithms that are used for solving the single source shortest path problems and Diskstra's algorithms will be represented.These parts in this chapter will be represented by their explanation algorithms and figures.

Finally at the fourth part of this project the topological optimization of reliable networks will be represented.This chapter will include five parts that are introduction,statement of the problem,proposed A-team,experimental results and conclusion.

CHAPTER 1

GENERAL PRINCIPLES AND PURPOSES OF NETWORK

1.1 Introduction to General Principles and Purposes of Networks

In this chapter of my project I'm going to explain the main headlines of network such as purposes of network, network applications and structure, user requirements, LAN(Local area network),MAN(Metropolitan area network),WAN(Wide area network) technologies.

There will be also discussions of the purposes and user requirements of networking(here I will talk about the ability of making the user more dissolved with the usage of networking and being satisfied of network usage) .

This chapter then considers in turn user interfaces to computer networks, network architecture (which is the building and main parts of computer network system), data transmission (it's an important part of networks which talks about the data that is transferred through networks), network standards and protocols, network control and performance.

1.2 Purposes of Networking

By bringing together the already rapidly expanding technologies of computing and telecommunications, computer networks is adding to both of these technologies capabilities that neither of them would have separately.

On the one hand, it makes possible a form of computing that is distributed in several ways. For example, several users at different locations can access the same computing system. The same user can carry out a data processing job, different parts of which are carried out by different computers in a network. A group of linked users can use their own computers or "intelligent" terminals for some purposes, but also use commonly held file stores, printers or processors for others. Users can not only access a very wide variety of computer data bases, sometimes over very long distances, but often extract and transform for their own purposes selected subsets of the information that these data bases contain.

On the other hand, computer networking adds an extra dimension to the scope of telecommunications in the ordinary sense. It provides several communications media and channels for numerical data, text, formulae, diagrams, graphics and images, as well as voice; indeed, in its most advanced form, it can handle, multimedia messages, using all these modes of message content, to telephone communications and broadcasting, it has added data communications, telex, telefacsimile, and more recently Teletex (a sophisticated form of communicating word-processing) videotext (the communication of information from computers to user- friendly displays).

But the potentialities of computer networking go farther still, because totally new applications of integrated information processing are emerging, that require both computing and telecommunications for their fulfillment. These include the whole realm of office automation that is now evolving rapidly, financial transaction services that are coming more and more to the public attention, electronic publishing, integrated information services, and a variety of ways in which geographically separated people will be able to communicate, exchange ideas, and interact with each other.

Thus computer networking has already established itself as a vitally important area of practical application, and will rapidly become much more important during the next few years. Not only will it perform many valuable functions in business and industry, but it will also be used increasingly widely by more and more members of the public.

Considering business sides, most business is done in developed countries through networks. Management networking is used for many purposes, some of these purposes are mentioned below:

- Increasing company profitability, efficiency or effectiveness
- Improving customer service
- Achieving business and personal targets

- Preparing for future personal advancement

Other purposes of implementing network for normal users include:

Implementation of administrative and financial database

Staff access to company records

Automation of letter, report or specification writing

E-mail for staff

Staff scheduling

General information automation (including library, plans, graphics and images)

Learning or training aids (interactive software

Computer skills training rooms (word processing, publishing, CADD, spreadsheets, databases)

- Printer sharing
- File transfer
- Internet access (graphical, text, news)
- Access to centralized information sources (e.g. CD-ROM stacks)
- Automate software updates
- Centralize application software

Networking is based on some very uncomplicated principles. Three common sense philosophies underpin the concept of networking and they can be summed up as follows:

- relationship building i.e. personally connecting with others
- relationship maintenance i.e. timely reconnecting and communicating
- information sharing i.e. adding value to the relationship

1.3 User Requirements

If computer networking is to become a widely used and well-integrated set of techniques, for large groups of people, whether executives, managers, professional's office workers, or citizens, one of the first requirements that it must fulfill is user friendliness. In other words, it should positively invite the user to come and try it; no longer should it put up a barrier, and convey a feeling of inaccessibility, together with an uneasy sense that it can be practiced only by a few "esoteric wizards".

That this is a real challenge is evident not only from the very genuine technical not to mention human, political and social, difficulties of computer networking those problems tend to be very much harder than those of computing alone and telecommunications alone, It also requires considerable, if not great, advances over the low degree of user friendliness all too often present in many areas of "ordinary" telecommunications and "ordinary" computing. Which of us will not have come across the exasperating difficulties, under too many circumstances, of trying to make even commonplace telephone calls? Which computer user will not have experienced the ham-handed ways in which manuals of even highly popular computer systems quite often do not explain sufficiently clearly accurately what the user should do in certain types of situation? Worse still, they sometimes forget to mention these contingencies at all.

Thus one vitally important ingredient of user-friendliness is that the basic concepts of computer networking be explained as simply as possible, given the circumstances, in as easy and clear a language as possible, with all necessary technical terms properly defined where they arise, preferably with illustrative examples.

A closely related ingredient is that, for any specific function of computer networking that a user needs to carry out with a specific system, either on the job or as a member of the public, there should be a clear but comprehensive statement of the whole sequence of steps that need to be carried out. This statement should neither be too long and complicated which makes the user unsatisfied nor too short and concise to be unreadable, and it should include at least one example.

Another important requirement of a computer networking system or service is that it should provide its users with a range of functions and facilities that are appropriate for their needs. Thus, for a business system, there is a fairly well defined group of requirements for office automation and integrated information systems, even now, and these will doubtless develop further. For private users, there are not only requirements for simple individual or household functions, such as electronic mail and financial transactions, but also the need to contribute to information, education and entertainment. In assessing this sort of requirement, it should be realized that it is not static, but rather that it is evolving rapidly. Not only that; users may well increasingly demand their own say in the new facilities to be offered by the computer-information-communication networks of the future.Last but not least are the ergonomic requirements of networking, that the equipment used shall provide a pleasant environment and interface for the user, which is neither tiring nor, in the long run, a health hazard or source of stress.

1.4 Network Applications

Perhaps the single most important application of computer networking, and certainly one of the most rapidly expanding, is its use for integrated office and business systems, in conjunction with other forms of office automation. These systems can operate at a local level, using LANs to carry out various office functions at a single site; they can also operate on behalf of organizations with several premises, using WANs to link their different LANs. Functions that can be supported by these systems include word processing and text processing, electronic mail and message services, and management information systems, as well as ordinary computing and data processing.

In addition, computer networks can support various financial transaction services for companies and other organizations. Similar transaction services for citizens are less well advanced; but electronic banking, credit card, shopping and travel booking facilities are beginning to operate or are being planned.

Computer networks have already been able to improve greatly the operation of data bases, information retrieval facilities, and other information services. Data bases made available in this way include those provided by private and public videotext systems, to provide useful information on a wide variety of subjects, and very large specialist data bases accessed by "ordinary" online retrieval services. One of the most significant developments is the provision of "third party data base" facilities, which allow a network's own data bases to be supplemented by a large number of other computer data bases, which can be linked to it through network "gateways."

There are many other actual and potential applications of networking, covering most aspects of human life. These include the use of network for: distributed computing and data processing, telesoftware, education and training, electronic publishing, message services, computer conferencing, community information services, and home information systems.

1.5 Network Technologies

Computer networking brings together various technologies concerned with electronics, telecommunications, computing and information processing.

A considerable variety of network architecture has been devised. The "star" network, linking a cluster of terminals to a central computer, has been used in both LANs, and WANs. However, LANs usually have either a "ring" configuration, with all their devices attached to nodes in a loop of cable, or a "bus" configuration, where their devices are attached to nodes on a single line of cable. WANs tend to use fairly general configurations of nodes, including peripheral (device) nodes and switching nodes.

WANs are linked to neighboring LANs and WANs by special gateways, which are nodes or node-pairs that act as interfaces between them. Although the earliest computer networks used very simple terminals, to provide users with access to local or remote computers, more sophisticated, "intelligent," forms of network terminals were later developed, to be used predominantly by business users and information providers, and having additional capabilities. A whole range of devices that can be attached to networks is now available for users, including: graphics displays, sometimes in color, word processors, a variety of printers and computers, even voice input and output devices. Multi-purpose terminals, with a considerable range of facilities, including local computing, word processing and data storage, are beginning to appear on the market. Memory devices and tile stores that can be attached include: floppy disk drives, "hard" (fixed) magnetic disks, magnetic tapes, video storage and, very recently, optical storage.

Transmission technologies, used in telecommunications, include: telephone lines, high bandwidth transmission lines, coaxial cables, fiber optics, lasers, radio waves, and satellite communications.

Standardization is becoming increasingly necessary, to avoid a chaotic proliferation of mutually incompatible network systems; on the whole, it seems to have been making good progress during recent years. Standard protocols are being developed, that provide operating rules for the interchange of information and for communication, both for data networks themselves and for the wide variety of applications that these networks support.

Technologies and techniques are also required for network control and for the improvement of network performance. To be fully effective, network control, to keep the network in full working order as continuously as possible, requires network measurements and regular monitoring of network performance. The performance and other characteristics of network behavior can be investigated both empirically and with the aid of mathematical models of networks and network traffic and protocols. Predictions of network performance can then be made by means of a judicious combination of analytical and simulation techniques applied to the models. Network design can be improved by devising appropriate performance and operating criteria, using models and empirical data to predict the performance of propose modifications or new features, and learning from practical experience of networks.

1.6 Network Structures

The first basic principle of network structure is that a computer network can be subdivided into several computing and information processing devices, all linked together by a common communications subsystem, sometimes called the "subnet"as explained in figure 1.1 . The essential requirement is that, regardless of the diversity of the different devices, the subnet should nevertheless be able to establish effective communication and interchange of information between all of them.

The subnet may itself have a variety of configurations.These configurations include: the *star* network, where there is one central node, usually attached to a central computer; the loop or *ring* network, where all the nodes are strung round a single loop of wire or cable; the *bus* network, where all the nodes occur in linear sequence, from one end of a long line, the "bus" to the other; the mesh 'network, where there is a rich interconnection between many different nodes, indeed sometimes between all pairs of nodes; the radio network, where there is no configuration of specific paths between different nodes, but where they are all in effective "wireless" radio contact with each other.

There are also important distinctions to be made between local area network (LAN) configurations, sited within a compact geographical area, and wide area network (WAN) configurations, the distances between whose nodes range from less than a mile to thousands of miles. Usually, the LANS have ring or bus configurations, while the WANS are usually meshes; star networks, though now less usual than before, can appear as either LANS or WANS.
The other basic principle of network architecture is that different types of network may be interconnected with each other, in such a may that any pair of nodes, accessible to each other via a path through several consecutive interconnected networks, can communicate effectively with each other. More specifically, neighboring networks are joined to each other by "gateways," which can be viewed either as single nodes, belonging to two or more networks, or as a configuration of neighboring, mutually linked, nodes, belonging to the different networks that are being brought together there. Figure 1.1 shows a typical configuration of interconnected networks of various types; for example, it shows not only interconnected

Neighboring: WAN: but, very important, the linkages between different LANS, Separated from each other by intervening WANS.

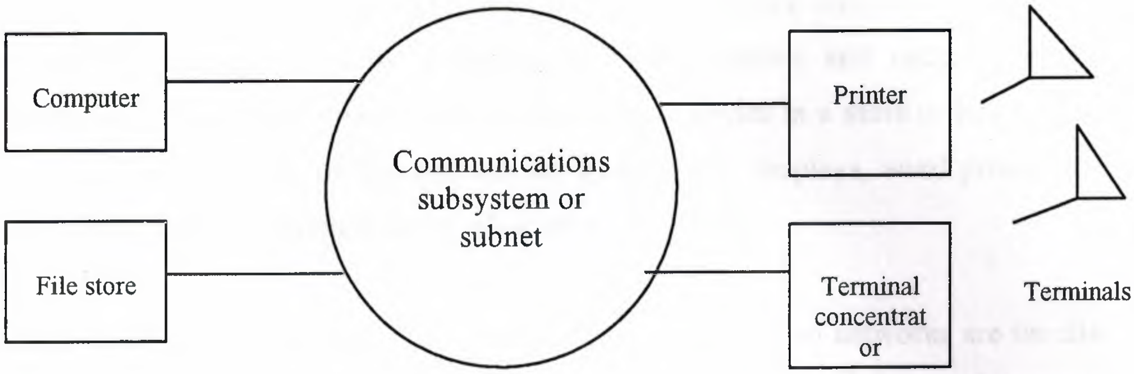

Figure. 1.1 : Example of a computer network, sharing attached devices, subnet and interfaces between devices and subnet SOURCE: Based on author's drawing

1.7 Equipment Linked to Networks

In the early days of computer networks, there were usually only two kinds of device attached to them, computers and terminals. The situation is very different now, when just about every information or communications device under the sun can be linked to a network.

User interfaces that can be connected to networks, include "ordinary" terminals that are usually VDUs, graphics terminals and plotters, that specialize in more or less sophisticated types of visual display, word processors, a wide variety of printers, voice input devices and voice output devices. Sometimes, clusters of devices are joined to a. network through a multiplexer, rather than each of these devices being connected directly.

Any sort of computer can now be interfaced with a network, ranging from the smallest microcomputer, through personal computers and minicomputers, to mainframes and distributed array processors.

Rapidly becoming more important, with the onset of office automation and other technological advances, is the multi-purpose work stations and integrated work stations, which combine several functions in a single device in a more or less unified way. Typically, devices of this sort can act as terminals, displays, word processors, computers, and data communicators, all at once.

Another very important class of devices that can be attached to networks are the file stores and mass memories. These can hold from about a hundred thousand to many million characters of information. They range from floppy disks and "hard" magnetic disks of various shapes and sizes, through magnetic tapes and video storage, to the optical information stores, which can already hold very large amounts of information very compactly and promise to have very much better performance within only a few years from now.

1.8 Data Transmission

Originally, computer networks relied entirely on telephone lines for the long distance communication of information across them. Today, with the advance of technology, the range of possible data transmission media is quite considerable. High bandwidth transmission lines and coaxial cables are providing channels for data transmission, over both short and long distances, that are far more ample and reliable than those available on telephone lines. Recently, fiber optics cables have begun to develop steadily, and will soon be able to provide local and even medium distance channels of even higher capacity, at costs that are still reasonable.

"Wireless" data communications of several types are coming into their own. Radio waves have not only provided the basis for more or less local "packet radio" services; they are also used in satellite communications systems, and information, "piggybacked" on broadcast television systems, is used in several teletext systems.

Recently, advances in electro-optical technology have allowed the development of communications system using laser light.

1.9 Network Architectures Standards and Protocols

The architecture of a computer network precisely defines the functions that the network and its components should perform, and the ways in which the network should be organized. The main purpose of the architecture is to ensure that the design and user requirements of the network are met as far as possible, by arranging that the different parts of the network cooperate effectively and by enabling the network system as a whole to evolve according to its aims. In effect, the architecture is an “organization chart" of the network. It is defined in terms of the relations between the different parts of the network; these relations include both protocols and interfaces.

Network protocols are essential, both for providing the basic rules of formatting and handling information that is to be communicated from one part of a network to another, and for helping to overcame problems of mutual “incompatibility” between different devices that are connected to a network, or, more generally, a system of interconnected networks. Very closely related to the design of protocols is the formulation of suitably agreed network standards, which is actively promoted by various national and international standards bodies, together with the specialist working parties that they have set up to consider and discuss new protocols.

In accordance with the principles of network architecture, the functions of a network, and therefore the protocols that implement them, operate at different layers and levels, of which seven are now generally recognized. At the lowest level, there is the physical intercommunication system, then, going progressively higher, there are link protocols, covering data transmission over links, and network protocols, primarily concerned with communication and routing across networks.

At a middle level, there are transport protocols, looking after reliable end-to-end transmission of a message from one device, over a network or sequence of networks, to another. Higher still are the session protocols, responsible for handling connections between individual processes in computers and devices that communicate with each other, and presentation protocols, performing generally useful transformations and conversions of the data to be exchanged. At the top level, there are application

Protocols, covering a range of user- oriented functions, such as transfer of information between data bases, distributed computing, and electronic mail and message services.

1.10 Network Protocols

The Internet protocols are the world's most popular open-system (nonproprietary) protocol suite because they can be used to communicate across any set of interconnected networks and are equally well suited for LAN and WAN communications.

The Internet protocols consist of a suite of communication protocols, of which the two best known are the Transmission Control Protocol (TCP) and the Internet Protocol (IP). The Internet protocol suite not only includes lower-layer protocols (such as TCP and IP), but it also specifies common applications such as electronic mail, terminal emulation, and file transfer.

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The Internet Protocol (IP) is a network-layer (Layer 3) protocol that contains addressing information and some control information that enables packets to be routed. IP is documented in RFC 791 and is the primary network-layer protocol in the Internet protocol suite. Along with the Transmission Control Protocol (TCP), IP (Transmission control protocol/internet protocol) is a suite of common network protocols for information interchange between computers.

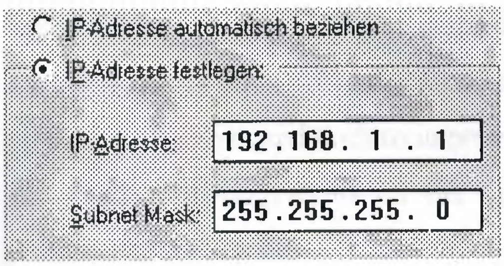
represents the heart of the Internet protocols. IP has two primary responsibilities: providing connectionless, best-effort delivery of datagram's through an internetwork; and providing fragmentation and reassembly of datagram's to support data links with different maximum-transmission unit (MTU) sizes.

1.10.1 IP Addressing

As with any other network-layer protocol, the IP addressing scheme is integral to the process of routing IP datagrams through an internetwork. Each IP address has specific components and follows a basic format. These IP addresses can be subdivided and used to create addresses for subnetworks.Each host on a TCP/IP network is assigned a unique 32-bit logical address that is divided into two main parts: the network number and the host number. The network number identifies a network and must be assigned by the Internet Network Information Center (InterNIC) if the network is to be part of the Internet. An Internet Service Provider (ISP) can obtain blocks of network addresses from the InterNIC and can itself assign address space as necessary. The host number identifies a host on a network and is assigned by the local network administrator.

1.10.2 IP Address Format

The 32-bit IP address is grouped eight bits at a time, separated by dots, and represented in decimal format (known as dotted decimal notation). Each bit in the octet has a binary weight (128, 64, 32,16, 8, 4, 2, 1). The minimum value for an octet is 0, and the maximum value for an octet is 255.Figure 1.2 illustrates the basic format of an IP address.



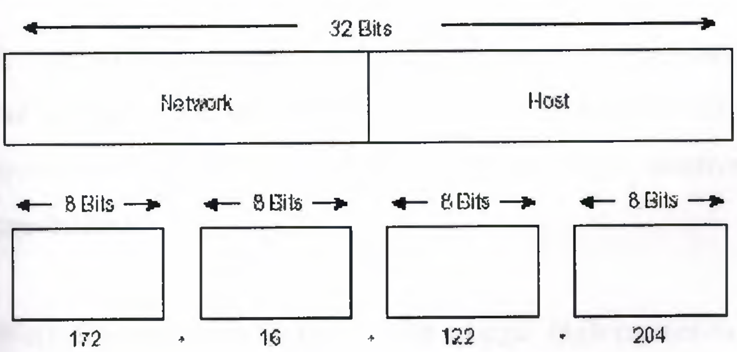


Figure 1.2: Basic format of an IP Adress

1.11 Network Control and Performance

In order that a computer network may be adequately controlled, it is important to obtain a good idea of its actual performance. This may be achieved empirically, partly by making network measurements at various times and places, partly by more systematic monitoring of important parts of the network. Various sorts of control, including bow control and congestion control, help to keep the information traffic across the network in reasonable order, and prevent it from getting out of hand.

Idea of network performance, it is necessary to supplement empirical studies of network behavior by theoretical studies. These use mathematical models to throw light on the performance of part or whole of a net- work, and the resulting calculations on the models are carried out, using judicious combination of analytical and simulation methods. In this way, using also the results of empirical studies, more or less accurate predictions can be made of how a network will behave if certain changes are made to its physical characteristics, to its configuration, and to its traffic. Such predictions can be used both to improve, the day-to-day operation of a network and to make valuable suggestions for the improvement of its architectural design d f the protocols that it uses.

1.12 Workstation

A type of computer used for engineering applications (CAD/CAM), desktop publishing, software development, and other types of applications that require a moderate amount of computing power and relatively high quality graphics capabilities.

Workstations generally come with a large, high-resolution graphics screen, at least 64 MB (megabytes) of RAM, built-in network support, and a graphical user interface. Most workstations also have a mass storage device such as a disk drive, but a special type of workstation, called a diskless workstation, comes without a disk drive. The most common operating systems for workstations are UNIX and Windows NT.

In terms of computing power, workstations lie between personal computers and minicomputers, although the line is fuzzy on both ends. High-end personal computers are equivalent to low-end workstations. And high-end workstations are equivalent to minicomputers.

Like personal computers, most workstations are single-user computers. However, workstations are typically linked together to form a local-area network, although they can also be used as stand-alone systems.
In networking, workstation refers to any computer connected to a local-area network. It could be a workstation or a personal computer.

1.13 Network Computers (NC)

A few years ago, it seemed that the world was ready for the age of a marvelous new creation called the network computer (NC). A network computer is a computer-like device with a very fast processor and no CD, hard drive, or floppy drive. When the user logs on from the network computer, a complete Java-based operating system downloads to the network computer. If the user starts an application, a Java-based application downloads to the network computer possibly with some server-based processing for certain tasks. The user could save any files to a well-protected and fault-tolerant storage device on the server or elsewhere on the network.

When the user turns off the network computer, the complete configuration disappears from memory. But it returns when the user logs on again. In fact, another user could log on to the same network computer and receive a completely different configuration.

The new user could even receive a completely different operating system. Meanwhile, the users' files are kept safe with the ISP. All software is managed, configured, and updated from the server, and the network computer is so simple that it isn't likely to break. If it does break, you just buy a new one because it is so inexpensive. In any ease, you don't have to disassemble, reassemble, or configure the network computer because there is nothing to configure.

This amazing vision captivated market watchers when it was first proposed, but so far the revolution of the network computer hasn't happened. One reason why the network computer hasn't caught on is the fact that hardware prices have fallen so sharply. You can now buy a complete computer for what a network computer cost a few years ago.

Another reason may be that, although lava development is proceeding very rapidly, we haven't yet reached the point where a complete Java-based operating system is viable for the mainstream. However, the network computer is only one of several thin-client solutions that have made their way to the market. You'll learn about another thin-client option (the terminal client) in the next section.

1.14 Types of Networks

The geographical area covered by a network determines whether the network is called local area network(LAN),metropolitan area network(MAN) or wide area network (WAN).Wide area network systems that are too far apart to be included in a small in-house network.Metropolitan area networks connect accross distances greater than a few kilometers but no far than 50 kilometers (approximately).Local area networks usually connect the users in the same office or building.

1.14.1 LAN(Local Area Networks):

Review and Classification of Local Area Network Technologies

A considerable variety of lan technologies are available, these technologies have been surveyed and compared by cotton(1979),for example ,who gives over thirty literature references. They can be classified in four ways:

1. By configuration or topology, for example: star, ring, bus, mesh).

2. By medium, the method by which data are transported within the network, for example: twisted pair wires, cable, radio; digital base band signaling, using only one frequency; digital broadband systems, using several frequencies shared by a channel; modulated signaling.

3. By sharing technique, the way in which many users are allocated bandwidth in the network, for example: dedicated (non-shared), time or frequency division multiplexing, statistical multiplexing, contention.

4. By user services and protocols, this can be provided by intelligent devices, attached to the network or its interfaces, regardless of the internal network transmission techniques.

Any sharing technique can be used with any technology (Clark et al, 1978), who describes a number of interesting combinations.

Some of the arguments for and against some of the most common variants of some of the technologies are now summarized; for further details, see Cotton (1979).

Local non-switched networks, using dedicated lines, are most suitable where only relatively few users need interconnection or where most users need to communicate only with one other user, as in the original time-sharing computer systems.Local circuit switching can be achieved, either through a public telephone exchange or through a branch exchange on the user's premises. Any user can be dialed conveniently, and costs are fairly small for low speeds, up to about 1200 bits/second.

Local message-switched networks tend to have reliability problems, especially when based on central switches, but can be attractive.Local packet-switched networks are very feasible, though sometimes more expensive than other approaches. Most of the LAN systems, described in this chapter, indeed in this book, are in this category.

Ring networks very efficiently share available transmission bandwidth, and can be implemented at high data rates with very simple transmission facilities; despite initial misgivings about their possible unreliability, they have turned out to be very reliable in practice.

Ethernets and other similar bus networks are suitable for serving many users at a single site, where no pair of stations is more than a few miles apart. They can provide gateway access to other networks. They are also very reliable and have good performance.

Cable bus systems allow many different services, such as data, voice and television traffic, to be supported on the same cable. Continuous high-bandwidth

1.14.2 What Is LAN?

LANs connect computers, devices within a small area, usually within a building or adjacent buildings.LAN transmission media usually do not across roads or other public throghfares.They are usually controlled and owned with respect to data processing equipment, such as processors and terminals and with respect to the equipment such as media and extender

Many local area networks are used to interconnect the computers and peripherals within an office or department. Through specialized hardware and sotware,each department's LAN is connected to a larger local area network within the company's building.Then this larger LAN is connected to a metropolitan area network that may interconnect different offices and branches throughout large city.And finally, the company's MANs my be connected to a wider area network that interconnects the companies to the regional or international offices.

A Local Area Network (LAN) links computers in a building, or across a school, office or campus. The LAN allows data and applications to be shared on multiple computers. A LAN also allows applications and/or files to be accessed on a central server via wired or wireless connections. With a wired LAN, computers are connected by a solid and fixed network of wires. It can be difficult to move and expensive to change

A LAN is a high-speed data network(medium allows a high bit transmission rate) that covers a relatively small geographic area(ex within a building). It typically connects personal computers, workstations, printers, servers, and other devices, LANs are connected by permanent cables that allow rapid data transfer. A LAN will generally comprise several personal computers, shared peripheral devices such as printers and scanners, and a central file server with high capacity disk storage. A network server stores data and programs that can be used and shared by any computer linked to the LAN (subject to users having access rights), Most LANs, as mentioned above. Node (individual computer) in a LAN has its own CPU with which it executes programs, but it also is able to access data and devices anywhere on the LAN. This means that many users can share expensive devices, such as laser printers, as well as data.

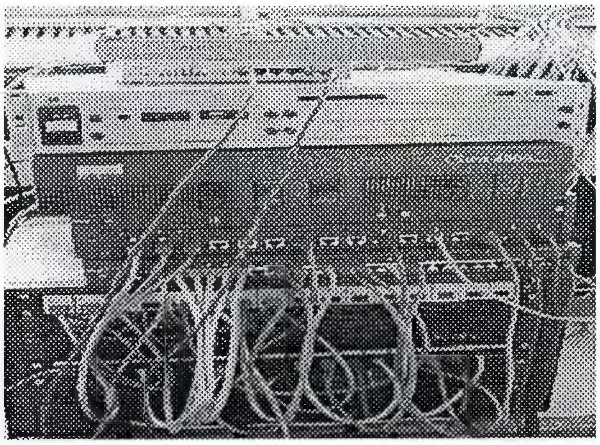


Figure 1.3 : Networking Equipment at the centre of a LAN

1.14.3 Specific LAN Requirements

The kind of hardware you use depends on the kind of access and/or modem you're using. If you're using dial-up access you'll need:

- One network card for each computer.
- One hub.
- A cable for each connection to the hub.

If you're using cable modem, DSL modem or direct access you'll need:

- One network card for each computer (may be wireless).
- One additional network card to connect to the mode (your WinProxy machine receives two cards, one
for the modem and one for the local network) (may be USB or wireless).
- One hub (unless wireless or wireless access point).
- A cable for each hub connection (unless wireless).

1.14.4 How does LAN operate?

A LAN requires special operating system software to allow the various devices connected to the LAN to communicate with each other.As Lan follows the rule of server-client networkes, the server must have the power to operate strongly within the network.This strongness and effectiveness of the server lies in the precense of a strong operating system ex:- Macintosh , windows 2000 may be also used.

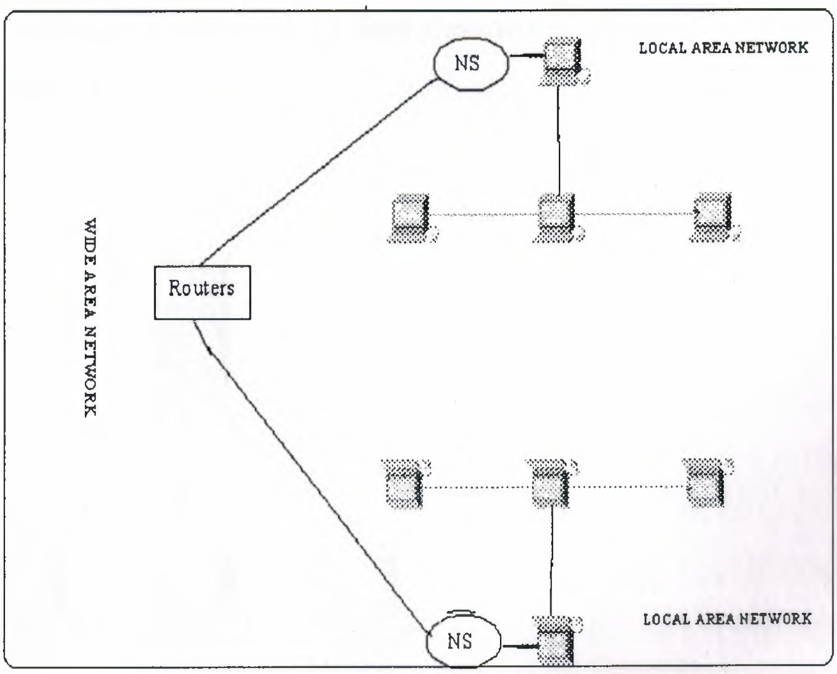


Figure 1.4 : A simple graph of LAN connection

1.14.5 LAN Transmission Methods

LAN data transmissions fall into three classifications: unicast, multicast, and broadcast.In each type of transmission, a single packet is sent to one or more nodes.

The three classification of local area network transmission methods, are explained below, showing how data is transferred from one machine into another.

1.14.5.1 Unicast

With unicast transmissions, a single packet is sent from the source to a destination on a network. The source-node addresses the packet by using the network address of the destination node. The packet is then forwarded to the destination network and the network passes the packet to its final destination. Figure 1.5 is an example of a unicast network.

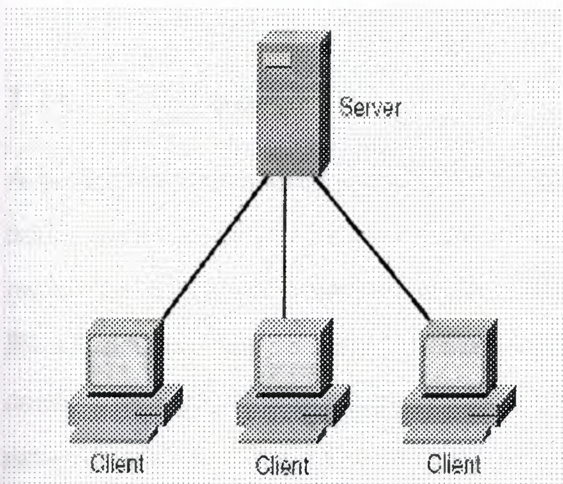


Figure1.5 : Unicast transmission method

1.14.5.2 Multicast

With a multicast transmission, a single data packet is copied and forwarded to a specific subset of nodes on the network. The source node addresses the packet by using a multicast address. For example, the TCP/IP suite uses 224.0.0.0 to 239.255.255.255. The packet is then sent to the network, which makes copies of the

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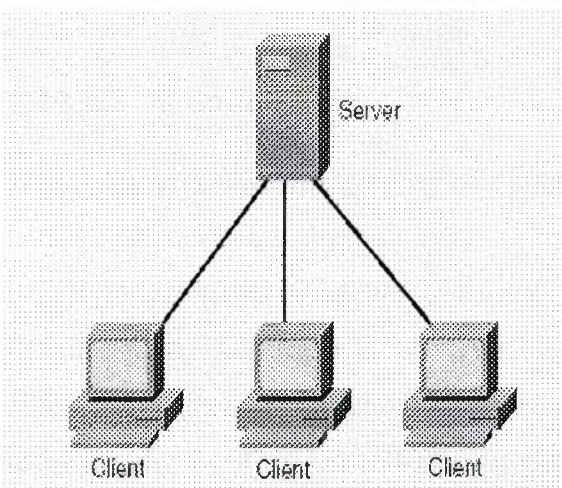


Figure1.5 : Unicast transmission method

1.14.5.2 Multicast

With a multicast transmission, a single data packet is copied and forwarded to a specific subset of nodes on the network. The source node addresses the packet by using a multicast address. For example, the TCP/IP suite uses 224.0.0.0 to 239.255.255.255. The packet is then sent to the network, which makes copies of the packet and sends a copy to each segment with a node that is part of the multicast address. Figure 1.6 is an example of a multicast network.

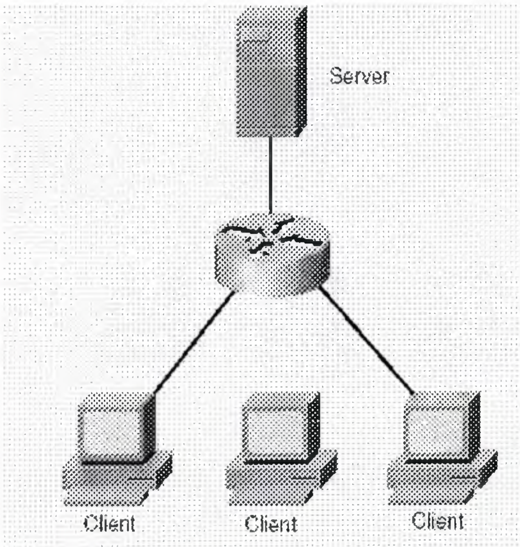


Figure 1.6 : Multicast transmission method

1.14.5.3 Broadcast

A broadcast transmission consists of a single data packet that is copied and sent to all nodes on the network. In these types of transmissions, the source node addresses the packet by using the broadcast address.Broadcasts are found in LAN environments. Broadcasts do not traverse a WAN unless the Layer 3 edge-routing device is configured with a helper address (or the like) to direct these broadcasts to a specified network address. This Layer 3 routing device acts as an interface between the local-area network (LAN) and the wide-area network (WAN).

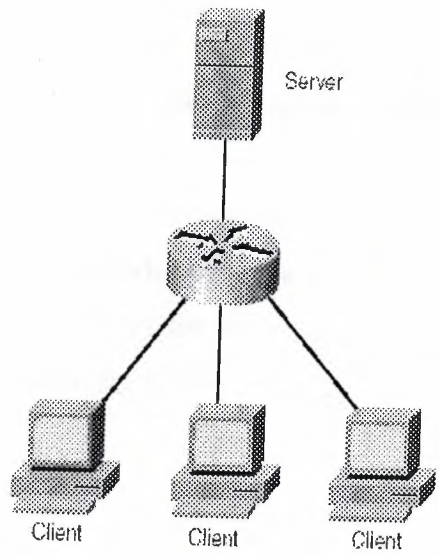


Figure 1.7

1.14.6 The OSI Model

If you spend much time in the company of network technicians you will eventually hear them say something like "That's Layer 2 only" or "That's our new Layer 4 switch". The technicians are referring to the OSI (Open System Interconnection) Reference Model.

This model defines seven Layers that describe how applications running upon network-aware devices may communicate with each other. The model is generic and applies to all network types, not just TCP/IP, and all media types, not just Ethernet. It is for this reason that any network technician will glibly throw around the term"Layer 4" and expect to be understood.

It should be noted, however, that most protocols in day-to-day use work on a slightly modified layer system. TCP/IP, for example, uses a 6- rather than a 7-layer model. Nevertheless, in order to ease the exchange of ideas, even those who only ever use TCP/IP will refer to the 7-layer model when discussing networking principles with peers from a different networking background.

Confusingly, the OSI was a working group within the ISO (International Standards Organization) and, therefore, many people refer to the model as the ISO 7-layer model. They are referring to the same thing.

Traditionally, layer diagrams are drawn with Layer 1 at the bottom and Layer 7 at the top. The remainder of this article describes each layer, starting from the bottom, and explains some of the devices and protocols you might expect to find in your data centre operating at this layer.

Layer 1

Layer 1 is the Physical Layer and, under the OSI Model, defines the physical and electrical characteristics of the network. The NIC cards in your PC and the interfaces on your routers all run at this level since, eventually, they have to pass strings of ones and zeros down the wire.

Layer 2

Layer 2 is known as the Data Link Layer. It defines the access strategy for sharing the physical medium, including data link and media access issues. Protocols such as PPP, SLIP and HDLC live here. On an Ethernet, of course, access is Governed by a device's MAC address, the six-byte number that is unique to each NIC. Devices which depend on this level include bridges and switches, which learnwhich segment's devices are on by learning the MAC addresses of devices attached to various ports.
This is how bridges are eventually able to segment off a large network, only forwarding packets between ports if two devices on separate segments need to communicate. Switches quickly learn a topology map of the network, and can thus switch packets between communicating devices very quickly. It is for this reason that mi-grating a device between different switch ports can cause the device to lose network connectivity for a while, until the switch, or bridge, re-ARPs.

Layer3

Layer 3 is the Network Layer, providing a means for communicating open systems to establish, maintain and terminate network connections.

The IP protocol lives at this layer, and so do some routing protocols. All the routers in your network are operating at this layer.

Layer 4

Layer 4 is the Transport Layer, and is where TCP lives. The standard says that "The Transport Layer relieves the Session Layer [see Layer 5] of the burden of ensuring data reliability and integrity". It is for this reason that people are becoming very excited about the new Layer 4 switching technology.

Layer5

Layer 5 is the Session Layer. It provides for two communicating presentation entities to exchange data with each other. The Session Layer is very important in the E-commerce field since, once a user starts buying items and filling their "shopping basket" on a Web server, it is very important that they are not load-balanced across different servers in a server pool.

This is why, clever as Layer 4 switching is, these devices still operate software to look further up the layer model. They are required to under-stand when a session is taking place, and not to interfere with it.

Layer 6

Layer 6 is the Presentation Layer. This is where application data is either packed or unpacked, ready for use by the running application. Protocol conversions, encryption/ decryption and graphics expansion all takes place here.

Layer 7

Finally, Layer 7 is the Application Layer. This is where you find your end-user and end-application protocols, such as telnet, ftp, and mail (pop3 and smtp).

OSI MODEL

LAYER7	Application
LAYER6	Presentation
LAYER5	Session
LAYER4	Transport
LAYER3	Network
LAYER2	Data Link
LAYER1	Physical

Figure 1.8 : The OSI model

1.14.7 LAN Hardware Structure

Network Cards: A wide variety of network cards—officially called Network Interface Cards and nicknamed NICs—is available. Most do at least an adequate job. If you're a novice networker, the primary things to look for are:

• Connection Jack . Be sure the NIC's jack matches the type of cable you're using. If you're using 10BaseT cable, for instance, the NIC you buy should have an RJ-45 compatible connector.

• Plug and Play compatibility. This feature allows Windows 95/98 to automatically configure the card, saving you a lot of time in the process.

• Interrupt Addresses. Interrupts on any machine are at a premium, so you'll want to determine which ones the NIC has available. Generally, the more you pay, the more latitude you'll have. ISA-bus cards are usually fast enough for a 10BaseT network; if you're running 100BaseT you'll probably want to go with PCI-bus card for speed. If you've only got one interrupt left and must add two cards, use two PCI-bus network cards; part of the PCI spec is that cards can share interrupt.

1.14.8 LAN Cabling Standards

The advantages of Structured cabling are:

I. **Consistency** – A structured cabling systems means the same cabling systems for Data, voice

II. and video.

. **Support for multi-vendor equipment** – A standard-based cable system will support

III. applications and hardware even with mix & match vendors.

IV. **Simplify moves/adds/changes** – Structured cabling systems can support any changes within

V. the systems.

. **Simplify troubleshooting** – With structured cabling systems, problems are less likely to down

VI. the entire network, easier to isolate and easier to fix.

VII. . **Support for future applications** – Structured cabling system supports future applications like

VIII. multimedia, video conferencing etc with little or no upgrade pain.

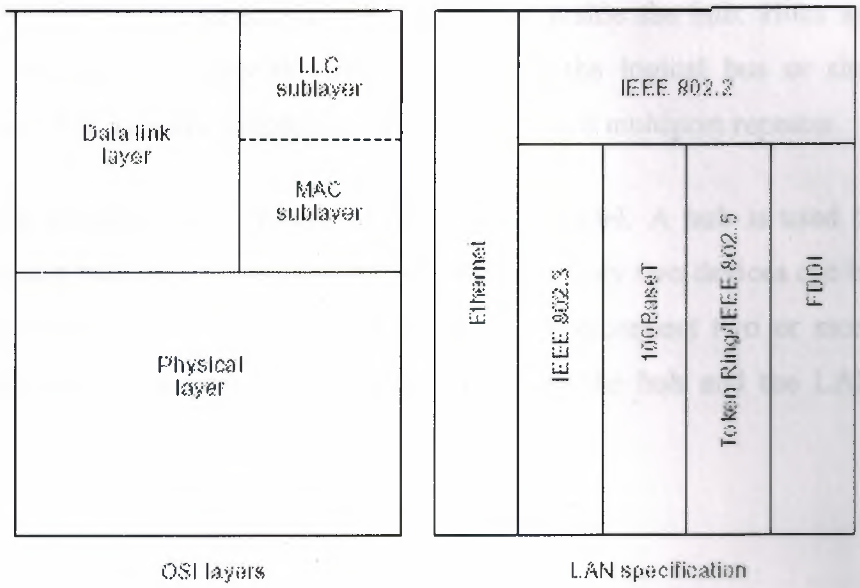


Figure 1.9

1.14.9 Devices For Interconnecting LAN

1.14.9.1 Hubs

Ethernet is a standardized way of connecting computers together to create a network. A hub is an Ethernet device used in conjunction with 10BaseT and 100BaseT cables. The cables run from the network's computers to ports on the hub. Using a hub makes it easier to move or add computers, find and fix cable problems, and remove computers temporarily from the network (if they need to be upgraded, for instance).

Hubs are available in most computer stores. It's probably a good idea to buy one with more ports than you need, just in case your network expands. Look for:

• A connection jack compatible with your cabling.

• A cascading jack which allows you to add an additional hub later, if necessary, without replacing the entire unit.

• Lights on the front. These can be useful when you're trying to diagnose network connection problems.

A hub is a physical layer device that connects multiple user stations, each via a dedicated cable.Electrical interconnections are established inside the hub. Hubs are used to create a physical star network.while maintaining the logical bus or ring configuration of the LAN. In some respects, a hub functions as a multiport repeater.

Hubs operate at the physical layer (Layer 1) of the OSI model. A hub is used to connect devices so that they are on one shared LAN. Because only two devices can be directly connected with LAN cables, a hub is needed to interconnect two or more devices on a single LAN. The cable termination points are the hub and the LAN device (host).There are three types of hubs as shown in below;

1) Intelligent Hubs

Intelligent hubs contain logic circuits that will shut down a port if the traffic Originating from that port indicates that bad, or malformed, frames are the rule rather than the exception.

2)Managed Hubs

Are hubs managed by supervisor and dont process by its own.

3)Stackable Hubs

1.14.9.2 Repeaters

Repeaters interconnect Ethernet segments by amplifying and retransmitting signals from one segment to another; the resulting network of segments is indistinguishable from a single large Ethernet as exactly the same electrical signals appear on every segment

A repeater is a physical layer device used to interconnect the media segments of an extended network.

A repeater essentially enables a series of cable segments to be treated as a single cable. Repeaters receive signals from one network segment and amplify, retime, and retransmit those signals to another network segment. These actions prevent signal deterioration caused by long cable lengths and large numbers of connected devices.

Repeaters are incapable of performing complex filtering and other traffic processing. In addition, all electrical signals, including electrical disturbances and other errors, are repeated and amplified.

The total number of repeaters and network segments that can be connected is limited due to timing and other issues. Figure 1.10 illustrates a repeater connecting two network segments.

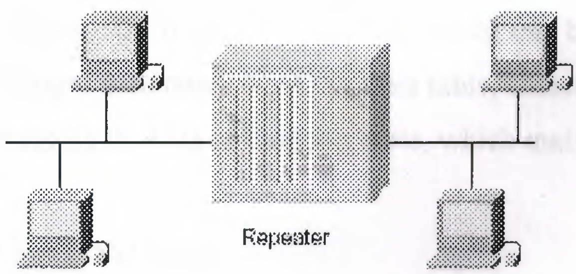


Figure 1-10 : A Repeater Connects Two Network Segments

1.14.9.3 Bridges

Bridges interconnect Ethernet segments by receiving and retransmitting entire frames, employing CSMA/CD technology to avoid collisions and avoiding the propagation of collisions between segments; filtering bridges can reduce traffic by only forwarding frames on the path from the source to the destination.

This section focuses on transparent bridges, which can also be referred to as learning or Ethernet bridges. Bridges have a physical layer (Layer 1), but are said to operate at the data link layer (Layer 2) of the OSI model. Bridges forward data frames based on the destination MAC address.

Bridges also forward frames based on frame header information. Bridges create multiple collision domains and are generally deployed to provide more useable bandwidth. Bridges don't stop broadcast traffic; they forward broadcast traffic out every port of each bridge device. Each port on a bridge has a separate bandwidth (collision) domain, but all ports are on the same broadcast domain.

Bridges were also deployed in complex environments, which is where broadcast storms became such a problem.

Routers were added to the complex bridged environments to control broadcasts. Later, VLANs were devised when switches were deployed in enterprise environments and brought back the old problem of broadcast storms.

Note: Bridges, like repeaters, do not modify traffic. Unlike repeaters, bridges can originate traffic in the form of spanning tree bridge protocol data units (BPDUs). Bridges maintain a MAC address table, sometimes referred to as a content addressable memory (CAM) or bridging table, which maintains the following information:

• MAC addresses
• Port assignment

Figure 2-11 Simple Bridge Network

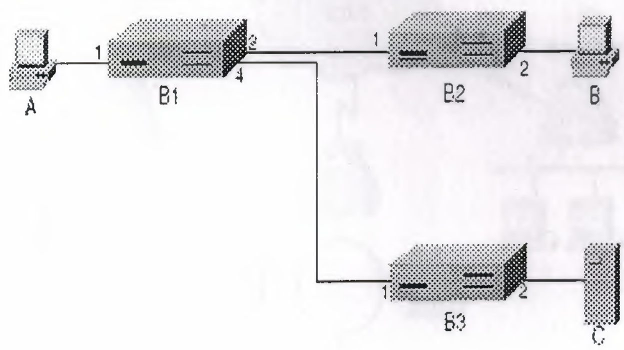


Figure1.11

The original all-ports broadcast of A's first frame to B ensures that B3 knows how to send to frames to A. An attempt by C to communicate with B results in B3 broadcasting the frame on all ports (except number 2), so the frame reaches B1 on port 4. While B1 forwards this frame to B2, it also learns what to do with frames destined for C.

1.14.10 Lan extender

A LAN extender is a remote-access multilayer switch that connects to a host router. LAN extenders forward traffic from all the standard network layer protocols (such as IP, IPX, and AppleTalk) and filter traffic based on the MAC address or network layer protocol type. LAN extenders scale well because the host router filters out unwanted broadcasts and multicasts. However, LAN extenders are not capable of segmenting traffic or creating security firewalls. Figure 1.12 illustrates multiple LAN extenders connected to the host router through a WAN.

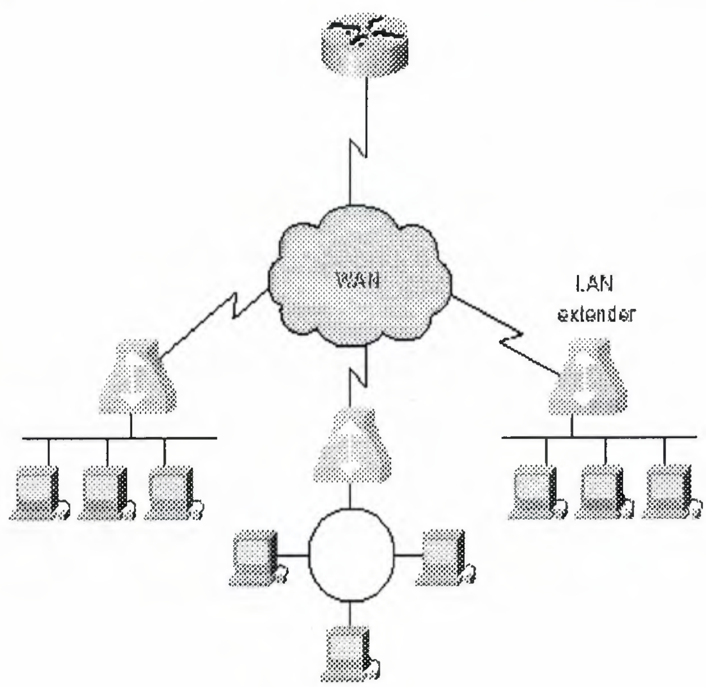


Figure 1.12 : Multiple LAN Extenders Can Connect to the Host Router Through a WAN

1.14.11 Wireless LAN

A wireless LAN enables a local network of computers to exchange data or other information without the use of cables. It can either replace or extend a wired LAN, and data can be transmitted through the air, through walls, ceilings and even cement structures, without wired cabling. With a wireless LAN in place, laptop or handheld computers may be carried from place to place while remaining connected. Any device within range of an access point can potentially connect to the wireless LAN. This provides greatly increased freedom and flexibility compared to a wired network.

An access point, or base station, that is usually physically connected to a LAN.
A wireless card that is either built into or added to a handheld, laptop or desktop computer.

With a wireless LAN, additional users and access points can be added as necessary. Students and teachers can stay connected as they move throughout the school and, depending on how it is configured, access information anywhere in the school or in the school grounds.

The most common wireless standard, 802.11b, has a data transfer rate of 11 megabits per second (Mbps), much slower than current wired LANs, which operate at 100Mbps. Newly installed wired networks now operate at 1000Mbps (1Gb).

With a wireless LAN, bandwidth is sufficient to allow the use of a wide range of applications and services. However, it has a limited ability to deliver multimedia applications at sufficient quality, and a wired LAN is likely to be necessary to access these. Ongoing advances in wireless standards continue to increase the data rate achievable with new equipment. 802.11b devices are often branded with

1.14.12 Advantages and Disadvantages of Local Area Networks

LANs offer computer users many advantages, including shared access to devices and applications, file exchange between connected users, and communication between users via electronic mail and other applications.

In addition to the benefits derived from users sharing common data and programs, use of LANs allows systems administrators to impose standards on users and to ensure data is systematically backed up. With a LAN, users can be required to store data on the central file server rather than their local hard drives, thereby ensuring that data administration can be centrally managed and backed up, and ensuring that data is available to all authorized staff on the LAN. Some of the advantages and disadvantages of Lan networks, may be expressed in like below:

Local Area Network (LAN) Support Specialist
Employees at this level are microcomputer-literate, entry-level specialists in networking. They learn network operations and perform simpler systems duties (such as data gathering, monitoring operations, or network documentation) as well as install equipment and software. They work under direct supervision of a designated technical supervisor.

1) Provides basic network support services to users (such as, the installation of personal computers and workstations onto the network, configuring network interface cards and client software, and installing and supporting network printers and queues)

2) Executes well-defined backup, recovery, and security procedures to ensure continual availability of the network

3) Provides assistance to network users in resolving routine network problems

4) Maintains and reviews logs and audit trails to detect intrusion, virus, or other problems and begins corrective action

Here at the Table 1 the advantages and disadvantages of the LAN,and the communications with wires and wireless LANs are represented.

Network (LAN)	**Serial Cable** (also known as null modem cable)
Fast (comes in 2 speeds, 10Mb/sec or 100Mb/sec) although the actual data rate is not actually that high - e.g. 10Mb/sec is actually about 6.4Mb/sec after network protocols	**Very slow** - maximum speed is 0.01152 Mb/sec
£10 - £15 per network card **Some cable** (cheap) **A hub if you want to connect more than 2 computers** (price depends on size and speed)	**Cheap** - expect change from £5
Takes up an ISA/PCI slot (depending on the card - PCI is better) - or your computer may already have a dedicated network port built into its motherboard	**Takes up a serial port** (usually serial port number 1 - also known as com ports). Not all modern laptops have a serial port built in as this is becoming old technology. If so you would have to buy a USB to serial adapter or similar
Only allows you to connect with other computers with a network card	**All (well most) computers have a serial port**
Despite rumors to the contrary, they are actually **fairly easy to set-up** (no flame e-mails please!)	**Easy to set up**
Software is easy to use - i.e. once the network is set up and running, you can then *forget* about it - you can treat other computers hard disks, floppy disks, CD-ROM's, etc as you would your own	**The software is a hassle to use.** By this I mean that in order to transfer a file, you must ensure that the 2 computers are ready with the relevant software running with identical settings. The computer that is receiving the file must be put into 'receiving mode' before the computer that is sending the file can send the file(s) that are to be transferred
Allows transfer of data between computers, peripherals to be shared, etc.	**Allows data to be transferred** between 2 computers
Allows an 'unlimited' number of computers to be connected	

	Wires	Wireless
Installation and Management	If you have computers in several rooms you will have to drill holes through walls - often into the attic and down again is the best option. If you have a	Nothing to install or manage - however it should be noted that thick walls, trees, etc. will have an impact on the range of the wireless connection. Not a great issue though
Tidiness	Wires are a pain to keep tidy	Nothing to keep tidy!

Reliability	Wires can be pulled, tampled on, chewed by cats, rodents(!), etc.	Nothing to go wrong
Portability	None/very limited	Take your computer (e.g. laptop, tablet or PDA) anywhere around your house/office/garden - or even the pub over the road
Speed	100Mb/sec is the current de-facto for home/office usage and 100Mb/sec or 1GB/sec for servers. Although up to 10GB/sec is now available	10Mb/sec is the most common. D-Link and a few other companies now do 22Mb/sec (which is slightly faster, but not true 22Mb/sec). 'Standards' are out that go faster than this (e.g. 53Mb/sec but this is not yet fully standardized and people are being warned not to move over to the 802.11g standard just yet...
Cost	Quite cheap	Now quite cheap now that the take up of it is booming - a couple of years ago this was very expensive
Security	Totally secure if your LAN is not connected to the Internet or other external source (i.e. it is a 'closed system') as someone would have to physically connect their computer to it in order to connect to anything	If not configured for security someone could be sitting outside your house/office with a laptop and could log onto your network. Secure once set up correctly: Limit or exclude access by MAC addresses - every network card in the world has a unique MAC address Encrypt data being transmitted so that others cannot evesdrop and capture data Hide node IDs in order to ensure privacy (i.e. make each node/device invisible to others not on the network)

Table 1

1.15 MAN(Metropolitan Area Network)

Metropolitan area Networks connect locations that are geographically located from 5 to 50 kilometers(approximately).They include the transmission of data ,voice, and television signals throughj the use of coaxial cable or optical fiber cable as their primary environment of transmission,altough many metropolitan area Networks are imlemented through the use of microwave technology.

Customers of metropolitan area Networks are usually large companies that need to communicate within a metropolitan area at high speed.So the developers of the MAN have to pay attention of the speed of the MAN, and optimize the speed according to the customer desires.The term of MAN is also used to mean interconnection of LANs

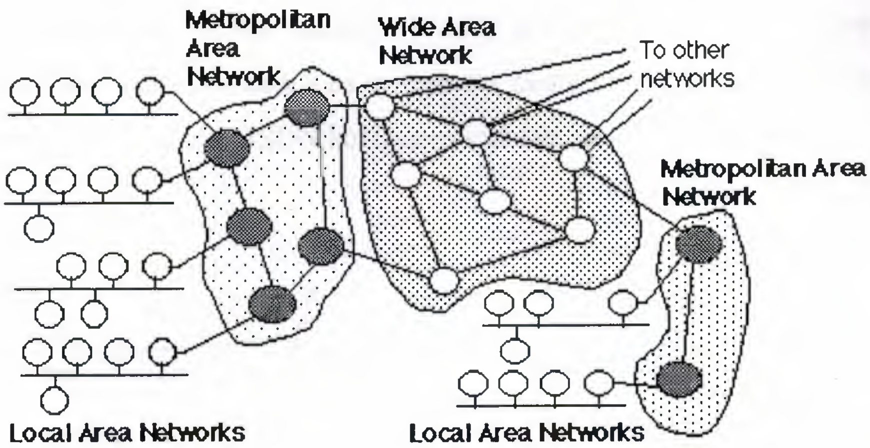


Figure 1.13

1.16 WAN(World Area Network)

WANs connect larger geographic areas, such as Florida, the United States, or the world. Dedicated transoceanic cabling or satellite uplinks may be used to connect this type of network.

Using a WAN, schools in Florida can communicate with places like Tokyo in a matter of minutes, without paying enormous phone bills. A WAN is complicated. It uses multiplexers to connect local and metropolitan networks to global communications networks like the Internet. To users, however, a WAN will not appear to be much different than a LAN or a MAN.

They use a combination of hardware.Wide area networks use a board range of communication media for interconnection that includes switched and leased lines, private microvawe circuits, and optical fiber, coaxial cable and satellite circuits.

Basically a wide area network is any communication network that permits message, voice, image signals or computer data to be transmitted over a widely dispersed geographical area.

A WAN is geographically large. It is often formed by the joining together of LANs in distant places. Foe example a national banking organization connects all of its branches across the country. WANs are getting blurry as fiber-optic cables have allowed LAN technologies to connect many km.s apart.WANs are usually connected using the internet, ISDN landlaines and sattelites.

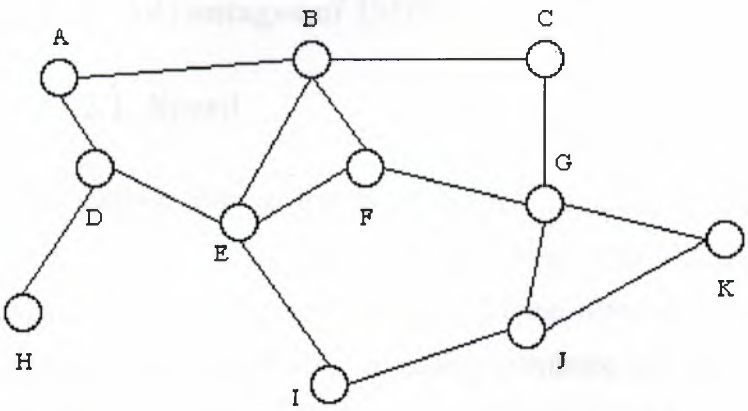


Figure.1.14 : Typical "mesh" connectivity of a Wide Area Network

1.17 ISDN Technology

1.17.1 What is ISDN

ISDN, which stands for **I**ntegrated **S**ervices **D**igital **N**etwork, is a system of digital phone connections which has been available for over a decade. This system allows voice and data to be transmitted simultaneously across the world using end-to-end digital connectivity.

With ISDN, voice and data are carried by bearer channels (B channels) occupying a bandwidth of 64 kb/s (bits per second). Some switches limit B channels to a capacity of 56 kb/s. A data channel (D channel) handles signaling at 16 kb/s or 64 kb/s, depending on the service type.

There are two basic types of ISDN service: Basic Rate Interface (BRI) and Primary Rate Interface (PRI). BRI consists of two 64 kb/s B channels and one 16 kb/s D channel for a total of 144 kb/s. This basic service is intended to meet the needs of most individual users. PRI is intended for users with greater capacity requirements. Typically the channel structure is 23 B channels plus one 64 kb/s D channel for a total of 1536 kb/s.

1.17.2 Advantages of ISDN

1.17.2.1 Speed

The modem was a big breakthrough in computer communications. It allowed computers to communicate by converting their digital information into an analog signal to travel through the public phone network. There is an upper limit to the amount of information that an analog telephone line can hold. Currently, it is about 56 kb/s bidirectionally. Commonly available modems have a maximum speed of 56 kb/s, but are limited by the quality of the analog connection and routinely go about 45-50 kb/s. Some phone lines do not support 56 kb/s connections at all. There were currently 2 competing, incompatible 56 kb/s standards (X2 from U S Robotics (recently bought by 3Com), and K56flex from Rockwell/Lucent). This standards problem was resolved when the ITU released the V.90, and later V.92, standard for 56 kb/s modem communications.

ISDN allows multiple digital channels to be operated simultaneously through the same regular phone wiring used for analog lines. The change comes about when the telephone company's switches can support digital connections. Therefore, the same physical wiring can be used, but a digital signal, instead of an analog signal, is transmitted across the line. This scheme permits a much higher data transfer rate than analog lines. BRI ISDN, using a channel aggregation protocol such as BONDING or Multilink-PPP, supports an uncompressed data transfer speed of 128 kb/s, plus bandwidth for overhead and signaling. In addition, the latency, or the amount of time it takes for a communication to begin, on an ISDN line is typically about half that of an analog line. This improves response for interactive applications, such as games.

1.17.2.2 Multiple Devices

Previously, it was necessary to have a separate phone line for each device you wished to use simultaneously. For example, one line each was required for a telephone, fax, computer, bridge/router, and live video conference system. Transferring a file to someone while talking on the phone or seeing their live picture on a video screen would require several potentially expensive phone lines.

ISDN allows multiple devices to share a single line. It is possible to combine many different digital data sources and have the information routed to the proper destination. Since the line is digital, it is easier to keep the noise and interference out while combining these signals. ISDN technically refers to a specific set of digital services provided through a single, standard interface. Without ISDN, distinct interfaces are required instead.

1.17.2.3 Signaling

Instead of the phone company sending a ring voltage signal to ring the bell in your phone ("In-Band signal"), it sends a digital packet on a separate channel ("Out-of-Band signal"). The Out-of-Band signal does not disturb established connections, no bandwidth is taken from the data channels, and call setup time is very fast. For example, a V.90 or V.92 modem typically takes 30-60 seconds to establish a connection; an ISDN call setup usually takes less than 2 seconds.
The signaling also indicates who is calling, what type of call it is (data/voice), and what number was dialed. Available ISDN phone equipment is then capable of making intelligent decisions on how to direct the call.

CHAPTER 2

THE NETWORK TOPOLOGIES

2.1 Introduction to the Network Topologies

Topologies remain an important part of network design theory. You can probably build a home or small business network without understanding the difference between a bus design and a star design, but understanding the concepts behind these gives you a deeper understanding of getting maximum efficiency.

One can think of a topology as a network's "shape." This shape does not necessarily correspond to the actual physical layout of the devices on the network. For example, the computers on a home LAN may be arranged in a circle, but it would be highly unlikely to find an actual ring topology there.

Network topologies are categorized into the following basic types:

- Linear bus topology
- Star topology
- Ring topology
- Tree topology
- Mesh topology

This chapter of the project will explain the main functions and the configurations of the network topologies listed above, and advantages and disadvantages of them

2.2 What is Network Topology?

The physical layout of the LAN is called Network Topology. Common LAN topologies are Ring, Bus, Tree, and Star topologies.LAN topologies define the manner in which network devices are organized, and their architecture in which they are implemented in real life. Four common LAN topologies exist: bus, ring, star, and tree. These topologies are logical architectures, but the actual devices need not be physically organized in these configurations. Logical bus and ring topologies, for example, are commonly organized physically as a star.

The physical topology of a network refers to the configuration of cables, computers, and other peripherals. Physical topology should not be confused with logical topology which is the method used to pass information between workstations.

2.3 Considerations When Choosing a Topology:

- **Money**: A linear bus network may be the least expensive way to install a network; you do not have to purchase concentrators.
- **Length of cable needed**: The linear bus network uses shorter lengths of cable.
- **Future growth**: With a star topology, expanding a network is easily done by adding another concentrator.
- **Cable type**: The most common cable in schools is unshielded twisted pair, which is most often used with star topologies.

2.4 Types of Network Topologies

When ever we are going to design a network we have to choose a network topology according to our network. The considerations when choosing a topology is given in above(2.2).In this part of Project we are going to explain the types of networks

2.4.1 Linear Bus Topology

A linear bus topology consists of a main run of cable with a terminator at each end (See fig. 2.1). All nodes (file server, workstations, and peripherals) are connected to the linear cable. Ethernet and LocalTalk networks use a linear bus topology.

When a bus topology is used, the microcomputer workstations are connected to a single cable that runs the entire length of the network.Data travels through the cable (so we can say the length and the standard of the cable is important), also called a bus, directly from the sending node to the destination node.The reason for its success is the early popularity of protocols. Currently the bus topology is most widely used of LAN configurations.

A bus topology is a linear LAN architecture in which transmissions from network stations propagate the length of the medium and are received by all other stations. Of the three most widely used LAN implementations, Ethernet/IEEE 802.3 networks---, including 100BaseT---, implement a bus topology, which is illustrated in when a bus topology is used,

Advantages of a Linear Bus Topology

- Easy to connect a computer or peripheral to a linear bus.
- Requires less cable length than a star topology.

Disadvantages of a Linear Bus Topology

- Entire network shuts down if there is a break in the main cable.
- Terminators are required at both ends of the backbone cable.

- Difficult to identify the problem if the entire network shuts down.
- Not meant to be used as a stand-alone solution in a large building.

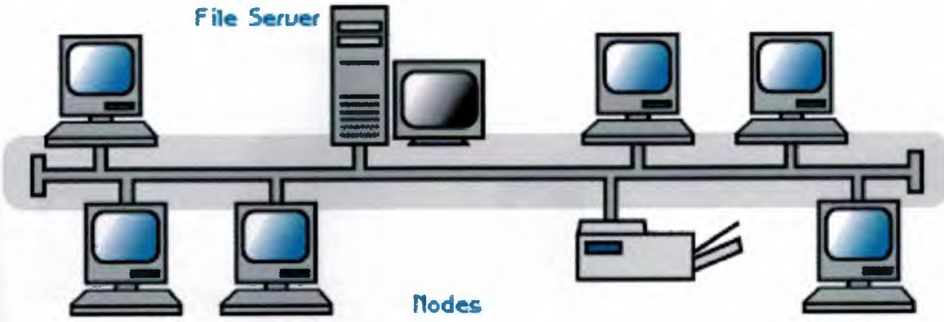


Figure 2.1 : Linear Bus topology

2.4.2 Star Topology

A star topology is designed with each node (file server, workstations, and peripherals) connected directly to a central network hub or concentrator (See fig. 2.2).

Data on a star network passes through the hub or concentrator before continuing to its destination. The hub or concentrator manages and controls all functions of the network. It also acts as a repeater for the data flow. This configuration is common with twisted pair cable however, it can also be used with coaxial cable or fiber optic cable

In a star configuration, each node is connected to a central server. Data flows back and forth between the central server and the nodes in the network. This configuration includes what is sometimes called the modified star topology which relies on the use of wiring hubs or concentrators to minimize the number of cables required to give to each workstation a direct connection to the central server.

A star topology is a LAN architecture in which the endpoints on a network are connected to a common central hub, or switch, by dedicated links. Logical bus and ring topologies are often implemented physically in a star topology, which is illustrated in Figure 2.2.

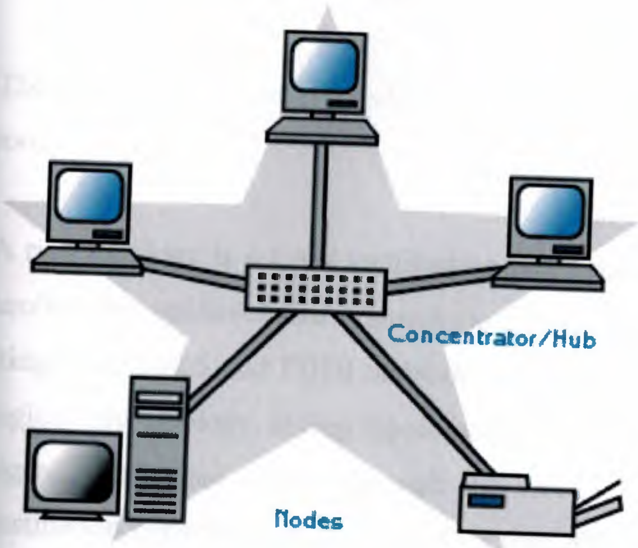


Figure 2.2 : Star topology

Advantages of a Star Topology

- Easy to install and wire.
- No disruptions to the network then connecting or removing devices.
- Easy to detect faults and to remove parts.

Disadvantages of a Star Topology

- Requires more cable length than a linear topology.
- If the hub or concentrator fails, nodes attached are disabled.
- More expensive than linear bus topologies because of the cost of the concentrators

Token Ring (IEEE 802.5) best represents a ring topology. Although the physical cabling is considered to be a star topology, Token Ring is a ring in logical topology, as demonstrated although physical topology is a physical layer attribute, the media access method used at the data link layer determines the logical topology. Token Ring defines a logical ring and contention, as Ethernet defines a logical bus. Even when attached to a hub, when one Ethernet device transmits, everyone hears the transmission, just as though on a bus.

2.4.4 Tree Topology

A tree topology is a LAN architecture that is identical to the bus topology, except that branches with multiple nodes are possible in this case. Figure 2.4 illustrates a logical tree topology.

A tree topology combines characteristics of linear bus and star topologies. It consists of groups of star-configured workstations connected to a linear bus backbone cable (See fig. 2.4). Tree topologies allow for the expansion of an existing network, and enable schools to configure a network to meet their needs.

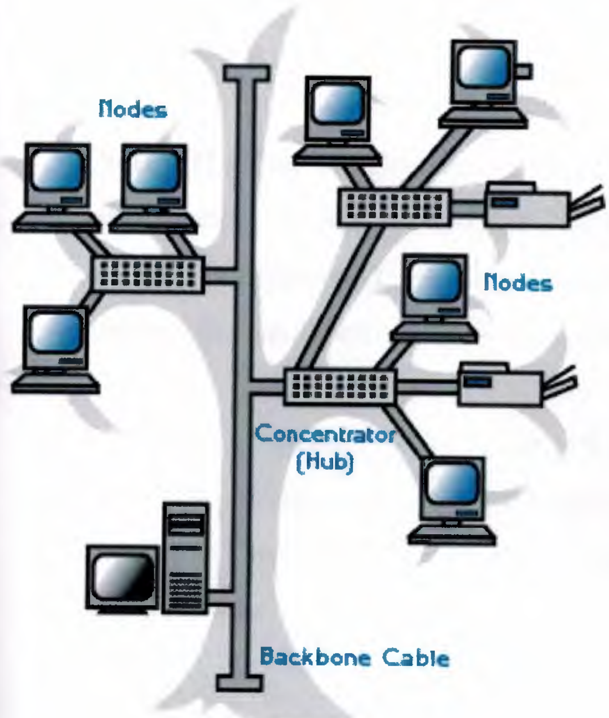


Figure 2.4 : Tree topology

Advantages of a Tree Topology

- Point-to-point wiring for individual segments.
- Supported by several hardware and software venders.

Disadvantages of a Tree Topology

- Overall length of each segment is limited by the type of cabling used.
- If the backbone line breaks, the entire segment goes down.

  More difficult to configure and wire than other topologies.

2.4.5 Mesh

Mesh topologies involve the concept of routes. Unlike each of the previous topologies, messages sent on a mesh network can take any of several possible paths from source to destination. (Recall that in a ring, although two cable paths exist, messages can only travel in one direction.) Some WANs, like the Internet, employ mesh routing.

Note:. The Tree Topology connection is more complicated, since it has branches that are identical to Bus Topologies. The transmission of data by any station in the network is controlled by the Central Hub in a Star Topology. Bus Topology is used to connect the equipment in the PLC local area network presented in this paper.

In a Bus Topology network, all PLCstations are attached through appropriate hardware interface cards called isolated Link Couplers. There are no switches or repeaters. Therefore, fewer hardware components are required for Bus Topology local area networks.

CHAPTER 3

OPTIMIZATION ALGORITHMS

3.1 Introduction to Optimization Algorithms

In this chapter I'm going to explain the optimization algorithms. I will talk about the Single –Source Shortest Paths and Diskstra's algorithm which solves the single-source shortest path problems, and also I will represent information about relaxation. The informations will be given by representing some of the figures and diagrams.

3.2 Single-Source Shortest Paths

Today in every business or working area the most important things for the users and the producters are costs and speed of the prouctions or applications that we are using. So if we say, the network is the most common used application around the world today, it has to provide communication fast and cheap. To develop technologies, or for to optimize our network, we have to find and use the shortest and most convenient methods, or paths. To provide those needs we may use some optimization algorithms.

For example, a motorist wishes to find the shortest possible route from Istanbul to Antalya.Given a random map of the Turkey on which the distance between each pair of adjacent intersections are marked, how we can determine the shortest route?

One possible way is to enumerate all the routes from Antalya to İstanbul,add up the distances on each route ,and select the shortest.It I easy to see ,however ,that even if we disallow routes that contain cycles ,there are millions of posiblities,most of which are simply not worth considering.For example ,a road from İstanbul to Kars to Antalya is obviously a poor choice because Kars is abaut thousand miles out of way.In this part of our Project we will be able to solve such problems efficiently and easily.

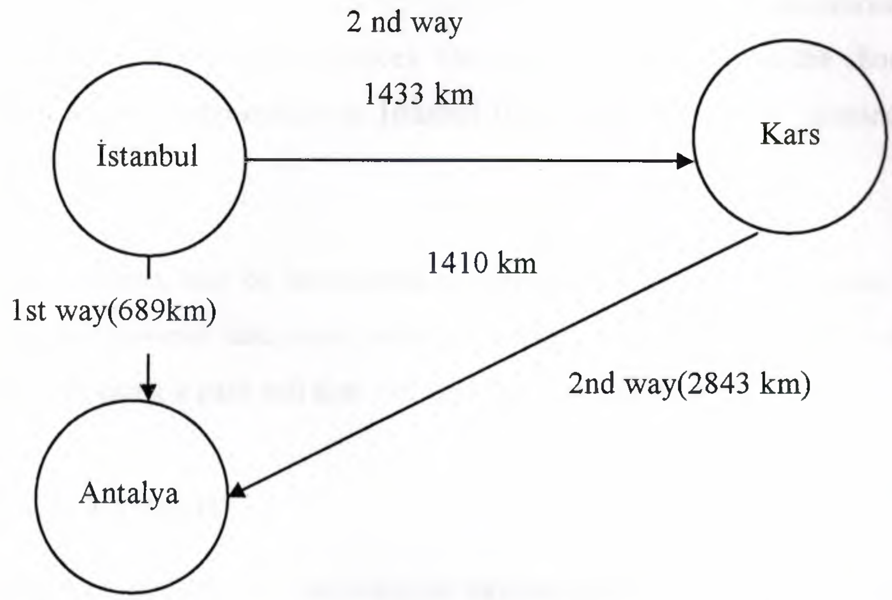


Figure 3.1 : The simple figure of İstanbul-Antalya example

As we can see from the figure 3.1 it is nonsense to use 2nd way, now we are going to represent the algorithms to find the shortest paths in such, and more complex situations;

In a shortest-paths problem there are given a weighted, directed graph G=(V,E),with weight function W: $E \rightarrow R$ mapping edges to real valued weights. The weight of path p={$v_0+v_1+v_2 \ldots\ldots\ldots v_k$) is the sum of the weights of its constituent edges;

$$W_{(P)} = \sum_{i=1}^{K} W(V_{i-1} - V_i).$$

We define the shortest-path weight from u to v by

δ (u,v) = min {W(p):U→V } : if there is a path from u to v,

∞ : otherwise.

A shortest path from vertex u to vertex v is then defined as any path p with weight W(p)= δ (u,v).

In the İstanbul-Antalya example, we can model the road map as a graph: vertices represent intersections, edges represent road segments between intersections, and edge weights represent road distances. Our aim has to be to find the shortest path (road) from a given intersection in İstanbul (Bakırköy) to a given intersection in Antalya (Beldibi).

Edge weights may be interpreted as meteristics other than distances. They are often used to represent time, cost, penalties, lossage, or any other quantity that accumulates linearly along a path and that one wishes to minimize.

3.2.1 Variants

Here we will focus on single-source shortest-paths problems. Given a graph G=(V,E) and we want to find the shortest path from a source given vertex vertex t from every vertex s Є V. Many different problems can be solved by the algorithm for the single source problem, including the following variant;

a)Single-destination shortest-paths problem: Find the shortest path to a given destination vertex t from every vertex. This single-source problem can be solved by reversing the direction of each edge in the graph.

b) Single-pair shortest-paths problem: Here we will find the shortest path from u to v for given vertices u to v.If we solve the single-source problem with source vertex u, we can also solve this problem. The point that we have to pay attention should be no algorithms for this problem are known that run asymptotically faster than the best single-source algorithm in the worst case.

c)All-pairs shortest-paths problem: Finding the shortest path from u to v for every pairs of vertices u and v.This problem can be solved by running a single-source algorithm once from each vertex; at the same time it can usually be solved faster, and its structure of interest in its own right.

3.2.2 Negative-Weight Edges

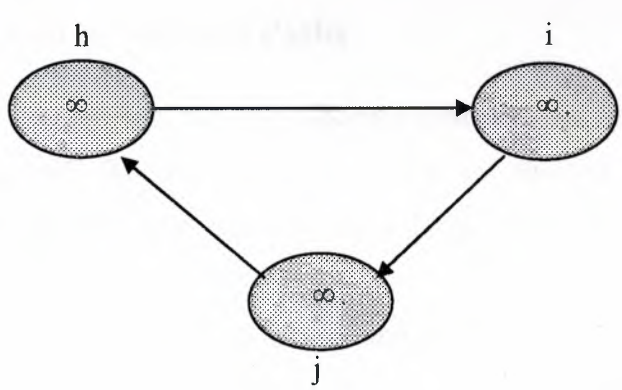
While solving the single-source shortest-paths problem, there may be edges whose weights are negative. We have a graph G=(V,E) and contains no negative-weight cycles reachable from the source s ,and another graph which contains negative-weight cycles reachable from the source sis we can say there are two conditions;

a)If the graph G=(V,E) and contains no negative-weight cycles reachable from the source s ,the for all v Є Vote shortest-path weight δ(s,v) remains well defined, even if it has a negative value.

b) If the graph G=(V,E) and contains negative-weight cycles reachable from the source s, the for all v Є Vowel can say the shortest-path weights are not well defined.

No path from s to a vertex on the cycle can be a shortest path-a lesser-weight path can always be found that follows the proposed 'shortest' path and then traverses the negative-weight cycle. If there is a negative-weight cycle on some path from s to vowel define δ(s,v) = $-\infty$.

The figure (3.2) below represents the effect of negative weights on shortes-path weights.



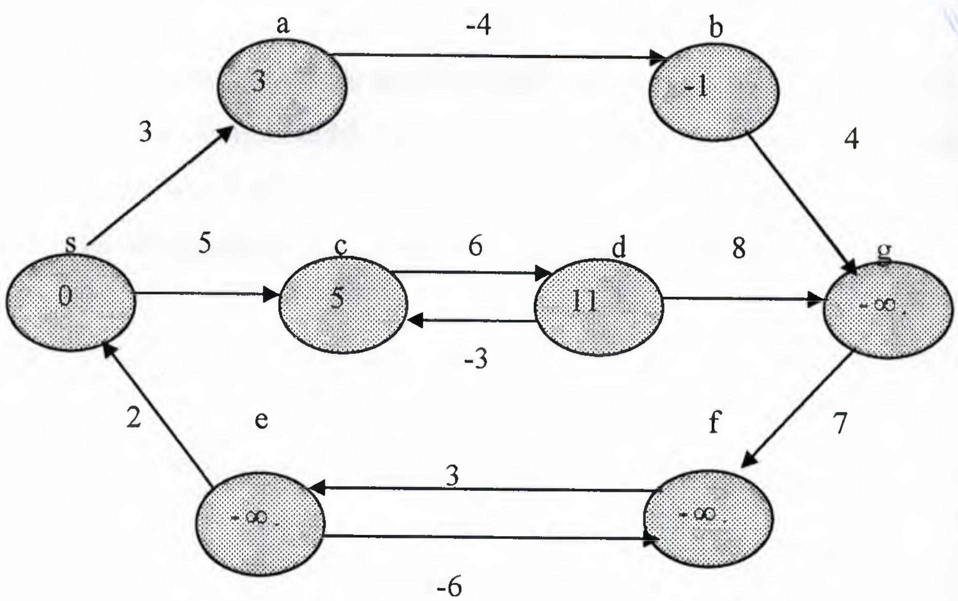


Figure 3.2 (Negative edge weights in a directed graph.Shown within each vertex is its shortest-path weight from source s.Because vertices e and f from a negative-weight cycle reachable from s,they shortest-path weights of $-\infty$.Because vertex g is reachable from a vertex whose shortest-path is weight is $-\infty$,it,too,has a shortest-path weight of $-\infty$.Vertices such as h,i and j are not reachable from s,and so their shortest-path weighs are ∞,even through they lie on a negative-weight cycle.)

3.2.3 Representing Shortest Paths

We often wish to compute not only shortest-path weights, but the vertices on the shortest-paths as well. The representation we use for shortest paths is similar to the one we used for breadth-first trees .Given a graph G=(V,E), we maintain for each vertex

v Є V a predecessor π[v] that is either another vertex or NIL. The shortest-paths algorithms at this part of project set the π attributes so that the chain of predecessors originating at a vertex v runs backwards along a shortest path from s to vetches given a vertex v for which $\pi[v] \neq$ NIL, the procedure PRINT-PATH(G,s,v) can be used top rint a shortest path from s to v.

During the execution of the shortest-paths algorithms, the π values need to indicate shortest paths. As in breadth-first search, we will be interested in the predecessor sub graph $G\pi=(V\pi,E\pi)$ inducted by the π values. Here ,we define the vertex set $V\pi$ to be the set of vertices of G with non-NIL predecessors, plus the source s:

$V\pi=[v \in V : \pi[v] \neq \text{NIL}] \cup \{s\}.$

The directed edge set $E\pi$ is the set of edges induced by the π values for vertices in $V\pi$.

$E\pi=\{(\pi[v],v) \in E: \pi-\{s\}\}.$

We will prove that the π values produced by the algorithms, in this chapter have the property that at termination $G\pi$ is a "shortest-paths tree" informally, a rooted tree containing a shortest path from a source s to every vertex that is reachable from s.
A shortest-paths tree is like the breadth-first tree, but it contains shortest paths from the source defined in terms of edge weights instead of numbers of edges. To be precise, let G= (E, V) be a weighted, directed graph with weight function ω :E $\rightarrow$R,and assume that G contains no negative-weight cycles reachable from the source vertex $s \in V$, so that shortest paths are well defined. A shortest-paths tree rooted at s is a directed sub graph $G'=(V',E')$,where $V' \subseteq V$ and $E' \subseteq E$,

1) V' is the set of vertices reachable from s in G,

2) $v \in V$ forms a rooted tree with root s, and

3) For all $v \in V'$,the unique simple path from s to v in G' is a shortest path from s to v in G.

Shortest paths are not necessarily unique, and neither are shortest-paths trees. For example shows a weighted, directed graph and two shortest-paths trees with the same root.

3.3 Shortest Paths and Relaxation

To understand single-source shortest-path algorithms, it is helpful to understand the techniques that they use and the properties of shortest paths that they exploit.The main technique used by algorithms at here is relaxation, a method that repeatedly decreases an upper bound on the actual shortest-path weight of each vertex until the upper bound equals the shortest-path weight.In this section we will see how relaxation works.

3.3.1 Optimal Substructure of a Shortest Path

Shortest-paths algorithm typically exploit the property that a shortest path between two vertices contains other shortest paths within it.This optimal-substructure property is a hallmark of the applicability of both dynamic programming and greedy method.In fact Dijkstra's algorithm is a greedy algorithm, and the Flody-Warshall algorithm ,which finds shortest paths between all pairs o vertices is a dynamic-programming algorithm.

3.3.2 Relaxation

In this part of the chapter we will see the technique of relaxation.For each vertex v Є **V**,we maintain an attribute d[v] ,which is upper bound on the weight of a shortest path from source s to v.We call d[v] a shortest path estimate.We initialize the shortest-path estimates and predecessors by the following procedure.

```
INITIALIZE-SINGLE-SOURCE (G,s)

For each vertex v Є V [G]
        do d[v] ←
              [v] ←NIL
d[S] ←0
```

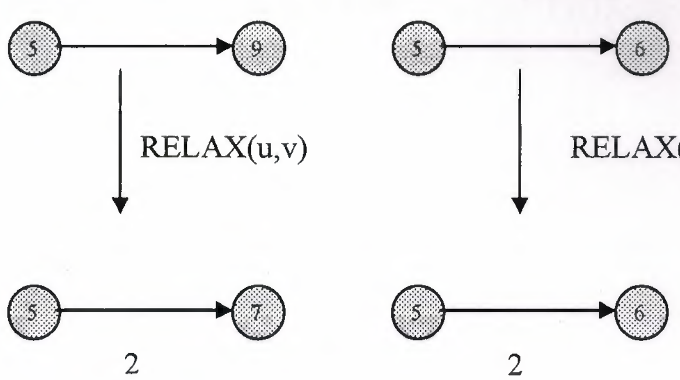
After initialization ∘[v]= NIL for all v Є V, d[v]=0 for v=s, and d[v] = for v Є V-{s}.

The process of relaxing an edge (u,v)consists of testing whether we can improve the shortest path to v found so far by going through u and ,if so, updating d[v] and [v].A relaxation step may decrease the value of the shortest-path estimate d[v] and update v's predecessor field [v].The following code performs a relaxation step on edge(u,v).

RELAX

```
if d[v] > d[u] + W (u,v)
    then d[v] ← d[u] + W (u,v)
              [v] ←u
```

Figure 3.3 shows two examples of relaxing an edge, one in which a shortest-path estimate decreases a done in which no estimate changes.



(a) (b)

Figure 3.3 (Relaxation of an edge(u,v).The shortest-path estimate of each vertex is short within the vertex.Because d[v] > d[u] + W (u,v) prior to relaxation, the value of d[v] decreases.(b)Here d[v] $\leq$d[u] + W (u,v) before the relaxation step so d[v] is unhanged by relaxation.)

Each algorithm in this chapter calls INITIALIZE-SINGLE-SOURCE an then repeatedly relaxes edges.Moreover,the relaxation is the only means by which shortest-path estimates and predecessors change.The *Dijkstra's algorithm and the* shortest-paths algorithm for directed acyclic graphs, each edge is relaxed exactly once.

3.4 Dijkstra's Algorithm

Dijkstra's algorithm solves the single-source shortest-path problem on a weighted, directed graph G=(V,E) for the case in which all edge weights are nonnegative.Therefore,we assume that w(u,v)$\geq$ 0 for each edge (u,v) Є E.

Dijktstra's algorithm maintains a set S of vertices whose final shortest-path weights from the source s have already been determined.That is, for all vertices v Є S ,we have d[v]=δ (s,v) .The algorithm repeately selects the vertex u Є V-S with the minimum shortest-path estimate, inserts u into S,and relaxes all edges leaving u.In the following implementation, we maintain a priority queue Q that contains all the vertices in V-S ,keyed by their d values.The implementation assumes that graph G is represented by adjacency lists.

```
DİJKSTRA(G,w,s)

    INITIALIZE-SINGLE-SOURCE (G,s)
1   S←Ø
2   Q←V[G]
3   While  Q    Ø
4       do u←EXTRACT-MIN(Q)
5       s ←S ∪{u}
6           for each vertex v Є Adj[u]
7                   do RELAX (u,v,w)
```

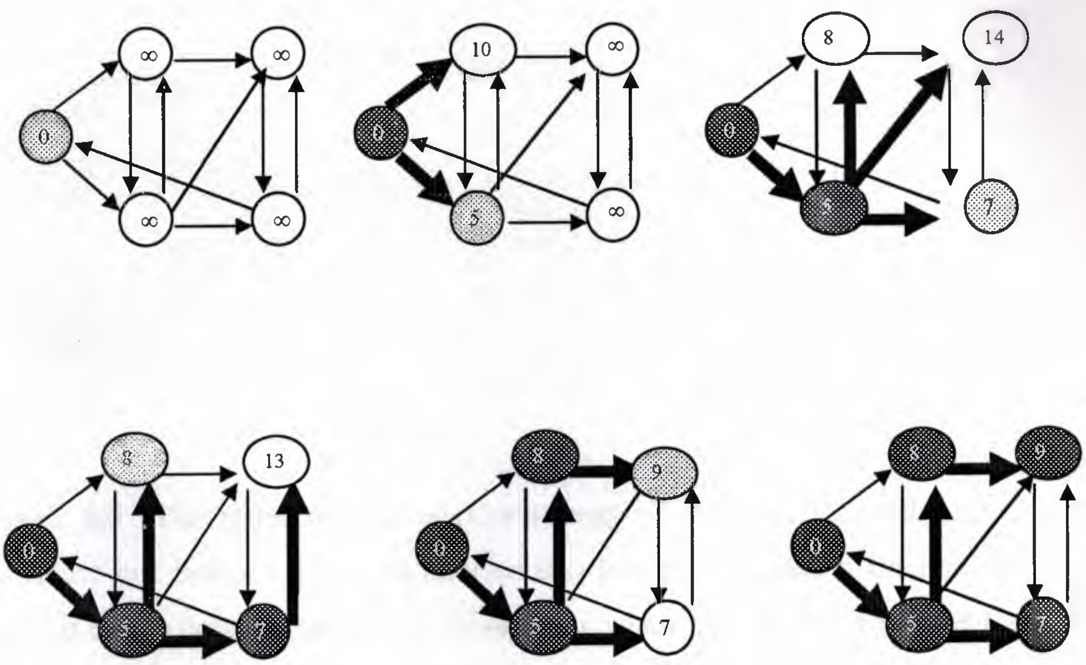


Figure 3.4 (The execution of dijkstra's algorithm.The source is the leftmost vertex.The shortest-path estimates are shown within the vertices, and shaded edges indicate predecessor values:if edge (u,v) is shaded, then $\pi[v]=u$ .Black vertices are in the set S,and white vertices are in the priority queue Q=V-S.)

Dijkstra's algorithm relaxes edges as shown in figure 3.4.Line 1 performs the usual initialization of d and π values, and line 2 initializes the set S to the empty set.Line 3 then initializes the priority queue Q to contain all the vertices in V-S=V- Ø=V.Each time through the while loop of lines 4-8,a vertex is extracted from Q=V-S and inserted into set S.Vertex u therefore, has the smallest shortest path estimate of any vertex in V-S.Then lines 7-8 relax each edge(u,v) leaving u,thus thus updating the estimate d[v] and the predecessor π[v] if the shortest path to v can be improved by going through u.

Dijkstra's algorithm always chooses the "lightest" or "closest" vertex inV-S to insert into set Sewer say that it uses a greedy strategy.Greedy strategies do not alway yield optimal results in general, but as the following theorem and its corollary show, Dijkstra's algorithm does not indeed compute shortest paths.The key is to show that each time a vertex u is inserted into set Sewer have d[u]= δ (s,u).

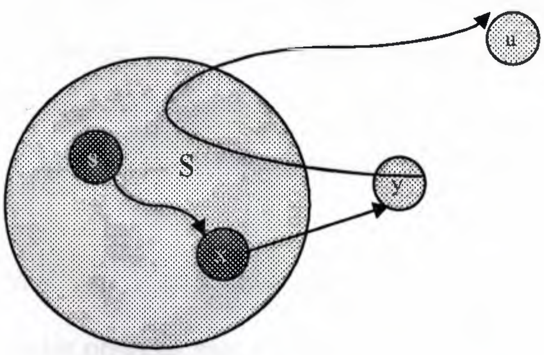


Figure 3.5 (The proof of theorem(Correctness of Dijkstra's algorithm).Set S is nonempty just before vertex u is inserted into it.A shortest path p from source s to vertex u can be decomposed into s→x→y→u, where y is the first vertex on the path that is not in V-S and x Є S immediately precedes y.Vertices x and y distinct, but we may have s=x or y=u.Path p_2 mayo r may non reenter set S.)

3.4.1 Theorem (Correctness of Diskstra's Algorithm)

If we run Dijkstra's algorithm on a weighted, directed draph G=(V,E) with nonnegative weight function w and source s ,then at termination , d[u]= δ (s,u) for all vertices u Є **V.**

The proof of the theorem above:I will show that for each vertex u Є **V.** ,we have d[u]= δ (s,u) at time when u is inserted into set S and this equality is maintained thereafter.

For the purpose of contradaction,let u be the first vertex for which d[u] δ (s,u) when it is inserted into set S.Now we will focus on,and pay attention on the situation at the begining of the iteration of the while loop in which u is inserted into S and derive the contradaction that d[u]= δ (s,u) at that time by examining a shortest path from s to u.We must have u s because s is the first vertex inserted into set S and d[u]= δ (s,u)=0 at that time.Because u s,we also have that S Ø just before u is inserted into S.There must be some path from s to u,for otherwise d[u]= δ (s,u)= .

Here there is at least one path, there is a shortest path p from s to u.Path p connects a vertex in S,namely stop a vertex in V-Snidely u.Let us consider the first vertex y alongp such that y Є V-S, and let x Є V be y's predecessor.Thus, as shown in figure 3.5,path p can be decomposed as s→x→y→u.

We can claim that d[y]= δ (s,y) when u is inserted into S.To prove this claim,observe that x Є S. Then,because u is choosen as the vertex for which d[u] δ (s,u) when it is inserted into S,we had d[x]= δ (s,x) when x was inserted into S.Edge (x,y) was relaxed at that time .

We can now obtain a contradiction to prove the theorem.Because y ocurs before u on a shortest path from s to u and all edge weights are nonnegative(notably those on path p_2), we have δ (s,y) ≤ δ (s,u)

$$
\begin{aligned}
d[y] &= \delta (s,y) \\
&\le \delta (s,u) \\
&\le d[u]
\end{aligned}
$$

But becauuse both vertices u and y were in V-S when u was chosen in line 5,we have d[u] ≤ d[y].Thus ,the two inequalities are in fact equalities, giving;

d[y]= δ (s,y)= δ (s,u)= d[y]

Consequently , $d[u] = \delta(s,u)$, which contradicts our choice of u. We conclude that at the time each vertex $u \in V$ is inserted into set S, we have $d[u] = \delta(s,u)$.

CHAPTER 4

TOPOLOGICAL OPTIMIZATINON OF NETWORKS

4.1 Introduction to Topological Optimization Of Networks

This chapter of the project represents an Asynchronous Team Algorithms(A-Team) implementation, in a parallel heterogeneous asynchronous environment, to optimize the design of reliable communication networks given the set of nodes a possible links.

The proposed team combines parallel genetics algorithms(GA), with different reliability calculation approaches in a network of personal computers, proving good experimental results with considerable speedup.

The chapter is organized by the following parts.Part one will be the introduction of A-Teams, at part two the problem will be stated, the proposed method will be introduced at part tree, and the experimental results will be given at part four.And finally part five will be the conclusion.

4.2 What We Are Going To Do ?

Network planning is concerned with the design of sufficiently reliable networks at responsible cost, to deliver high capacity and speed.Because of the lack of good network designing tools, engineers have been using their experience and intuition to design networks in many fields as telecommunications, electricity distribution ,gas pipeline an computer networks.

For the present work, a reliable network design problem is started as all-terminal network reliability .In this approach, every pair of nodes needs a communication path to each other.That is the network forms at least a spanning tree.Thus, the primary design problem is to choose enough links to interconnect a given set of nodes with minimal costs, given a minimum network reliability to be attained.

Considering the complexity of designing reliable networks, and the amount of different published method, this problem seems to be a good candidate for Team algorithms(TA).TA is a technique, which distinct algorithms interacting in the solution of the same global problem. Team algorithms can be naturally implemented in parallel assigning different sub-problems to each processor of an asynchronous distributed system ,like a computer network.This parallel asynchronous combination of different algorithms is known as A-Team(Asynchronous team) have achieved excellent results by applying this technique for hydroelectric optimization., a different engineering goal with a similar mathematical framework.Therefore this chapter proposes the implementation of the of an A-Team for the topological optimization of telecommunication networks, subject to a reliability constraints.

The paper is organized in the following way: Section 2 states the problem. The proposed method is introduced in section 3, with section 4 presents experimental results. The conclusion is left for section 5.

4.3 Statement of the Problem

A network is modeled by a probabilistic undirected graph G-(N,L,p),in which N represents set of nodes is set of possible links, and p is the reliability of each link.It is assumed one bi-directional link between each pair of nodes; that is, there is no redundancy between nodes.

We suppose that our optimization problem starts as;

$$\text{Minimize } Z=\sum_{i=1}^{N-1}\sum_{j=j-1}^{N} c_{ij}\, x_{ij}$$

Subject to: $R(x) \geq R_0$

Where x_{ij} is a decision variable {0,1}, c_{ij} is the cost of a link(i,j),R(x) is the network reliability, and R_0 is the minimum reliability requirement.

To solve the problem, the following assumptions are made;

- The n nodes are perfectly reliable.A problem with a node may be simulated by the failure of its incident links.
- The cost of c_{ij} and reliability p_{ij} of each link (i,j) are known.
- The links have two states: either operational (x_{ij} =1) or failed x_{ij} =0.
- The links failures are independent.
- No pair is considered.
- Two-connectivity is required.

4.4 Proposed A-Team

The main algorithm consists of two kinds of processes, a coordinator and the PGAs(Parallel genetic algorithms).There is only one coordinator, which is responsible of creating the PGA process, collect their results and take the note of the global statistics.The PGAs do the real work.Once the coordinator initializes all the processes, each PGA computes it solutions, broadcasts its partial results to the others, and receives what its peers have sent to it.

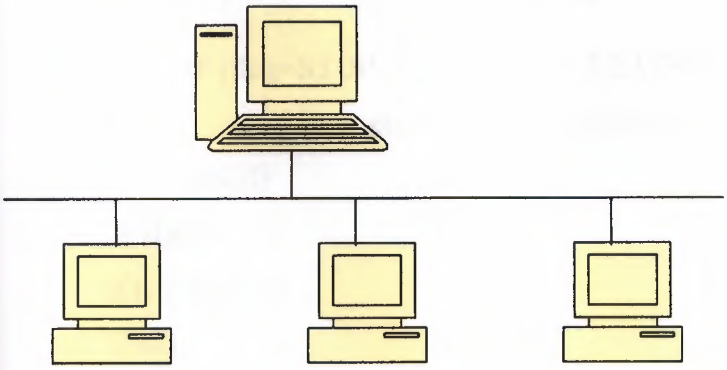


Figure4.1 : Asynchronous Team(A-team) implementation

4.4.1 The Coordinator

First the coordinator spawns P slaves processes ,where P depends on the number of available processors, and the relative performance between them.Work balance is required for an efficient implementation.There are several ways to balance the computational load by using parallel genetic algorithms(PGA),as example with different population size in each processor.

The second task of the coordinator is to gather partial results sent by the PGAs, check if a received solution is better than the current one, and if this is the case, to replace it.

Finally the coordinator checks the finishing criteria.For the present implementation it stops after being informed that all the PGAs have already satisfies a given finishing condition.

```
START
SPAWN P PGAs
Stop_counter=0
DO WHILE (Stop condition<p )
    RECIEVE candidate network N_r and flag

    IF (N_r is better than N_best ) N_best = N

    IF (flag=STOP_CONDITION_REACHED)
            Stop_counter=stop_counter+1
    ENDIF
ENDDO
KILL P PGAs
END
```

4.4.2 Genetic Algorithm

The proposed GA is based on a previous work with the following main features:

- All the network solutions keep the two connectivity constraits;that is, there should be at least two links incident to each node.
- A specialized initialization is used to enhance the efficiency of the search.
- The crossover and mutation operations are specialized.
- A repair algorithm is utilized to keep the networks under the two-connectivity constraint.
- There are two different approaches to calculate network reliability.First an upper bound of all the network candidates included in the population is efficiently calculated.Then the computational expensive Monte Carlo simulation is used to get a real good approximation of the actual all-terminal reliability of the best candities.

4.4.3 Encoding

In the present proposal, a network is encoded by a string of bits, where each bit represents the operability bof a link.The position of the bit in the string matches the label (figure 4.2) of the link.The coding is implemented at bit level, in this way, a network with up to 16 links can be saved as an integer of 16 bits, where the highest order bit is labeled 1,and the bit of lowest order is labeled 16.For instance: the network of figure4.2 is encoded by(reading from left to right) 010100000000000.Thus the former network is represented by the integer $2^{14} + 2^{12} + 2^{11}$

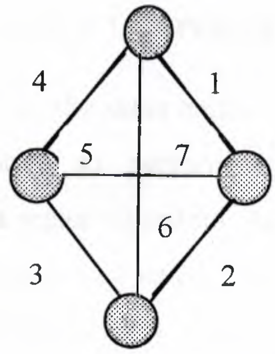


Figure 4.2 : The solid lines shows where the lines are up, and the dotted line are the failure ones

4.4.4 Parallel Implementation

There are several ways to implement a GA in a parallel asynchronous environment. For the present work, identical processes, called PGAs (Parallel Genetic Algorithms) are assigned to different processors. Each PGA has its own population, randomly generated by each independent process. The population size is maintained constant in each PGA process, even though it may receive any number of network candidates from the peer processes. For that porpoise, a genetic selection operator is used after asynchronously receiving any number of candidates, to choose between the own population and the incoming candidates (see Pseudocode 2). That way, the interaction between processes is performed, interchanging good candidate networks. Every *g* generations, or when the PGA find a new best network, a PGA broadcast his best network to share it with its peers. If *g* is too large, there will be little interaction, but if it is too small, there may be large overhead with premature convergence.

4.4.5 PGA Genetic Operatiors

A PGA uses basically the same mutation and crossover operators.These are specialized operators to perform local search and preverse two-connectivity constraints using a repair algorithm.Both mutation and crossover, use a set of operators:union,intersection and subtraction.These operators are efficiently using bit operators (OR,AND,NOT).

4.4.5.1 PGA Genetic Operators

A PGA uses basically the same mutation and crossover operators presented. These are specialized operators to perform local search and preserve two-connectivity constraints using a repair algorithm. Both, mutation and crossover, use set operators: union, intersection and subtraction. These operators are efficiently implemented using bit operators (OR, AND,NOT). On the other hand, the proposed selection operator is not identical to the one presented .It has been extended to deal with variable-size population, as explained above. There are several PGA running in parallel, and interchanging partial results with their peers. So, when a PGA does a selection, it has to select a constant number of candidates, among the last population plus the recently arrived candidates, in order to preserve population size. The PGA objective function (OF)

A penalization is used in the objective function to allow infeasible networks in the population, but preventing them to be chosen as the best one. This is done because two unfeasible networks can breed feasible solutions. A constant k has been introduced to the penalization function proposed in [23] to increase this restriction. Initial studies indicate that the objective function formulae can be further improved using a variable penalization, to get an adaptive penalization that would resemble a simulated annealing.

Each PGA runs independently of their peers, informing the coordinator when it reaches a stop-criteria. There are two finishing criterias:

- convergence of the population to a homogenous population;
- maximum number of generations.

A PGA does not stop when its finishing criterion is satisfied, because it may receive new network candidates from its peers. It just informs the coordinator instead. The coordinator is the one in charge of testing general convergence and killing the PGA processes.

At every generation, each member of the population is compared to the best candidate. If a given network has no more than *l* links that are not in the best, this network is considered similar to the best. When the average of similar networks is more than a given percentage, the population is considered homogenous.

4.4.6 The PGA Algorithm

A PGA process has five main tasks ;

- To generate the initial population.
- To recieve canditate networks that have been transmitted by the peers and to apply selection over the whole population.
- To perform regular GA operations (crossover and mutation)
- To broadcast the best network it finds.
- To inform the coordinator when a given finishing criteria is satisfied.

4.5 Experimental Results

The experimental experiences have been performed over a 10 Mbps Ethernet network, with three personal computers with intel 80486 processors of different configurations .The programs were written in C and the parallel implementation was done by parallel virtual machine.The sequental GA, used as reference, process a population size P times larger than the one on the PGAs, where P is the number of spawned PGA processor.

```
START
POPULATİON pop[], pop_old[],imported[]
Pop_size =s                /*population size*/
Gen=0                      /*generation number*/
Exp_freq                   /*export every exp_freq generations*/
GENERATE_NEW_POPULATION (pop_old)
FOR (i=1 to s)
      UPPER_BOUND(pop_old[i])      /*reliability calculation*/
END FOR
ORDER_POP_BY_OF(pop_old)           /*by objective function*/
X best =pop_old[i]

MONTE_CARLO(pop_old[i])
DO WHİLE (TRUE)
     IMPORT NETWORKS                    /*from other processes*/
     For (i=1 to pop_size2)
     SELECT_TWO_NETWORKS
     İf  (RANDOM < crossover_rate)
                 GET_CHILDREN_BY_CROSSOVER
     ELSE
                 CLONE_CHİLDREN_FROM_PARENT
     ENDIF
     IF(STOP_CRITERIA) INFORM COORDINATOR
     IF (RANDOM<mutation_rate)MUTATE_CHILD1
     IF (RANDOM>mutation_rate)MUTATE_CHILD2
     INSERT_CHILDREN(pop)
ENDOR
ORDER(pop)
i=1
DO WHILE  (pop[i]) better than x best   AND i<pop_size)
       MONTE_CARLO(pop[i])
İf pop[i] better than x best
           Pop[i]=x best
```

EXPORT (x_{best})

ENDIF

i=i+1

END DO

İf (gen MOD exp_freq =0) EXPORT(x_{best})

gen=gen+1

Pseducode2 (Parallel genetic algorithm)

Figure 4.3 shows a typical running of the (iA and the implemented A-Team, plotting the temporary best solution as a function of time.It can be seen that the A-Team converges much faster than GA.In fact, A satisfies a finishing criterion(by population homogenization) more than 400 s before the GA finds a similar quality solution.

Run	Best cost	A-Team Reliability	Time(s)	Best cost	Sequental GA Reliability	Time(s)
1	140	0.9412	339	147	0.9416	230
2	143	0.9374	305	149	0.9470	719
3	153	0.9458	158	140	0.9382	341
4	139	0.9360	374	135	0.9323	983
5	139	0.9375	192	140	0.9446	1480
6	142	0.9444	155	142	0.9364	334
7	142	0.9371	177	150	0.9381	640
8	141	0.9464	294	142	0.9370	1755
9	154	0.9467	351	139	0.9340	652
10	140	0.9379	198	139	0.9388	669
avg.	143	0.9410	254.3	142.3	0.9388	780.3
Standard deviation	5.54	0.0044	86.38	4.85	0.0043	497.55

Table.1 : Experimental results after 10 runs

Table 1 presents results over 10 runs when designing a 10 nodes network that may be fully interconnected, i.e there are 45 possible links.Each link has a reliability of %90 and an all terminal reliability requirement of %95 .It can be noted that the A-Team not only gets good solutions, but also a predictable running time when compared to sequental GA.

	Best cost	Reliability	
	Time(s)		
	1536.5	0.8646	
GA	21481.5		
A-Team	1383.3	0.8285	9302.3

Table.2 (Average over 3 runs for a 50-nodes-fully connected network design)

Table.2 shows the average over three run of a network design problemwith 50 nodes fully interconnected.As can be seen speedup scales very well indicated that the proposed A-Team can be used with advantage in the design of larger reliable networks.

4.6 Conclusion of The Chapter

This chapter presented a network design problem subject to reliability constrain that is especially complex because not only the design itself is NP-hard ,but also the exact reliability calculation.For this reason ,several different methods have been published but non of them is efficient enough to solve the problem network size of nowadays

The complexity of the design and the variety of completely different algorithms, each one with its own strength, make of this problem an ideal field for testing Asynchronous Team Algorithms, a technique to exploit available computer power of Asynchronous distributed systems, as computer networks.

Considering the most modern organizations today have access to a good number of computers interconnected through a network, the presented technique gives an ideal approach to solve very large and complex problems as the design of reliable networks.Furthermore, using the same ideas with relatively little change in the presented implementation, the authors are studying a variety of similar design problems, as the following ones;

- Maximize reliability of a network, given a maximum budget.
- Design of reliable networks with different with different kinds of links as: optical, wireless comminication, telephone lines etc.
- Design of reliable networks with constrains as:maximum numbers of hubs between any two nodes, minimum total throughput, maximum delay etc.

CONCLUSION

In my project I explained ,networks and its general applications by representing types,topologies,algorithms and topological optimization of networks.I used figures,tables and programs to explain the contents of each chapter.

I tried to answer the questions that why we are using network and what to do for optimization of networks and network traffic.

Finally at the end of this Project I had a chance of learning and focusing to the new developments of network technologies,and how to optimize these new technologies for computer users.Now I can understand beter that why networking is essential and takes a big importance of our social life.This project became a great exsercise form e that I will be able to apply at the rest part of my life.

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