

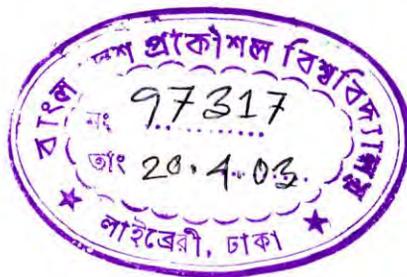
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**A Project On**

# **Corporate Network Design and Simulation**

**Submitted for the partial fulfilment of PGDIT course**

**Submitted on: Sunday, 6 October 2002**



#97317#

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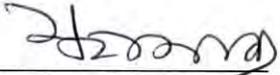
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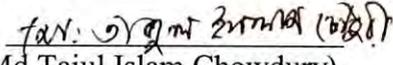
## DECLARATION

It is hereby declared that except where specific references are made to other investigators, the work embodied in this project is the result of investigation carried out by the authors under the supervision of Mr.A.A.Munir Hasan , System Administrator , Institute of Information and Communication Technology (IICT) ,Bangladesh University of Science and Technology(BUET).

Neither this report nor any part of it has been or is being concurrently submitted to any other institute for any degree.

  
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## **ACKNOWLEDGEMENT**

It is indeed a great pleasure and pride privilege for us to express our deepest sense of honor, heartiest thanks and gratefulness to our revered teacher Mr.A.A.Munir Hasan, System Administrator, Institute of Information and Communication Technology (IICT), Bangladesh University of Science and Technology (BUET) for providing us the concept, plan, guidance overall supervision and constructive criticism throughout the project.

We are also grateful to Dr.S.M.Lutful Kabir, Professor and Director Institute of Information and Communication Technology (IICT), Bangladesh University of Science and Technology (BUET) for his overall support in carrying out our project.

Last but not least, we express our thanks to Almighty Allah to bring this project and report into reality.

Date  
6<sup>th</sup> October, 2002

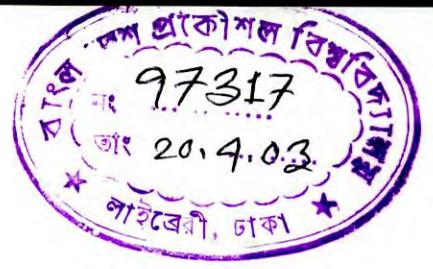
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## INTRODUCTION

Most large corporate offices now-a-days use computer networks. In the developed countries all the corporate offices have been using network facilities for many years. For controlling geographically dispersed company locations, for fulfilling customer service requirements and for smooth company management, large businesses have found networks highly effective. In countries like ours corporate networks are not as common as in the developed world. But the situation is changing and most companies will start using networks within a few years.

Keeping this in mind here we study information requirements of a large corporate level company and design a logical network to fulfill these requirements. We have also simulated the design in our laboratory to verify its robustness. One important consideration during the exercise has been the cost of different options available.

In our whole work we followed the step by step procedure of network design and management. We tried to explain every thing in detail so that any company that wants to develop a corporate network can get a simple guideline.



## Chapter 1

### Management and Network Design

# 1 Management and network design introduction

Every business, whether non-profit or for-profit, has a number of goals. Examples of these goals include:

- The desire to increase the business's customer base.
- The need to properly serve customers and keep them happy by providing the company's services as best as possible.
- The desire to increase the company's profit level, or in a non-profit organization to provide the funds necessary to meet the organization's goal and objective.
- The desire to conduct business more efficiently and effectively.

## 1.1 Systems development life cycle:

To properly understand a problem, analyse all possible solutions, select the best solution, and implement and maintain the solution, you need to follow a well-defined plan. One of the most popular and successful plans currently used by business today is the systems Development life cycle (SDLC) is a methodology for a structured approach for the development of a business system, including planning, analysis, design, implementation and support. A methodology is a series of steps and tasks that professionals, such as system developers, can follow to build quality system faster, with fewer risks, and at lower costs. Although virtually every company that uses SDLC and every textbook that teaches SDLC has a slight different variation, most agree that the SDLC includes the following phases:

- Planning
- Analysis
- Design
- Implementation
- Maintenance

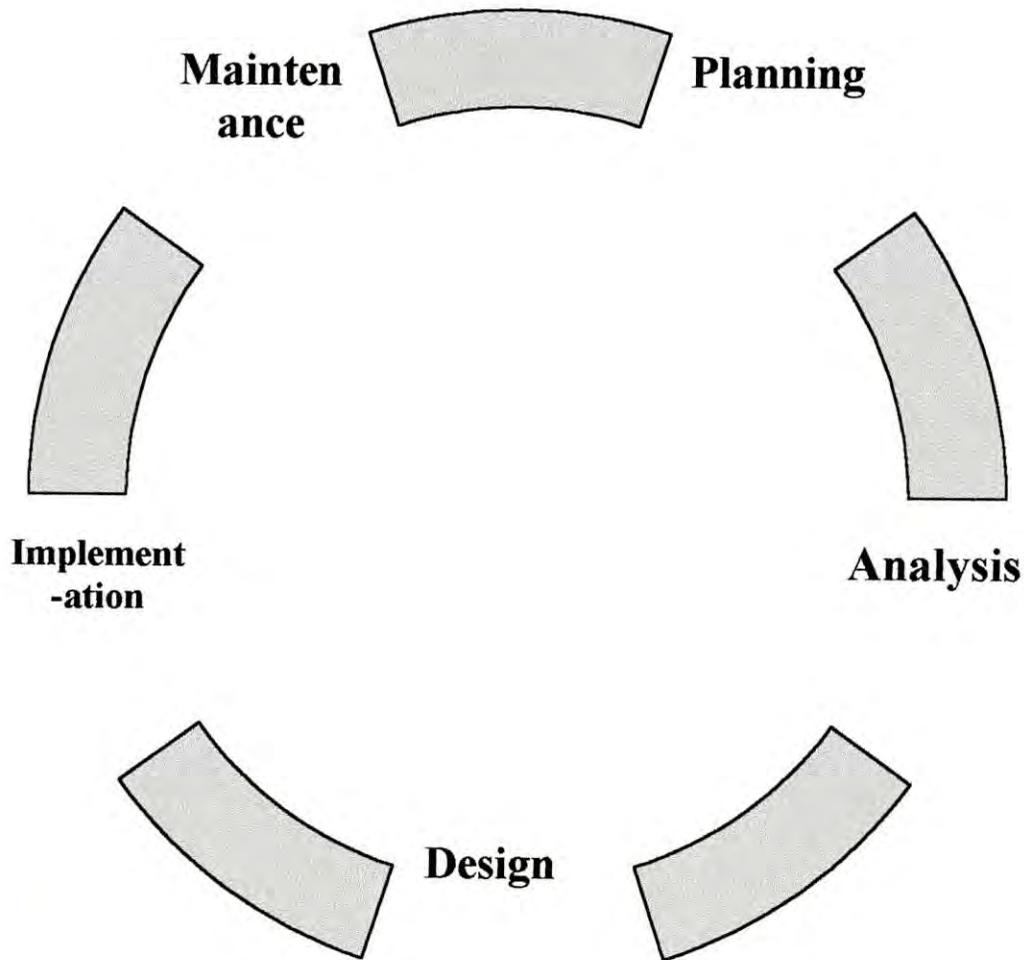


Figure: Cyclic nature of the phases of the Systems Development Life Cycle

### 1.1.1 Planning & Analysis Phase

During the planning phase you identify problems, opportunities and objectives. The systems analyst must honestly look at what is occurring in a business. What is the business trying to do? To effectively carry out this phase, the systems analyst meets with other members of the organization to outline the problems, opportunities, and objectives. The systems analyst interviews managers to learn what their goals are.

During the analysis phase, information requirements are determined for the particular users involved. Information requirements can be gathered by sampling and collecting

hard data, interviewing, questionnaires, observing decision maker's behaviour and office environments, and prototyping.

During the analysis phase, you also analyse system needs. What are the needs of the system? What is the flow of data within the system? The systems analyst creates data flow diagrams to show the flow of data within the system. The systems analyst should also create a series of maps of the locations that are part of the proposed system. These maps-called network models, can be used to determine computer network topologies and the necessary data flow over those networks.

At the end of the analysis phase, the systems analyst prepares a written systems proposal that summarizes what has been found, provides feasibility studies and cost-benefit analyses of alternatives, and makes recommendations of what(if any thing) should be done. This systems proposal is a business proposal and usually does not yet recommend a particular type of computer system or network installation. The recommendation of particular computer hardware and software usually occurs in the next phase, the design phase.

### **1.1.2 Design Phase**

During the phase, the system that was recommended and approved at the end of the analysis phase is designed. The systems analyst uses the information collected earlier to create a logical design of the information system.

At the end of the design phase, the new system is tested. Testing is performed by the systems analyst and end-users, and it can be done on individual pieces and on the system as a whole. Network specialists are, once again, called upon to test the networks and to make sure they perform the necessary transactions, can support the anticipated load.

### **1.1.3 Implementation Phase**

During the implementation phase, the system is installed and preparations are made to move from the old system to the new system. Training of users is performed. Testing continues, evaluations are performed, and feedback is accepted. Any and all networks are monitored continuously by network managers, and all feedback is used to correct network problems or weaknesses. Any system documentation that is needed to support the new system is created during the implementation phase.

### **1.1.4 Maintenance Phase**

Maintenance is the largest phase in the SDLC and one that often lasts for years. The maintenance phase has been compared to the portion of an iceberg that is hidden under water. With respect to time and costs, the planning, analysis, design, and implementation

phases are relatively small- like the portion of the iceberg that is above the surface of the water- compared to maintenance. In contrast, the maintenance phase takes more time and money; it is comparable in size to the portion of the iceberg that is below the surface. With careful and accurate analysis and design, the time and cost of the maintenance phase can be kept to minimum.

## **1.2 Network Modelling**

When a systems analyst or a person acting in the role of systems analyst is asked to design a new computer system, the analyst will create a set of models for both the existing system( if there is one), and for the proposed system. Typically these models are designed to show the flow of data through the system and the flow of data through the systems.

To model a network environment for a corporation, you create a figure called a location connectivity diagram. A location connectivity diagram (LCD) is a network modelling tool that depicts the various locations involved in network and the interconnections between those locations. Two basic forms of LCDs can be created: an overview LCD and a detailed LCD. An overview LCD depicts the major locations involved in a corporate networking environment.

## **1.3 Feasibility Studies**

Analysing and designing a new computer system can be time consuming and expensive. While the project is in the analysis phase and before a system is designed and installed, a feasible solution must be found. The term feasible has several meanings when applied to computer-based project. The proposed system must be technically feasible. A technically feasible system is one that can be created and implemented using currently existing technology. Does technology exist that can be incorporated into working solution? If technology from two or more vendors is suggested, will the differing technologies work together? If a vendor claims accurate or misleading? Does the company have the technical expertise to build, install, or maintain the proposed system?

The proposed system must b also be financially feasible. A financially feasible system is one that can be created given the company's current financial ability. Can the proposed system solve the current problem and stay within budget? How long if ever, will it take before the proposed system returns a profit?

In addition, the proposed system must be operationally feasible. An operationally feasible system is one that operates as designed and implemented. Will the proposed system produce the expected results? Will users be able to use the proposed system, or will it be difficult or inconvenient to use that users will not adopt the proposed system?

Finally, the proposed system must be time feasible. A time feasible system is one that is installed in timely fashion that meets organizational needs. Cat the proposed system be designed, built, tested, and installed in an agreeable and reasonable amount of time?

## 1.4 Capacity Planning

Computer networks are mission critical systems, and designing a new computer network or increasing the capacity of a current system requires careful planning. If one designs a system that is not capable of supporting the generated traffic, response times will be sluggish and users will not be able to complete the necessary work in the required amount of time. This inability to perform work duties will lead to missed deadlines, projects backing up or even failing, and low employee morale. If the company is selling a product and that product can be purchased electronically, sluggish response times will equate to dissatisfied customers. In the Internet age when a competitor's web site is a simple click away, dissatisfied customers will quickly turn elsewhere.

At the other end of the spectrum, if you over-design a system, you will spend money unnecessarily to create that may never reach its capacity. It is arguable that if one is going to err in design, it is probably best to err in the direction of over designing, especially since it is difficult to predict the growth rate of new users and applications. Of all systems designed during the last ten years, a large percentage of systems are more than likely too small and cannot support the demands placed on them. Smaller percentages of network system are over designed and remain relatively idle.

Capacity planning involves trying to determine the amount of network bandwidth necessary to support an application or a set of applications. Capacity planning is fairly difficult and time consuming operation, and it is easy to plan poorly and thus design a system that will not support the intended applications. A number of techniques exist for performing capacity planning, including linear projection, computer simulation, benchmarking, and analytical modelling.

Computer simulations involve modelling an existing system or a proposed system using a computer-based simulation and subject it to varying degrees of user demand (called load). The advantage of a computer simulation is its ability to mimic conditions that would be extremely difficult, if not possible, to create on real network. On the negative, computer simulation are difficult to create, and mistakes are easy to make and hard to discover. One mistake in a simulation can produce false results. Thus extreme care must be taken when creating a simulation.

Capacity planning is difficult and not trivial. Once capacity planning is properly done, however, a network administrator can determine if the company's local area networks and wide area network connections can support the intended applications. Knowing the necessary capacity, however, does not tell the whole story. Other questions need to be answered. For example, how does one know whether the current network can or cannot handle the intended applications? Once the needed capacity is determined, you then need to closely examine the current network to determine its actual capacity. One of the techniques determining current network capacities is creating a baseline.

## **1.5 Creating a Baseline**

Creating a baseline for an existing computer network involves the measurement and recording of a network's state of operation over a given period of time. Creating a baseline involves capturing many network measurements over all segments of a network, including numerous measurements on workstations, user applications, bridges, routers, and switches. Since collecting this information appears to be such a large undertaking, why would you want to create a baseline? Networking personnel create a baseline to determine the normal and current operating conditions of the network. Once a baseline is created, the results can be used to identify network weaknesses and strengths, which can then be used to intelligently upgrade the network.

## **1.6 Network Manager Skills**

Once the analysis and design phase of network development are completed and the computer network is in place and operating, it is the network manager's responsibility to keep it running. Keeping a network running includes making repairs on failed components, installing new applications and updating the current ones, keeping current system users up to date, and looking for new ways to improve the overall system and service level.

## **Chapter 2**

### **Planning**

## 2 Planning

Under this phase we visit and study some corporate level company and tried to understand their structure, activities, geographical location and requirements. We visited BAT and SWMC and studied their network. With these experiences we did step by step establishment of a network for a virtual corporate company.

### 2.1 Company geographical location map:



Figure 2.1 company geographical location map

## 2.2 Overview location connectivity diagram

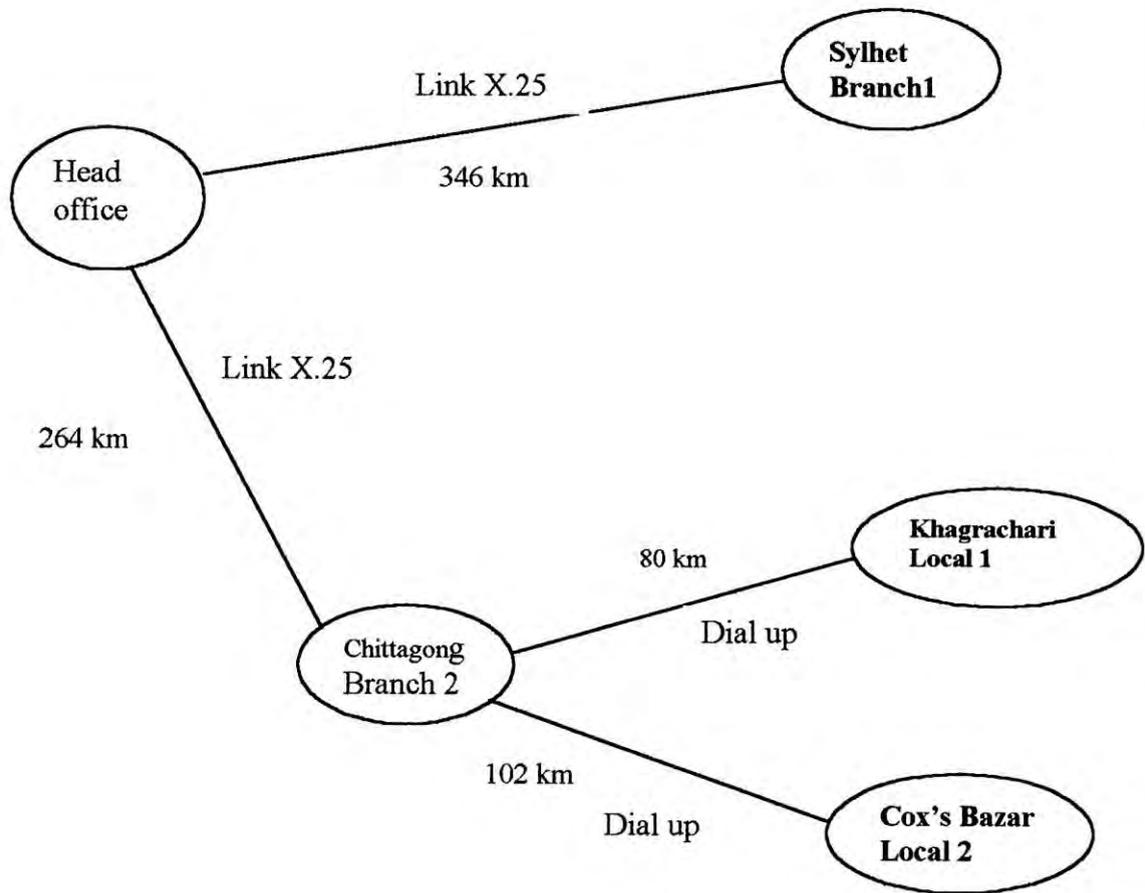


Figure 2.2 Overview location connectivity diagram

### 2.3 Head office floor plan:

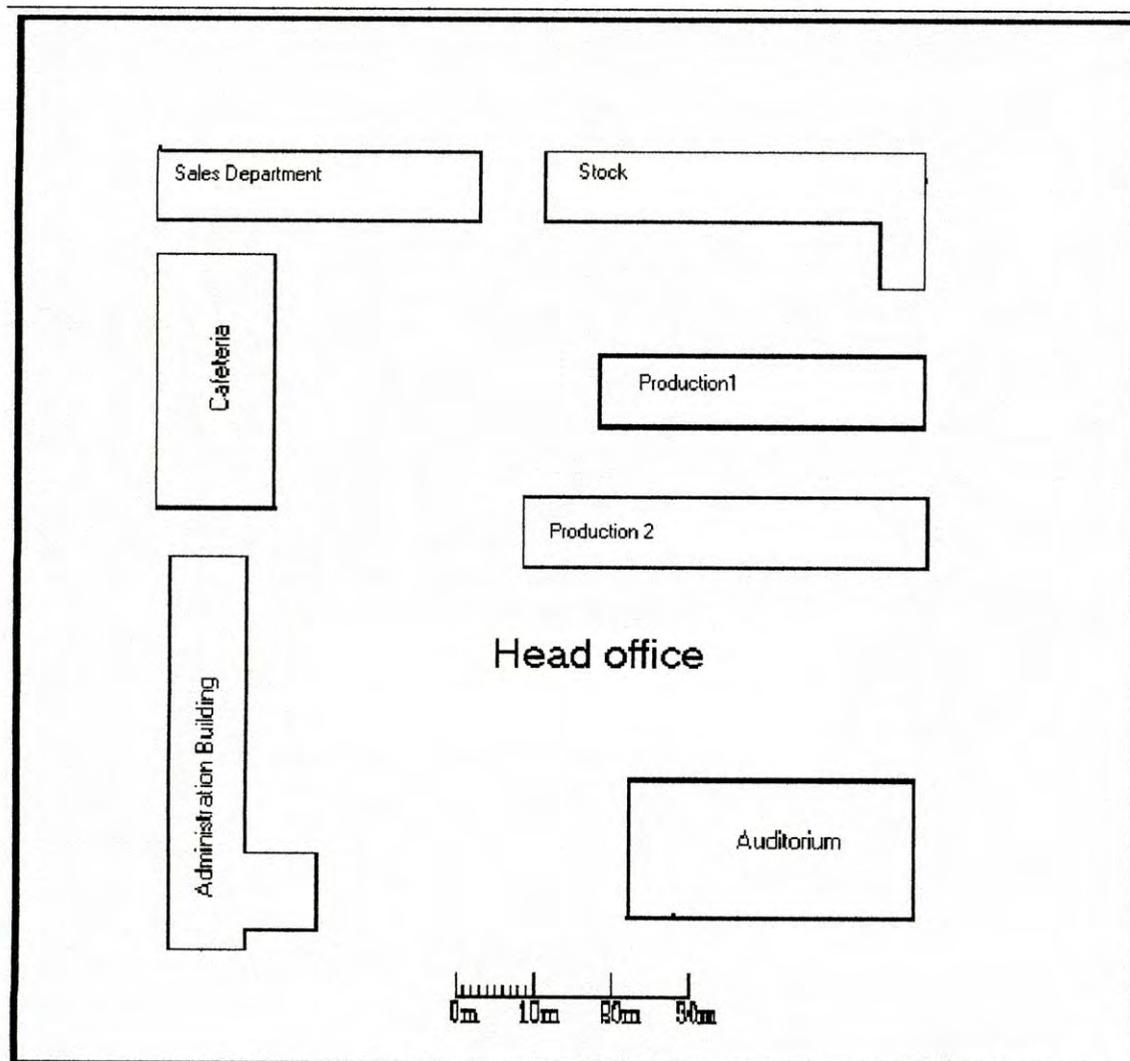


Figure 2.3 Head office floor plan

## 2.4 Corporate network objectives

Assessment of the corporate network as a tool designed to achieve business objectives.

Corporate Network Uses	Short-Term	Mid-Term	Long-Term
Company performance data		X	
Cost savings	X		
Cross-functional information sharing	X		
Employee communications	X		
Employee processes (forms, enrolments, etc.)		X	
Human resources communications	X		
Information access	X		
Morale/image enhancement			X
Productivity enhancement		X	
Sales support	X		
Teamwork facilitation	X		
Top-down management communication	X		
Training and development	X		

**Table 2.1 Corporate network Uses and Objectives**

For each use, establish a measurable objective. A measurable objective is a tangible target, such as:

- Productivity enhancement: During the first quarter, telephone requests for information from human resources executives will decline by 20 percent and five additional percentage points each subsequent quarter throughout the first year. (This frees up human resources personnel to focus on more productive activities.)
- Teamwork facilitation: During the measurement period, five geographically dispersed teams will adopt the intranet's work-flow management capabilities to facilitate their ongoing team-based efforts.

- Training and development: By year-end, 500 employees will sign up for training classes using the intranet online enrolments form.
- Top-down communication: Employee comprehension of management decisions will improve by at least 10 percentage points (assessed by comparing this year's internal communication audit to last year's communication audit) and be directly attributable to supplemental and support information related to key management decisions that are accessible on the intranet.

## 2.5 Audience Identification

Identify the audiences for whom the intranet is intended. Assign a short-term, mid-term, and long-term label to each appropriate audience, as in Table 2.2 (Remember, an intranet can begin as a tool for management only and expand later to include all employees, or it can begin as a tool for administrative staff and expand later to include manufacturing employees, and so on.) Several of the categories listed cross over into others, so not all categories will be appropriate. Use only those that meet the characteristics of your specific organization.

Department	Short-Term	Mid-Term	Long-Term
All employees			X
Clerical employees	X		
Managers	X		
Manufacturing employees			X
Marketing employees (corporate)	X		
Marketing employees (field)		X	
Operational employees (manufacturing, marketing, research and development, etc.)	X		
Sales employees (corporate)	X		
Sales employees (field)	X		
Specialists (doctors, research scientists, etc.)	X		
Employees in specific departments (Human Resources, Legal, Finance, etc.)		X	
Supervisors	X		
Union employees		X	

**Table 2.2 Corporate network Audiences and Scheduled Participation**

For each category, indicate the number of employees. Then determine how many of those employees have direct access to a computer workstation. Using Table 2.3, determine how many of those workstations are already networked and how many are already configured to access the Internet.

<b>Department</b>	<b>Number of Employees</b>	<b>Number of Employees on Network</b>	<b>Number of Employees with Internet Access</b>
All employees	1010	340	X
Clerical employees	200	150	X
Managers	10	10	X
Manufacturing employees	500	20	X
Marketing employees (corporate)	10	10	X
Marketing employees (field)	20	10	X
Operational employees (manufacturing, marketing, research and development, etc.)	50	20	X
Sales employees (corporate)	30	30	X
Sales employees (field)	100	20	X
Specialists (doctors, research scientists, etc.)	20	20	X
Employees in specific departments (Human Resources, Legal, Finance, etc.)	30	20	X
Supervisors	20	20	X
Union employees	20	10	X

**Table 2.3 Audiences Online**

## 2.6 Communication Strategies

In this phase, you identify the products, services, communications, and transactions that employees will be able to engage in and use on the intranet. These are the actual tactical elements of the intranet that will need to be built in order for it to be functional and serve specific needs.

## 2.7 Products

Existing materials that can be defined as a unit or item that will be transferred part-and-parcel to the intranet are the products you should identify. Products can also be *tools* that employees can use to do their jobs, which are distinct from other parts of the intranet. Use the following table to check off the products you plan to incorporate.

Products	Yes	No
Employee handbooks and manuals	X	
Utilities for work-flow management	X	
Other		X

Table 2.4 Products

## 2.8 Services

Certain components of the intranet will provide a direct service to the individual employee using it. Employees would go to these sections in order to avail themselves of the service. Use the following table to check off the services you plan to incorporate.

Services	Yes	No
Employee directory	X	
Internal job postings	X	
New-hire orientation	X	
Training and development (e.g., self-paced tutorials)	X	
Other		X

Table 2.5 Services

## 2.9 Communications

Identify the information that is published for other employees to access as needed, as well as two-way communication that engages more than one employee in a discussion or conversation. Use the following table to check off the communications you plan to incorporate.

<b>Communications</b>	<b>Yes</b>	<b>No</b>
Departmental publication of material	X	
Company events calendar	X	
Cross-functional, many-to-many communication (e.g., newsgroups)	X	
Competitor/marketplace information	X	
Designated areas where specialists can communicate with each other (e.g., engineering discussion group)	X	
Employee benefits information	X	
Other		X

Table 2.6 Communications

## 2.10 Transactions

Finally, identify the parts of the intranet in which data is actually sent from the client to the server in order to complete some type of transaction. For example, use the following table:

<b>Client Server Transactions</b>	<b>Yes</b>	<b>No</b>
Benefits enrolment	X	
Performance evaluations	X	
Budgeting	X	
Training (e.g., signing up for training classes)	X	
Financial reporting	X	
Other		X

Table 2.7 Transactions

## 2.11 Support Requirements

The intranet will require support from a number of different sources. Your organization may have most of the resources in-house, but some-such as graphic design-may have to be acquired from outside vendors. Even if you have the expertise within the company, the individuals who do that work may not have time for a new assignment.

The first step toward addressing issues of resources is to identify the kind of support that will be required for the intranet. The following table lists some ideas.

<b>Support Requirements</b>	<b>Yes</b>	<b>No</b>
Ongoing Support and Maintenance	X	
Script coding for special interactive functions	X	
Graphics development	X	
Server backups and maintenance	X	
<b>Content Development</b>		
Content system management	X	
Regular updating of manuals and other text	X	
Consultation on departmental site development	X	
<b>Training</b>		
Initial training	X	
New-hire training	X	
Telephone support for employees with questions or problems	X	

Table 2.8 Support Requirement

## 2.12 Security

One of the hottest issues companies face in the quest to develop any kind of networked computer environment is security. There are a finite number of solutions to a host of issues. First, identify the issues that face your organization and determine whether these are high- medium- or low-level security matters, using this table:

<b>Security Issue</b>	<b>High</b>	<b>Medium</b>	<b>Low</b>
Access to the intranet from unwanted outside visitors	X		
Confidential data	X		
Protection from viruses	X		
Desire to ensure that internal information stays inside	X		
Competitors' access to data	X		
Internal hackers	X		
Other		X	

Table 2.9 Security Issue

Next, use the following table to determine which security precautions and/or systems will be required for your intranet in order to address these issues.

<b>Security Precautions Required</b>	<b>Yes</b>	<b>No</b>
Data encryption	X	
Fire walls	X	
Multiple server locations (mirrors)		X
Password authentication	X	
Explicit policies with clear consequences for violations	X	
Other		

Table 2.10 Security Precautions

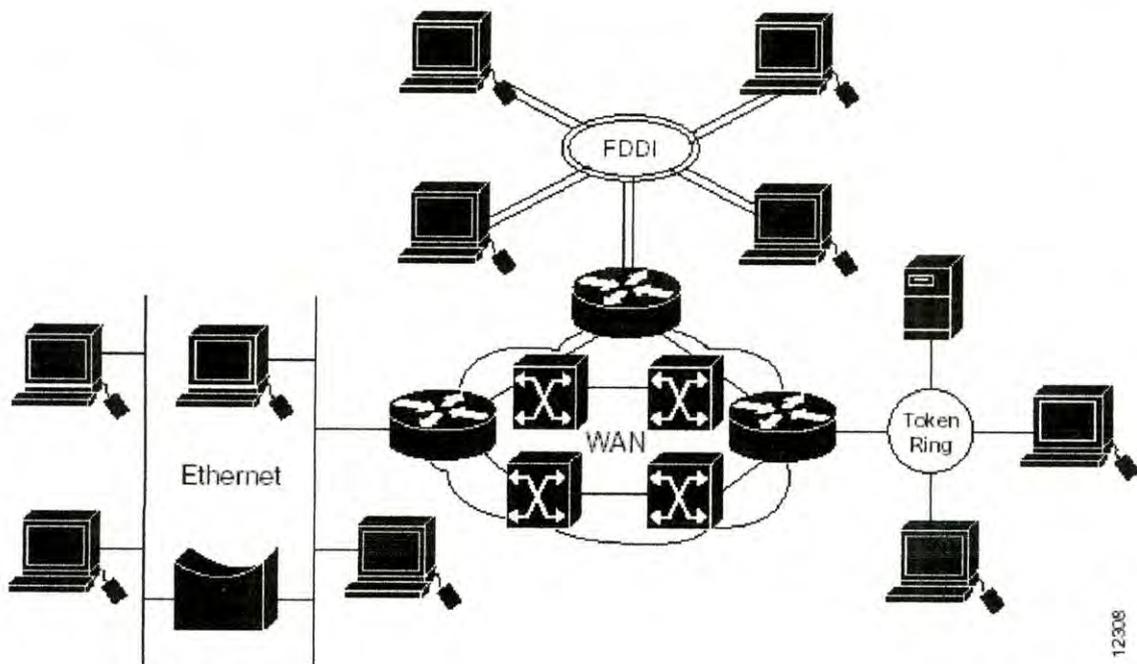
## **Chapter 3**

### **Analysis**

### 3 Analyses

#### 3.1 Internet

An internetwork is a collection of individual networks, connected by intermediate networking devices, that functions as a single large network. Internetworking refers to the industry, products, and procedures that meet the challenge of creating and administering internetworks. Figure 1-1 illustrates some different kinds of network technologies that can be interconnected by routers and other networking devices to create an internetwork:



**Figure 3.1 Different network technologies can be connected to create an internetwork.**

#### *LAN*

A local area network (LAN) is a communication network that interconnects a variety of data communication devices within a small geographical area. Within a small geographic area usually implies that a local area network can be as small as one room, or can extend

over multiple rooms, multiple floors within a building, and even multiple building within a single campus area.

## WAN

At a basic level, a WAN can be created by tying a series of simple, point-to-point links together. On the other end of the spectrum, a WAN might comprise many different systems and LANs, all interconnected using a variety of techniques, including standard telephone lines, packet-switching networks and ISDN links. Between the two extremes are networks that are superficially simple but technically complex, and those that are superficially complex but technically simple.

### 3.2 Intranet

An intranet is a private corporate or educational network that uses the Internet's TCP/IP protocols for its underlying transport. The protocols can run on a variety of network hardware, and can also co-exist with other network protocols, such as IPX. People from inside an intranet can get at the larger Internet resources, but those on the Internet cannot get into the intranet, which allows only restricted access from the Internet.

- Videoconferencing is an important application that requires sending massive quantities of data. Intranets can be built using components that allow the extremely high bandwidths required for transferring such information.
- Often an intranet is composed of a number of different networks inside a corporation that all communicate with one another via TCP/IP. These separate networks are often referred to as *subnets*.
- Software that allows people to communicate with each other via e-mail and public message boards and to collaborate on work using workgroup software is among the most powerful intranet programs. Applications that allow different corporate departments to post information, and for people to fill out corporate forms, such as time sheets, and for tapping into corporate financial information are very popular.
- Much of the software used on intranets is standard, off-the-shelf Internet software such as the Netscape Navigator and the Microsoft Explorer Web browsers. And customized programs are often built, using the Java programming language and CGI scripting.
- Intranets can also be used to allow companies to do business-to-business transactions, such as ordering parts, sending invoices, and making payments. For extra security, these intranet-to-intranet transactions need never go out over the public Internet, but can travel over private leased lines instead.
- Intranets are a powerful system for allowing a company to do business online, for example, to allow anyone on the Internet to order products. When someone orders

- a product on the Internet, information is sent in a secure manner from the public Internet to the company's intranet, where the order is processed and completed.
- In order to protect sensitive corporate information, and to ensure that hackers don't damage computer systems and data, security barriers called firewalls protect an intranet from the Internet. Firewall technology uses a combination of routers, servers and other hardware and software to allow people on an intranet to use Internet resources, but blocks outsiders from getting into the intranet.
  - Many intranets have to connect to "legacy systems"-hardware and databases that were built before an intranet was constructed. Legacy systems often use older technology not based on the intranet's TCP/IP protocols. There are a variety of ways in which intranets can tie to legacy systems. A common way is to use CGI scripts to access the database information and pour that data into HTML formatted text, making it available to a Web browser.
  - Information sent across an intranet is sent to the proper destination by routers, which examine each TCP/IP packet for the IP address and determine the packet's destination. It then sends the packet to the next router closest to the destination. If the packet is to be delivered to an address on the same subnetwork of the intranet it was sent from, the packet may be able to be delivered directly without having to go through any other routers. If it is to be sent to another subnetwork on the intranet, it will be sent to another internal router address. If the packet is to be sent to a destination outside the intranet-in other words, to an Internet destination-the packet is sent to a router that connects to the Internet.

### **3.3 Topologies**

Before defining LAN topologies, the distinction needs to be made between Physical Topology and Logical Topology.

#### **3.3.1 Physical Topologies**

Physical topology refers to the real, visual topology, or architecture of the network. It describes how network devices are physically connected by the media.

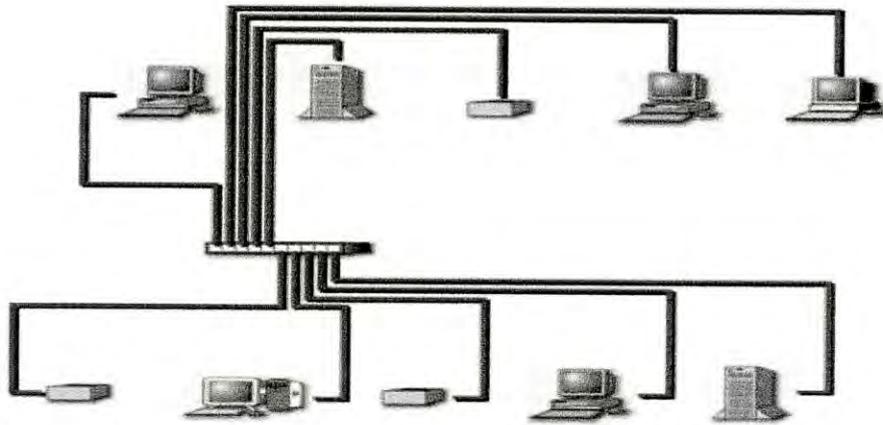


Figure 3.2: Physical Topology

### 3.3.2 Logical Topology

Logical topology refers to the method the media access protocol uses to determine device priority. It creates a simple view of the basic network structure, so a determination may be made about the order in which devices transmit.

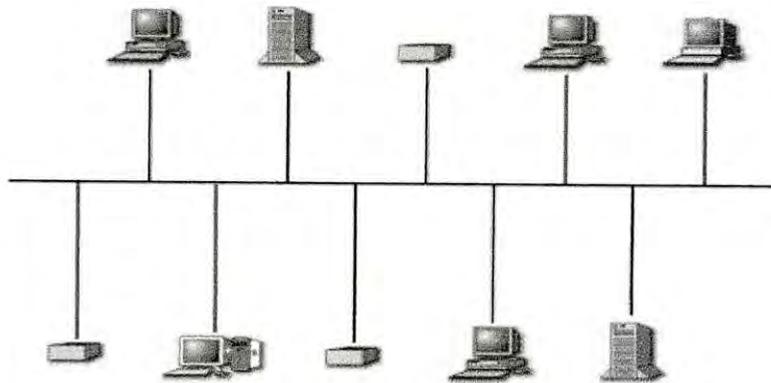


Figure 3.3: Logical Topology

### 3.3.3 Common LAN Topologies

The most commonly implemented LAN topologies are **Bus**, **Ring**, and **Star**. Each layout has particular advantages and disadvantages.

These topologies have evolved as the transmission media used in LANs improved. The advancements in transmission media also led to an improvement in LAN media access protocols.

### *Bus Topologies:*

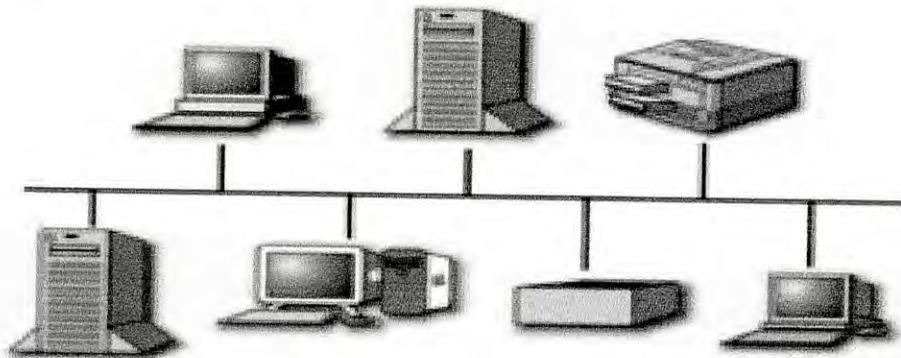


Figure 3.4: Bus Topology

In a bus topology:

- a single cable connects each workstation in a linear, daisy-chained fashion.
- signals are broadcasted to all stations, but stations only act on the frames addressed to them

Bus Topology Pros/Cons

- The main advantage of the bus topology is the ease of initial set-up.
- The primary disadvantage is that a break in the cable affects the entire LAN.

### **Ring Topology**

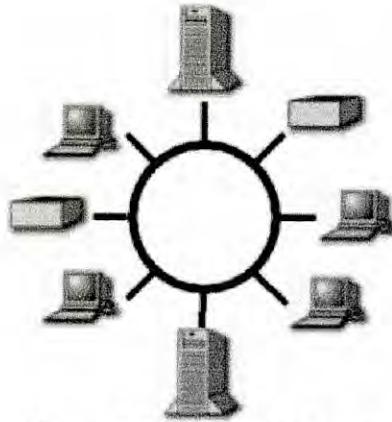


Figure 3.5: Ring Topology

In a ring topology

- Unidirectional links connect the transmit side of one device to the receive side of another device.
- Devices transmit frames to the next device (downstream member) in the ring.

Ring Topology Pros/Cons

- The only advantage of the ring topology is that it uses the network's lengths, which are shorter, using less cabling.
- The main disadvantage is that a cable break between devices affects the entire LAN (only in the Token Ring Standard). Cost is another factor. The ring topology usually construes higher implementation costs.

## Star Topology

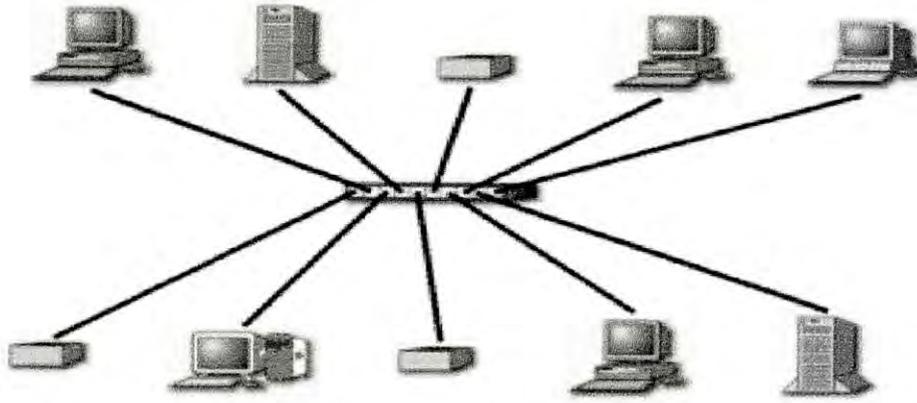


Figure 3.6: Star Topology

In a star topology, each station is connected to a central hub or concentrator that functions as a multi-port repeater.

Each station broadcasts to all of the devices connected to the hub. Physical LAN topologies are usually characterised as either bus or ring. Note that a LAN's Physical and Logical topology often differs.

#### Star Topology Pros/Cons

- The primary advantage of the star topology is that a cable break usually affects only one workstation. Workstations can be added easily, without affecting the entire network.
- The main disadvantage is the amount of cable used.

### Topology Comparison

Topology	Use	Pros	Cons
Bus	Central logical topology for Ethernet	Ease of initial set-up Low	Cable breaks affect the entire LAN

		Low implementation costs	
Ring	Central logical topology for Token Ring and FDDI	Uses less cabling	Cable breaks between devices affect the entire LAN (only in the Token Ring Standard).  Higher implementation costs.
Star	Central physical topology for various logical implementations	Cable break usually affects only one workstation  Workstations can be added easily, without affecting the entire network	Uses excessive cabling due to physical distance factors

Table 3.1 Topology Comparison

### 3.4 Protocol

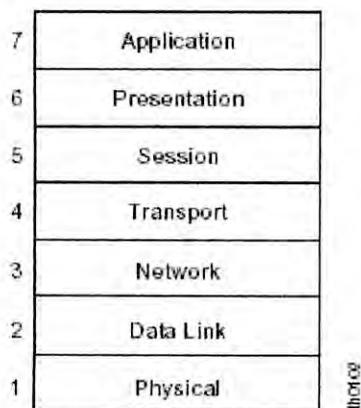
#### Open Systems Interconnection (OSI) Reference Model

The Open Systems Interconnection (OSI) reference model describes how information from a software application in one computer moves through a network medium to a software application in another computer. The OSI reference model is a conceptual model composed of seven layers, each specifying particular network functions. The model was developed by the International Organization for Standardization (ISO) in 1984, and it is now considered the primary architectural model for inter-computer communications. The OSI model divides the tasks involved with moving information between networked computers into seven smaller, more manageable task groups. A task or group of tasks is then assigned to each of the seven OSI layers. Each layer is reasonably self-contained, so that the tasks assigned to each layer can be implemented independently. This enables the solutions offered by one layer to be updated without adversely affecting the other layers.

The following list details the seven layers of the Open System Interconnection (OSI) reference model:

- Layer 7—Application layer
- Layer 6—Presentation layer
- Layer 5—Session layer
- Layer 4—Transport layer
- Layer 3—Network layer
- Layer 2—Data Link layer
- Layer 1—Physical layer

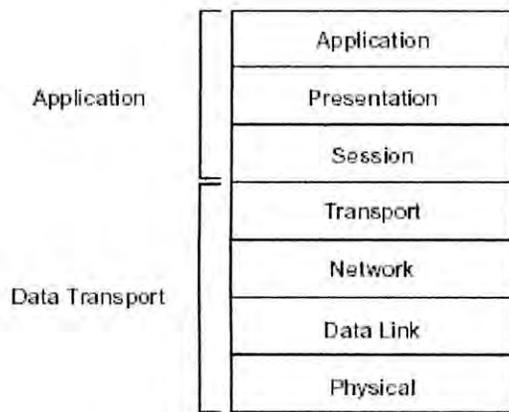
Figure 3.7 illustrates the seven-layer OSI reference model.



**Figure 3.7 the OSI reference model contains seven independent layers.**

#### Characteristics of the OSI Layers

The seven layers of the OSI reference model can be divided into two categories: *upper layers* and *lower layers* the *upper layers* of the OSI model deal with application issues and generally are implemented only in software. The highest layer, application, is closest to the end user. Both users and application-layer processes interact with software applications that contain a communications component. The term upper layer is sometimes used to refer to any layer above another layer in the OSI model. The *lower layers* of the OSI model handle data transport issues. The physical layer and data link layer are implemented in hardware and software. The other lower layers generally are implemented only in software. The lowest layer, the physical layer, is closest to the physical network medium (the network cabling, for example), and is responsible for actually placing information on the medium. Figure 1-3 illustrates the division between the upper and lower OSI layers.



**Figure 3.8** Two sets of layers make up the OSI layers.

### ***Protocols***

The OSI model provides a conceptual framework for communication between computers, but the model itself is not a method of communication. Actual communication is made possible by using communication protocols. In the context of data networking, a *protocol* is a formal set of rules and conventions that governs how computers exchange information over a network medium. A protocol implements the functions of one or more of the OSI layers. A wide variety of communication protocols exist, but all tend to fall into one of the following groups: *LAN protocols*, *WAN protocols*, *network protocols*, and *routing protocols*. *LAN protocols* operate at the network and data link layers of the OSI model and define communication over the various LAN media. *WAN protocols* operate at the lowest three layers of the OSI model and define communication over the various wide-area media. *Routing protocols* are network-layer protocols that are responsible for path determination and traffic switching. Finally, *network protocols* are the various upper-layer protocols that exist in a given protocol suite.

## **3.5 IP Addressing**

A host is a computer or device, such as a router, on a TCP/IP network. Every TCP/IP host is uniquely identified by its IP address. An IP address consists of a network ID and a host ID. If two different hosts belong to the same network, they have the same network ID. The two hosts will have different host ID's and can communicate with each other locally without going through a router. If two hosts have different network ID's, they belong to different segments on the network. They must communicate with each other remotely through a router or default gateway. An IP address consists of 32 binary bits, where each bit is either a 0 or 1. We first write the 32 bits into four 8-bit numbers separated by a period in between each 8-bit number. 11000001. 00001010. 00011110. 00000010 (IP

address in binary form) To convert the IP address from binary to decimal form, we convert each of the four 8-bit numbers according to the following table:

8 Bit (octet)	1	1	1	1	1	1	1	1
Decimal (power of 2)	128	64	32	16	8	4	2	1

The above IP address would translate into

$$11000001 = 128 + 64 + 1 = 193$$

$$00001010 = 8 + 2 = 10$$

$$00011110 = 16 + 8 + 4 + 2 = 30$$

$$00000010 = 2$$

So in decimal form, the IP address is:

193. 10. 30. 2

The network ID in the address consists of a certain number of bits starting from the left. The host ID consists of the remaining bits.

Example 1. The network ID might consist of the first 8 leftmost bits. Then the host ID consists of the remaining 24 bits.

01010001. 00001010. 00011110. 00000010 (IP address in binary form)

[---8 bits---] [-----24 bits-----]  
 [--Net ID--] [-----Host ID-----]

01010001. 10001010. 00011110. 00001010 would be an IP address that has the same network ID but a different host ID. The two IP addresses in decimal form are respectively 81.10.30.2 and 81.138.30.10. The two IP addresses are class A addresses because the first eight bits has a decimal value that lies in the range 1 through 126. The network segment they both belong to is known as 81.0.0.0, where zeros have been substituted in the host ID bits.

Example 2. The network ID consists of the first 16 leftmost bits and the host ID consists of the next 16 bits. 10000001. 00001010. 00011110. 00000010 (IP address in binary form)

[-----16 bits -----] [-----16 bits-----]  
 [-----Net ID-----] [-----Host ID-----]

10000001. 00001010. 00011111. 00010010 would be an IP address that has the same network ID but a different host ID. The two IP addresses in decimal form are respectively, 129.10.30.2 and 129.10.31.18. The two IP addresses are class B addresses because the first eight bits has a decimal value that lies in the range of 128 -191. The network segment that both IP addresses belong to is named 129.10.0.0, where zeros have been substituted in the host ID bits.

Example 3. The network ID consists of the first 24 leftmost bits and the host ID consists of the next 8 bits. 11000001. 00001010. 00011110. 00000010 (IP address in binary form)

[-----24 bits-----] [---8 bits---]  
[-----Net ID-----] [---Host ID--]

11000001. 00001010. 00011110. 00000110 would be an IP address that has the same network ID but a different host ID. The two IP addresses in decimal form are respectively, 193.10.30.2 and 193.10.30.6. The two IP addresses are class C addresses because the first eight bits has a decimal value that lies in the range of 192-223. The network segment that both IP addresses belong to is named 193.10.30.0, where zeros have been substituted in the host ID bits.

### Default Subnet Masks for Class A, Class B, and Class C addresses

How can we identify which bits belong to the network ID and which bits belong to the host ID? The answer is to use a subnet mask. Here is how we write the subnet mask in binary bit form. If a certain bit is part of the network ID, we write a 1 in the corresponding bit of the subnet mask. If a certain bit is part of the host ID, we write a 0 in the corresponding bit of the subnet mask. Going back to examples 1 through 3, we have

Example 1. The network ID might consist of the first 8 leftmost bits. Then the host ID consists of the remaining 24 bits. 01010001. 00001010. 00011110. 00000010 (IP address in binary form)

[---8 bits---] [-----24 bits-----]  
[---Net ID--] [-----Host ID-----]

The subnet mask is therefore [11111111] [00000000. 00000000. 00000000]

Note that the two IP addresses below are on the same network segment because their bits corresponding to a '1' in the subnet mask are identical.

01010001. 00001010. 00011110. 00000010 (IP address 81.10.30.2)  
01010001. 10001010. 00011110. 00001010 (IP address 81.138.30.10)  
11111111. 00000000. 00000000. 00000000 (subnet mask 255.0.0.0)  
For a Class A address, the default subnet mask is 255.0.0.0

Example 2. The network ID consists of the first 16 leftmost bits and the host ID consists of the next 16 bits.

10000001. 00001010. 00011110. 00000010 (IP address in binary form)

[-----16 bits-----] [-----16 bits-----]  
[-----Net ID-----] [-----Host ID-----]

The subnet mask is therefore [11111111. 11111111] [00000000. 00000000]

Note that the two IP addresses below are on the same network segment because the bits corresponding to a '1' in the subnet mask are identical.

10000001. 00001010. 00011110. 00000010 (IP address 129.10.30.2)  
10000001. 00001010. 00011111. 00010010 (IP address 129.10.31.18)  
11111111. 11111111. 00000000. 00000000 (subnet mask 255.255.0.0)

For a Class B address, the default subnet mask is 255.255.0.0

-----  
Example 3. The network ID consists of the first 24 leftmost bits and the host ID consists of the next 8 bits.

11000001. 00001010. 00011110. 00000010 (IP address in binary form)

[-----24 bits-----] [---8 bits---]  
[-----Net ID-----] [---Host ID--]

The subnet mask is therefore [11111111. 11111111. 11111111] [00000000]

Note that the two IP addresses below are on the same network segment because the bits corresponding to a '1' in the subnet mask are identical.

11000001. 00001010. 00011110. 00000010 (IP address 193.10.30.2)  
11000001. 00001010. 00011110. 00000110 (IP address 193.10.30.6)  
11111111. 11111111. 11111111. 00000000 (subnet mask 255.255.255.0)

For a Class C address, the default subnet mask is 255.255.255.0

### 3.6 Subnetting

Suppose you acquire one single network ID. At this stage, your network can consist of hosts all on one network segment. If you want to set up a network with more than one segment, you must subdivide your network into subnets. The method for subdividing the network is known as subnetting. Suppose you have a Class B network of 129.10.0.0. 10000001. 00001010. yyyyyyyy . yyyyyyyy (IP address in binary form)

[-----16 bits-----] [-----16 bits-----]  
[-----Net ID-----] [-----Host ID-----]

The first 16 bits form the network ID and the last 16 bits form the host ID. To form different host ID's, we can vary the bits in each of the last 16 bits. To subdivide this network, we keep the network ID the same. However, we will use some bits from the host ID to form a subnet ID as follows.

[-----16 bits-----] [5 bits] [-----11 bits-----]  
[-----Net ID-----] [Subnet] [-----Host ID-----]

We set the rule that if two hosts are on the same network segment, they must have the same network ID and the same subnet ID. That is, the two hosts must have identical bits in the network ID and subnet ID. If two hosts have identical network ID's but have different subnet ID's, they are on different subnet segments. Thus, if we can form many different subnet ID's, we have formed many segments in our network.

Before subnetting: one network; different hosts formed from 16 bits

Now: subnet segments formed from 5 bits; different hosts formed from 11 bits

So the rule of thumb is: If we subdivide a network into more subnets, each subnet segment will have fewer potential hosts. How do we write the subnet mask for the above subnetted network? Recall that if two hosts are on the same segment, their network ID and subnet ID must be identical. In the above subnetted network, there are 16 bits in the network ID and 5 bits in the subnet ID. So we write a '1' for each of these bits in the subnet mask and a '0' for each bit in the host ID

[11111111] [11111] [000. 00000000] Subnet mask

[-----16 bits-----] [5 bits] [-----11 bits ----]

In decimal form, this subnet mask is 255.255.248.0 (because 11111000 = 248; 11111111 = 255)

Given the above subnetted network 129.10.0.0 with subnet mask 255.255.248.0, here are two examples of IP addresses on the same subnet segment.

10000001. 00001010. 10010 011. 00010000 (129.10.147.32) IP address 1

10000001. 00001010. 10010 100. 01010101 (129.10.148.85) IP address 2

11111111. 11111111. 11111 000 . 00000000 (255.255.248.0) subnet mask

Notice that each '1' in the subnet mask corresponds to a bit that both IP address must have identical.

10000001 . 00001010 . 10011 011 . 0010000 (129.10.163.32) is an IP address that does not have all bits identical in the bits where there is a '1' in the subnet mask. Therefore, this IP address is on a different subnet segment (remote).

So given two IP addresses and a subnet mask, we can compare the binary bits corresponding to those with a '1' in the subnet mask. If those bits are identical, the two IP addresses belong to the same subnet segment. Otherwise, the two IP addresses belong to two different subnets.

-----  
Calculating Number of Subnets and Hosts in each Subnet Given a network ID and a subnet mask,

How many subnets can we form? How many hosts can we form on each subnet?

The answers to both questions will depend on powers of 2.

Suppose we have the following

[16 bits] [3 bits] [13 bits]

[Network] [Subnet] [Host]

There are three bits used to form the subnet ID. Each bit can have a value of 0 or 1. Writing all the possibilities for the subnet ID, we have 000, 001, 010, 011, 100, 101, 110, and 111 by rule, we will not accept subnet ID's with all 0's and all 1's. Therefore, 6 possible subnets can be formed. Another way to calculate this is to note that in the example, we have three bits and each bit can have two possible values. Therefore, the total possible number of subnets will be  $(2 \times 2 \times 2) - 2$ , where we subtract two to eliminate the all 0's and all 1's cases. In general, the total number of subnets will be  $(2^S) - 2$ , where S is the number of bits in the subnet ID. (In math symbols, Notice that each '1' in the subnet mask corresponds to a bit that both IP address must have identical.

10000001 . 00001010 . 10011 011. 0010000 (129.10.163.32) is an IP address that does not have all bits identical in the bits where there is a '1' in the subnet mask. Therefore, this IP address is on a different subnet segment (remote).

So given two IP addresses and a subnet mask, we can compare the binary bits corresponding to those with a '1' in the subnet mask. If those bits are identical, the two IP addresses belong to the same subnet segment. Otherwise, the two IP addresses belong to two different subnets.

---

Calculating Number of Subnets and Hosts in each Subnet Given a network ID and a subnet mask,

How many subnets can we form? How many hosts can we form on each subnet?

The answers to both questions will depend on powers of 2.

Suppose we have the following

[ 16 bits ] [ 3 bits ] [ 13 bits ]  
 [Network] [Subnet] [Host]

There are three bits used to form the subnet ID. Each bit can have a value of 0 or 1. Writing all the possibilities for the subnet ID, we have 000 , 001, 010, 011, 100, 101, 110, 111 By rule, we will not accept subnet ID's with all 0's and all 1's. Therefore, 6 possible subnets can be formed. Another way to calculate this is to note that in the example, we have three bits and each bit can have two possible values. Therefore, the total possible number of subnets will be  $(2 \times 2 \times 2) - 2$ , where we subtract two to eliminate the all 0's and all 1's cases. In general, the total number of subnets will be  $(2^S) - 2$ , where S is the number of bits in the subnet ID. (In math symbols,

10000011 . 01101011 . 101 00000 . 00000011 (131.107.160. 3)  
 11111111 . 11111111 . 111 00000 . 00000000 (subnet mask)

In addition to looking at the bits and subnet mask, we can tell that the above IP address lies on another subnet by the fact that the decimal value of the last two octets is 160.3. Recall that we found previously that for this subnet, the last two octets in the IP address must have a decimal value somewhere between 32.1 and 63.254.

(In decimal numbers,  
160.3 is greater than 160  
160 is greater than 64  
64 is greater than 63.254  
Therefore, 160.3 is greater than 63.254)

Next, we present a shortcut for finding the range of IP addresses for a subnet with a given subnet mask.

-----  
Blocking / Incrementing Shortcut In the previous example, we had the following situation in decimal form:

Network 131.107. y. z (Class B address)

Subnet mask: 255.255.224. 0

We found previously that the possible range of one of the subnets is: 131.107.32.1 through 131.107.63.254  
Shortcut Method To arrive at that result, we worked with binary bits. Next, we will use a shortcut to arrive at the same answer using only decimal numbers. This shortcut avoids the use of binary numbers.

Step 1: Take the rightmost non-zero number of the subnet mask (224). Subtract this number from 256. (256 - 224 = 32) This is the increment.

Step 2: Append the increment to your network address. (131.107. 32. z)

Step 3: Repeatedly add the increment (32) to the result in step 2 until you reach the original rightmost non-zero number of the subnet mask (224).

131.107. 64.z = 131.107. ( 32 + 32) .z

131.107. 96.z = 131.107. ( 64 + 32) .z

131.107.128.z = 131.107. ( 96 + 32) .z

131.107.160.z = 131.107. (128 + 32) .z

131.107.192.z = 131.107. (160 + 32) .z

131.107.224.z but we do not accept this one because 224 corresponds to the case of a subnet ID with all 1's. (224 = 11100000)

Step 4: Write out the smallest and largest IP addresses for your subnets. For our first subnet, we have 131.107.32.z. The smallest possible value is 131.107.32.1 because our host ID cannot have all 0's. The largest value on this subnet must be smaller than the start of the next subnet, which is 131.107.64.1. In addition, our host ID cannot have all 1's. So we eliminate 131.107.63.255 as a valid IP address. The largest value for an IP address on this subnet would be 131.107.63.254. \*\*\*\*

Note:

11111111 . 11111111 . 11100000 . 00000000 (subnet mask 255.255.224.0)

10000011 . 01101011 . 001 11111 . 11111110 (131.107.63.254, accepted)

10000011 . 01101011 . 001 11111 . 11111111 (131.107.63.255, largest binary value but not accepted because of all 1's in host ID)

10000011 . 01101011 . 010 00000 . 00000001 (131.107.64.1, smallest value for next subnet)

Using the above logic, we find these to be range of values for all 6 subnets:

Subnet 1: 131.107. 32. 1 through 131.107. 63.254  
Subnet 2: 131.107. 64. 1 through 131.107. 95.254  
Subnet 3: 131.107. 96. 1 through 131.107.127.254  
Subnet 4: 131.107. 128.1 through 131.107.159.254  
Subnet 5: 131.107. 160.1 through 131.107.191.254  
Subnet 6: 131.107. 192.1 through 131.107.223.254

---

Example 2 (Class A IP addresses)

Network: 10. X. y. z

Subnet Mask 255.240.0.0

What are the ranges of IP addresses for all subnets?

240 is the rightmost nonzero number in the subnet mask.

$256 - 240 = 16$  (increment)

Append the increment to the network address until you reach 240.

10. 16.0.z

10. 32.0.z = 10. (16 + 16) .0 .z

10. 48.0.z = 10. (32 + 16) .0 .z

10. 64.0.z = 10. (48 + 16) .0 .z

10. 80.0.z and so on

10. 96.0.z

10.112.0.z

10.128.0.z

10.144.0.z

10.160.0.z

10.176.0.z

10.192.0.z

10.208.0.z

10.224.0.z

10.240.0.z but we do not accept this one because this corresponds to all 1's in the subnet ID.

Subnet 1: 10. 16. 0. 1 through 10.31.255.254 \*\*

Subnet 2: 10. 32. 0. 1 through 10.47.255.254

Subnet 3: 10. 48. 0. 1 through 10.63.255.254

Subnet 4: 10. 64. 0. 1 through 10.79.255.254

and so forth

\*\* Note:

11111111 . 11110000 . 00000000 . 00000000 (subnet mask 255.240.0.0)

00001010 . 00011111 . 11111111 . 11111110 (10.31.255.254)

is the largest possible acceptable IP address on the same subnet that is less than:

00001010 . 00100000 . 00000000 . 00000001 (10.32. 0. 1)

---

Creating Your TCP/IP Chart

To get your answers quickly during the exam, you should use a chart that you've written down during the astronomy tutorial.

A 1 - 126, N = 8 bits

B 128 - 191, N = 16 bits

C 192 - 223, N = 24 bits, where N = how many bits in Network ID

$N + S + H = 32$ , where S = # of bits in Subnet ID, H = # of bits in Host ID

# bits	subnet	# subnets	increment		# hosts	$= (2^H) - 2$
In mask (S)	mask	$(2^S) - 2$	$256 - \text{mask}$	A	B	C
2	192	2	64	4M	16K	62
3	224	6	32	2M	8K	30
4	240	14	16	1M	4K	14
5	248	30	8	500K	2K	6
6	252	62	4	250K	1K	2
7	254	126	2	130K	510	----
8	255	254	1	65K	254	----

Table 3.2 Subnetting Mask

You only need to remember a few things to derive the whole chart.

The second column is the sum of  $128 + 64$ ,

$$128 + 64 + 32$$

$$128 + 64 + 32 + 16, \text{ and so on}$$

The third column is  $(2^S) - 2$ , starting with  $S = 2$

The other columns can be derived through dividing by 2.

### 3.7 Software Products:

Along with installing a network, a corporate also needs to purchase or download from the internet any software products it may need. Without the correct software, a corporate will not be able to access or offer the services that it decides are necessary. These include driver software such as TCP/IP drivers, application software such as email programs or word processors and server software such as file servers or a web server. Figure shows how the different network software pieces interact of a Macintosh and a Windows machine. At the lowest level of a machine, a hardware driver communicates directly with the network interface card installed on a machine. Software drivers supporting the different software protocols such as AppleTalk, IPX and TCP/IP act as intermediaries, communication with both the hardware drivers below them and the applications and servers above them. Applications and servers provide and interface to the user. Just like

in the OSI model, a layered approach is used. This insulates the upper layers from the requirements of communicating with the specific hardware present of a machine. This allows all application and server software to function identically regardless of the brands of equipment installed of a machine.

## **The software installed on a workstation**

### **3.7.1 Driver Software**

There are two parts to the driver software as shown in figure, a hardware driver and a network driver. The hardware driver usually comes on a disk with the network card, along with instructions on how to install it. Some of the network drivers come pre-installed on computers, while others need to be bought. On a Macintosh, the AppleTalk drivers have always been a part of the standard system software. The MacTCP software, the TCP/IP offered by Apple, was not part of the standard system software until the release of System 7.5 several years ago. Before that time, MacTCP was a separately purchased product. All machines shipped over the last few years, and all currently shipping machines include MacTCP but any machine that is not running System 7.5 will require that a copy of MacTCP be bought for it. Of all the Windows varieties, only Windows 3.1 and earlier do not include network drivers as part of the standard system, it requires an additional product be bought which will add a WinSock interface to Windows, allowing all TCP/IP based applications and servers to run. Windows for Workgroup, Windows 95, and Windows NT all include the necessary network drivers as part of the standard system software.

### **3.7.2 Application Software**

Applications are programs such as Microsoft Word or ClarisWorks that run on a workstation. They allow a computer user to perform a task on the computer such as write a paper, check their email, or browse the web. When selecting applications, a corporate office can set a standard that all the offices have to follow, or they can allow each branch office to choose their own. By establishing a standard, a corporate office can assure staff and related people to access their files from anywhere in the office. A standard will also make training and support easier since entire school will only use a controlled group of applications. Without a standard, each office can choose their individual applications that their staff is already familiar with or which serve a specific purpose such as multimedia authoring. A corporate office can also select different standards for different branches, depending on the requirements of that particular office. The best approach for corporate office is to establish a standard for everyday applications such as word processors or email programs, but to allow freedom when choosing special purpose software. This

allows branch office staff to choose software to fit their special needs still making papers and other common files easily shared among different branches.

Applications fall into two categories, stand-alone and clients. The first are programs such as those listed in table, which do not require interaction with other machines to function. They are available from many vendors, offering different capabilities and costs. A corporate office should compare all the alternatives for a given type of program, and select the one offering the best price and feature match. A corporate office should consider buying integrated packages that offer a word processor, a spreadsheet and a database in single product. A corporate office should also buy only the capabilities they need or expect to need in the future. For example, if a corporate office is going to select an integrated package as a standard, it should consider if it needs the extra capabilities of Microsoft Office. If not, the corporate office can save money by selecting ClarisWorks or Microsoft Works instead.

Application	Common products
Word processor	Microsoft Word, WordPerfect
Spreadsheet	Microsoft Excel, Lotus 1-2-3
Integrated Packages	Microsoft Office, Microsoft Works, Claris works
multimedia authoring	Macromedia Director, Hyper Studio, Super Card

Table 3.3 some common stand alone application software

The second groups of applications are ones such as those listed in table, which require a network to function. Many of the applications in this category are available as either shareware or freeware, and offer similar or better performance than the competing commercial products. The corporate office should investigate the free alternative before it spends money on commercial products. In addition, the choice of client software may depend on the server software selected. For example, if the corporate office decides to standardize on Internet email, then they must choose an email client such as Eudora that supports Internet email.

Application	Common products
Email	Eudora, Microsoft Word, Quick Mail
Web Browser	Netscape Navigator, NCSA Mosaic, Internet Explorer
Video conferencing	CU-See Me

Table 3.4 some common client software

### 3.7.3 Server Software

Server software runs on a machine and provides various services. Often server software requires a dedicated machine for it to run on, and even when it does not require a dedicated machine, server performance is usually better if applications are not run on the machine. The server software will also run faster if installed on a faster computer. For this reason, the corporate office needs to buy fast machines for use as servers. Server software exists for both Macintosh and PC platforms, as well as for UNIX machines. UNIX machines are complex, high performance workstation often used in the engineering world. Most of the platforms support all the servers as shown in the table, although some brands of server software will only run on specific platforms.

Server functions	Macintosh	Windows 3.1,95	Windows NT	Novell Netware	UNIX
File Server	Yes	No	Yes	Yes	Yes
Print Server	Yes	No	Yes	Yes	Yes
Multimedia Server	Yes	No	Yes	Yes	Yes
Email Server	Yes	Yes	Yes	Yes	Yes
Web Server	Yes	Yes	Yes	Yes	Yes
Administrative Record Keeping	Yes	Yes	Yes	Yes	Yes

Table 3.5 Server functions supported by different platforms

#### 3.7.3.1 File and print Server:

There are three main choices when selecting a file and print Server, AppleShare, Windows NT, and Novell Netware. As shown in table, they offer many of the same features. All of them support both Macintosh and Windows 3.1 clients, but if a corporate office using other clients, such as Windows 95 or OS/2, they will need to select an appropriate server that can support those clients. The installation and maintenance of the file server software are also issues that need consideration. File servers are complex packages requiring training to be used optimally. If a staff member already has experience with one of the choices, then the corporate office can save time and money by not needing to train a server administrator on a new product.

Features	AppleShare	Windows NT	Novell Netware
Hardware platform	Macintosh	PC compatible	PC compatible
Maximum Number of concurrent users	50-100	1000	1000
Approximate cost for 100 users	\$1400	\$850	\$4300
Performance	Yes	Yes	Yes
Print serving	Excellent	Good	Good
Ease of installation	Excellent	Good	Good
Reliability	Very Good	Excellent	Excellent
<b><u>Clients supported :</u></b>			
DOS/Windows NT	Yes	Yes	Yes
Macintosh	Yes	Yes	Yes
Windows NT	No	Yes	Yes
Windows 95	No	Yes	Yes
OS/2	No	No	Yes

Table 3.6 Features available on different file servers

Multimedia server: Multimedia comes in a variety of forms. It includes audio and video segments often on multimedia CD-ROMs. Depending on the needs of the corporate office, the same platforms acting as the file server can also act as the multimedia server. All three platforms acting as the file server can also act as the multimedia server. All three platforms support the sharing of multiple CD-ROMs. Additional software can be bought for Windows NT and Novell Netware that will allow them to serve audio and video segments, the optimal solution is to use a UNIX system with software specifically designed to serve these segments. This can also cost a lot of money and requires the corporate office to support a UNIX system.

### 3.7.3.2 Email server:

Selecting an email server can be a complex problem. Each brand, such as Microsoft mail or Quick mail, uses its own mail protocols. The internet also supports several different protocols. All of these email protocols are incompatible with each other without software to translate between protocols. Server programs called software gateways, will translate between most of the different email protocols, but a corporate office can save money and avoid problems by standardizing on a single protocol. The recommended email solution combines two protocols used on the internet, Simple Mail Transfer Protocol (SMTP) and Post Office Protocols (POP). The first transmits email from the sender to the receiver's

email server, and the second allows the receiver to view their email. As shown in table, server software to support the internet protocols is available for all three file server platforms, and the file server can also act as an email server. As an added benefit, all the software listed in the table is available at no cost. Unfortunately, these email servers can't handle a large number of users and the performance of the servers decrease after several hundred email accounts are in use. An UNIX machine act as an email server for the corporate office requiring better performance, although this is not recommended unless a corporate office has an UNIX machine running another purpose or absolutely requiring higher performance.

<b>platforms</b>	<b>SMTP and POP server software</b>
Macintosh	Apple internal mail server
Windows NT	NT mail
Netware	Mercury

**Table 3.7 Email server software available for different platforms**

### 3.7.3.3 Web server:

Web servers are also available for the same three platforms that file servers and email servers can run out, and often share the same machine used as a file and email server. Table lists some of the available choices. The wide range of choices allows a corporate office a lot of freedom selecting the web server. Some issues to consider while selecting a products are cost, performance and how easily and in what programming one can expand the web server. Some commercial products may cost up to \$1000. Performance is also an issue, but is tied to the price. The last consideration is how the web server offers access to external programs. These programs called Common Gateway Interfaces (CGIs), handle the advanced actions on a web page such as frame processing. Each platform offers a different interface to CGIs, and CGIs designed for one program is not usually useable on another. Again, a UNIX machine can act as a web server for a corporate office requiring better performance, although this is not recommended unless a corporate office has an UNIX machine running another purpose or absolutely requiring higher performance.

<b>Platforms</b>	<b>Web server software</b>
Macintosh	Webster, NetPresenz
Windows NT	Netscape server
Netware	Novel web server
UNIX	NCSA http, CERN httpd, Netscape server

**Table 3.8 Web server software available for different platforms**

### **3.7.3.4 Administrating record keeping system:**

A corporate office usually buys an administrative record keeping system as a complete system containing all the necessary hardware and software needed to install and use the system. It will include both server and client software in the package. The system should also be customizable, allowing changes in its reporting and record keeping capabilities without requiring a new system to be bought.

Most administrative systems operate in one or two environments; either centralized or distributed. In a centralized environment, a central computer stores all the information, often at the administrative wing of the corporate office. All requests for the information travel across the corporate office LAN to the central office where the system fulfills the request for information travel across the corporate office LAN to the head office and returns with the response.

In a distributed environment, all the branch offices store their records and when anybody from another office requires information, the machine he is dealing with sends a request across the LAN and the response is generated from the database.

Another option is that a corporate office can develop a custom administrative record keeping system; this would require the corporate office to hire a full-time computer consultant to design, implement, and support the system. The software the consultant develops should meet the requirements of the office. Comparing the costs a corporate office has to take the decision about the administrative record keeping system.

## **3.8 Cost estimation**

While developing budgets a corporate office will need for cost estimation for the corporate office network. This section deals with details of the costing involved.

- General Networking costs
- Network equipment costs
- Labour costs
- Computer costs
- Software costs

## **Chapter 4**

### **Designing**

## 4 Designing

### 4.1 Hierarchical network design

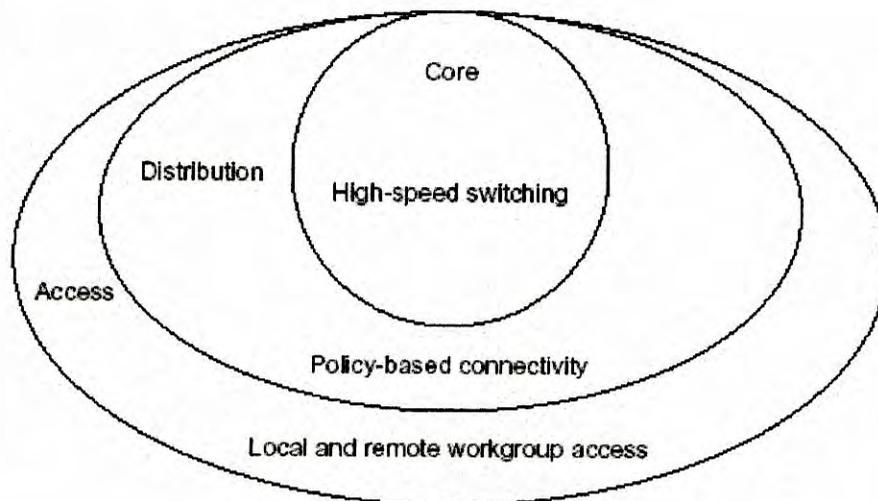


Figure 4.1 Hierarchical network design model.

## 4.2 Logical Design

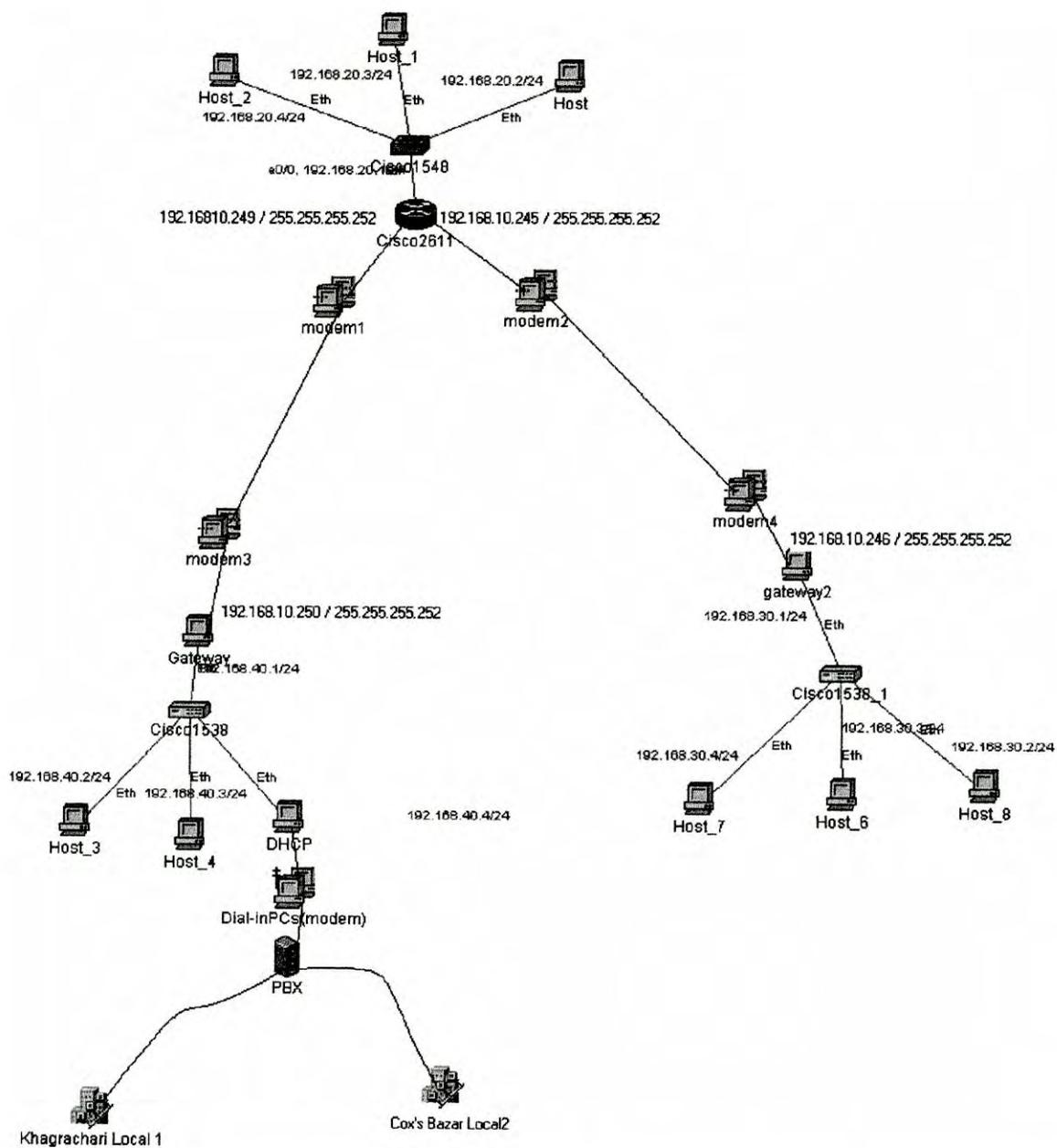


Figure 4.2: Logical design



## 4.4 Device Selection

### 4.4.1 Router Selection

Among the manufacturer of networking devices Cisco is pioneer. Its product is reliable and available in our country. So we are discussing only Cisco routers. This section highlights some of the products that are suited for the various company sites.

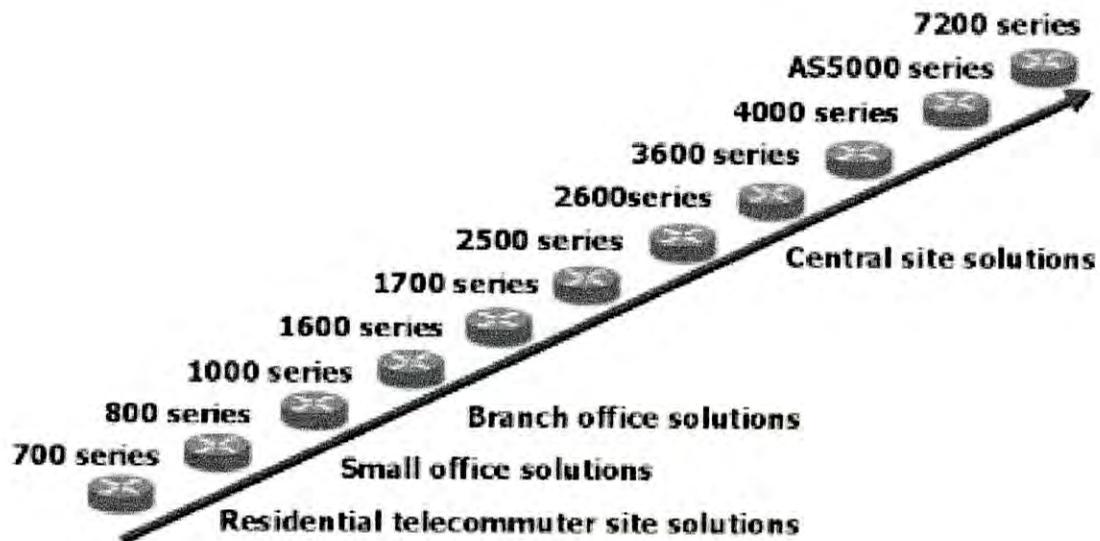


Figure 4.5 Router selection

From the above options 2611 model of 2600 series router is best suited our design.

## 4.4.2 Switch Selection

Cisco offers a wide range of switch products

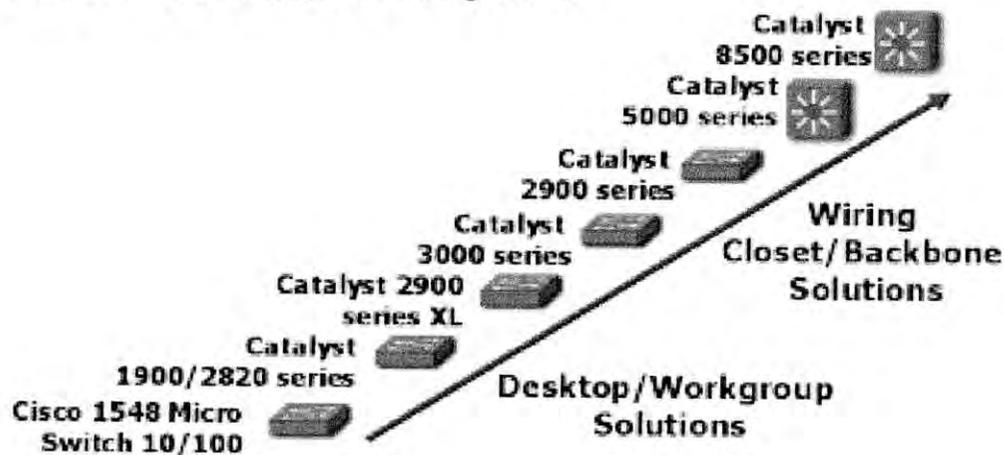


Figure 4.6 Switch selection

The series of devices displayed in the image reflects a snapshot of some Cisco offerings. Cisco's product line is continuously evolving in response to customer needs and other technology migration issues.

### Selection Issues

Need for 10 Mbps, 100 Mbps, or 1000 Mbps on media  
Need for trunking and inter-switch links  
Workgroup segmentation (VLANs)  
Port density needs  
Different user interfaces  
Since one of the major advantages of switches is the variety of link speeds that they offer, one key issue to consider is what dedicated access to 10 or 100 Mbps is required. As you move up to higher end Catalyst switches, port density (the number of available ports on the switch) gets very high (well over 100 Fast Ethernet ports per switch). The upper end switches can also integrate modules to switch packets with ATM.

So considering various issues we decided to use Catalyst 2900.

### 4.4.3 Hub Selection

Cisco offers a wide range of hub products

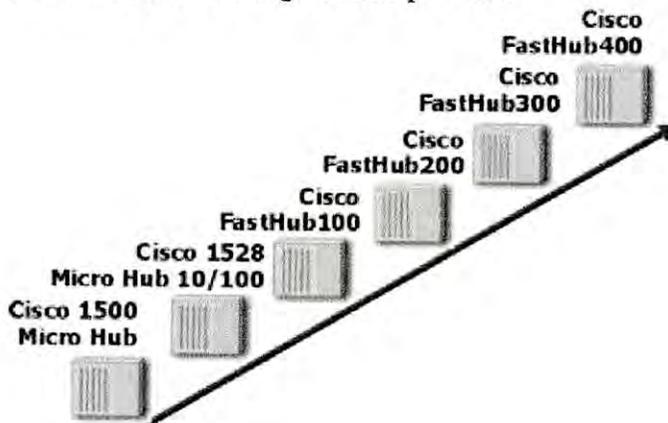


Figure 4.7 Hub selection

### Selection Issues

Hub selection issues include: Need for 10 Mbps or 100 Mbps on media Port Density  
Need for management console Easy Operations Before implementing hubs, we assess which workstations need 10 Mbps and which higher end workstations need an upgrade to 100 Mbps. Lower-end hubs offer only 10 Mbps while mid-range hubs auto sense the data rates of Ethernet frames and provide for either 10 Mbps or 100 Mbps. This middle range can handle both current and future bandwidth needs. Hubs allow for a variety of port densities and we can stack hubs to get multiples of the hubs densities. The series of devices displayed in the image reflects a snapshot of some Cisco offerings. Cisco's product line is continuously evolving in response to customer needs and other technology migration issues.

Most hubs are simple to plug in and operate. For most hubs, there is no console port. If you want a managed hub that has an integral console, select from the higher end hub series.

So considering various issues we decided to use AcerHub116 and Cisco 1528MicroHub10/100.

## 4.5 IP Addressing

For WAN connection

Net ID : 192.168.10.0

Out of 8 bits first 6 bit taken for subnetting so

Subnet mask : 255.255.255.252

Total subnet (internal): 64

Usable : 62

Total host per subnet : 4

Usable host per subnet: 2

Subnet no.	Subnet Address	Usable hosts
1	192.168.10.244	192.168.10.245 & 192.168.10.246
2	192.168.10.248	192.168.10.249 & 192.168.10.250

Table 4.1 WAN connection

For LAN connection

Office location	Net ID	Subnet Mask	Usable Host Range
Head office	192.168.20.0	255.255.255.0	192.168.20.1~192.168.20.254
Branch 1(Sylhet)	192.168.30.0	255.255.255.0	192.168.30.1~192.168.30.254
Branch 2(Ctg.)	192.168.40.0	255.255.255.0	192.168.40.1~192.168.40.254
*Local 1(Khag)	192.168.50.0	255.255.255.0	192.168.50.1~192.168.50.254
*Local 2 (Cox's)	172.16.0.0	255.255.0.0	172.16.0.1~172.16.254.254

Table 4.2 LAN connection

\*These IP will be assigned dynamically

## 4.6 Router Configuration

```
Router >enable
```

```
Router # config terminal
```

```
Router (config) enables hostname TTJ
```

```

TTJ(coinfig)#enable password ****
TTJ(coinfig)#interface Ethernet 0
TTJ(coinfig-if)#ip address 192.168.20.1 255.255.255.0
TTJ(coinfig-if)#no shutdown
TTJ(coinfig-if)#interface Serial 0
TTJ(coinfig-if)#ip address 192.168.10.245 255.255.255.252
TTJ(coinfig-if)#no shutdown
TTJ(coinfig-if)#interface Serial 1
TTJ(coinfig-if)#ip address 192.168.10.249 255.255.255.252
TTJ(coinfig-if)#encap ppp
TTJ(coinfig-if)#no shutdown
TTJ(coinfig-if)#router igrp 110
TTJ(coinfig-if)#network 192.168.10.0

```

## 4.7 IP Connectivity

The large corporate companies that we visited not connected to WAN. Only some limited users have internet connection. But these connections are not through their network for security prevention. In our design WAN connection is omitted but if any one want to connect them with internet they can easily connect by adding a card and a real IP connection in router.

## 4.8 Cost Analysis

### 4.8.1 IPLC (International Private Leased Line Circuits)

Registration Fee: Tk. 20,000 (One Time)

Installation and Testing:

Sl.	Speed	Installation	Additional Charge for CPE* (Modem)
1	64 Kbps & 128 Kbps	Tk. 40,000	Tk. 90,000
2	192 Kbps to 512Kbps	Tk. 40,000	Tk. 1,90,000
3	576 Kbps to 1024Kbps	Tk. 45,000	Tk. 1,90,000
4	2048Kbps	Tk. 50,000	Tk. 3,20,000

\*CPE-Customer Premises Equipment

Table 4.3 installation and testing charges (IPLC)

**C) Rental Charges for 64 KBPS (Half Circuit) :**

Destination	Annual Charge (in lak Tk.)	Comment
Countries in IOR region (Asia, Europe, Oceanic and Africa)	9	For corporate users
	6.75	For Internet Service Providers & Software Exporters earning US\$ 0.4 to 10 million per year in foreign currency.
	5.40	Software Exporters earning more than US\$ 10 million per annum in foreign exchange.
Countries outside IOR (American Region)	11.60	For corporate users
	8.70	For Internet Service Providers & Software Exporters earning US\$ 0.4 to 10 million per year in foreign exchange.
	6.96	Software Exporters earning more than US\$ 10 million per annum in foreign exchange.

Table 4.4 Rental charges (IPLC)

For Inland Portion of the circuit, usual charges will apply, except registration & installation charge; maximum rental charges will be Tk. 1, 50,000 per annum. Distance will be calculated from respective earth station. Minimum commitment time is 1 year. Minimum 3 months notice is necessary for discontinuation.

**D) Charges for Temporary Use:**

1. Installation Charge : As above
2. Rental Charge (64 Kbps half Circuit) : Tk. 100,000 per month or Tk.5, 000 per day  
Tk. for IOR and Tk. 120,000 per month or 6, 000 per day for others.

3. CPE Rental Charge: Per month 10% of the CPE Charge. Per Day 1% of CPE Charge.
4. Minimum Charge: Equivalent to 5 days charge.

#### 4.8.2 National (Point to Point High Speed Data Circuits)

**Registration Fee:** Tk. 10,000 (One Time)

##### **Installation and Testing (One Time):**

Sl.	Speed	Installation	Additional Charge for CPE* (Modem)
1	64 Kbps & 128 Kbps	Tk. 20,000	Tk. 90,000 for each end
2	192 Kbps to 512Kbps	Tk. 20,000	Tk. 1,90,000 for each end
3	576 Kbps to 1024Kbps	Tk. 25,000	Tk. 1,90,000 for each end
4	2048Kbps	Tk. 30,000	Tk. 3,20,000 for each end

\*CPE-Customer Premises Equipment

Table 4.5 Installation and testing charges (national point to point)

Installation charges shall be payable to the respective head of accounts through channels.

##### **C. Annual Rental Charges (for 64 KBPS):**

- First 30 KM : Tk. 96,000
- From 30 to 100 KM : Tk. 96,000+Charges of Additional Distance @ TK 1000 Per Kilometre.
- From 100 to 400 KM : 166,000+Charges of Additional Distance @ TK 800 Per Kilometre.
- Beyond 400 KM : Tk. 4,06,000 + Charges of Additional Distance @ TK 500 Per Kilometre.
- Per KM additional charge if Optical Fibre is used : Tk. 100

##### **D. Charges for Temporary Use:**

1. Installation Charge : As above

2. Rental Charge : Per month 10% of the annual charge. Per day 0.5% of Annual Charge.
3. CPE Rental charge : Per month 10% of CPE Charge. Per day 1% of CPE charge.

### 4.8.3 Local (Point to Point High Speed Data Circuits)

**A) Registration Fee:** Tk. 10,000 (One Time)

**B) Installation & Testing Charges (One Time):**

Same Exchange Area:

Sl.	Speed	Installation	Additional Charge for CPE* (Modem)
1	64 Kbps & 128 Kbps	Tk 10,000	Tk. 90,000 for each end
2	192 Kbps to 512Kbps	Tk. 15,000	Tk. 1,90,000 for each end
3	576 Kbps to 1024Kbps	Tk. 20,000	Tk. 1,90,000 for each end
4	2048 Kbps	Tk. 25,000	Tk. 3,20,000 for each end

\*CPE - Customer Premises Equipment

Table4.6 Installation and testing charges (local point to point)

Installation charges shall be payable to the respective head of accounts through proper ways.

**Different Exchange Area:**

In addition to the above charges Tk. 5,000 will be charged.

**C) Rental Charges (For 64 KBPS):**

Same Exchange Area:

1. Up to 6 KM : Tk. 60,000 per annum Tk. 5,000 per month
  2. for each additional KM : Tk. 1,500 per annum Tk. 125 per month
- Exchange Area:
1. Up to 10 KM : Tk. 72,000 per annum Tk. 6,000 per month
  2. For each additional KM : Tk. 1,500 per annum Tk. 125 per month

**D) Charges for Temporary Use:**

1. Installation Charge : As above
2. Rental Charge : Per month 10% of the annual charge. Per day 0.5% of annual charge.
3. CPE Rental Charge : Per month 10% of CPE charge. Per day 1% of CPE charge.
4. Minimum Charge : Equivalent to 5 days charge.

**4.8.4 E1 Access charge from PSTN to ISPS**

**A) Registration Fee:** Tk. 10,000 (One Time)

**B) Installation & Testing Charges (One time):**

Speed	Installation
2048 Kbps	Tk. 30,000

**Table 4.7 Installation and testing charges (E1)**

**C) Rental Charges:**

Rental Charges: TK. 76,000 per annum TK. 19,000 per quarter

Multiplication Factor for Multiple speeds of 64 Kbps:

Sl. No.	Speed	Multiplication Factor for Local	Multiplication Factor for National	Multiplication Factor for International
1	128	1.8	1.8	1.7
2	192	2.5	2.5	2.3
3	256	3.1	3.1	2.8
4	320	3.6	3.6	3.3
5	384	4.0	4.0	3.8
6	512	4.8	4.8	4.6
7	768	6.4	6.4	6.2
8	1024	8.0	8.0	7.8
9	2048	12.0	12.0	11.0

Table 4.8 Rental charges (E1)

#### 4.8.5 Tariff for X.25 Services

##### A) Installation Charge (One time):

X.25 Leased: TK. 3000

X.28 Leased: TK. 2000

##### B) Rental Charges:

X.25 Leased : TK. 15,000 per year

X.28 Leased : TK. 10,000 per year

X.28 dial up line : TK. 1,000 per year

### C) Volume Charges (Data Transfer Charges):

#### National:

Peak hour (9:00 to 17:00 hrs) : TK. 5 per Kilo Segment  
Mid peak hour (17:00 to 23:00 hrs) : TK 3 per Kilo Segment  
Off Peak hours (23:00 to 9:00 hrs) : TK 2 per Kilo Segment

#### International:

TK. 250 per Kilo Segment for any destination.  
\*1 Kilo Segment = 64 Kilo Byte.

Rental Charges of 1(one) year is payable in advance. Shifting Charge shall be equal to the installation charge of respective services.

### 4.9 Overall Cost

Type of Equipment	Number	Unit Cost	Cost
Cisco 2611Router	1	\$4000.00	\$4000.00
X.25 services	2	\$500.00	\$1000.00
Cisco Catalyst 2900	1	\$2000.00	\$2000.00
AcerHub116(24 port)	20	\$400.00	\$8000.00
Cisco 1528MicroHub10/100(5 port)	40	\$50.00	\$2000.00
CAT 5 UTP Cable	5000	\$0.2	\$1000.00
Fibre Optic	500	\$10	\$5000.00
Outlets			\$1000.00
Wall Cabinet	10	\$100.00	\$1000.00
Supplementary Cost			\$2000.00
Installation Costs			\$5000.00
<b>Grand Total</b>			<b>\$32000.00</b>

Table 4.9 Overall cost

## **Chapter 5**

### **Simulation**

## 5 Simulations

In laboratory simulation we tried to establish a network following our design. For unavailability and for lab limitation we were not able to model a exact network. In small scale we tested the perfection of our design. What we did

- ξ Establish three LANs modelled head office and two branches
- ξ Cabling the work station with UTP cable
- ξ Used a Router of 2600 series
- ξ Used a Switch in the head office LAN where the main server situated
- ξ Used Hub in other two branches LAN
- ξ Configured two gateway in to branches LAN
- ξ Connected head office LAN with Router by cat 5 UTP cable
- ξ Connected two get ways with Router by cat 5 UTP cable
- ξ Three windows 2000 server was configured in three LAN
- ξ Configured one DHCP server in one LAN and by dialled up from a workstation

## **Chapter 6**

### **Conclusion**

## 6 Conclusion

IT common business knowledge is that more can be learnt from a failure than from success. If true then many systems analysis have learned an awful lot. According to Sequent Computer Systems, 76 percent of 500 information technology director surveyed had experienced a major project failure. The top reasons cited for projects failing included requirements that changed as the project progressed, poor planning, unrealistic expectations, ambiguous objectives, lack of project resources, lack of user input, insufficient executive support, technical incompetence of the supplier, and poor quality suppliers.

In Bangladesh the situation is rather tough. If a large corporate company go for an establishment of a computer network very few skilled hands can help them and very few guidelines they will get. We hope our project and further more work like this can eliminate the problem.

