CONVERTING TRADITIONAL STRUCRED CABLING IN TO INTELLIGENT BUILDING SYSTEM

BY

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Thesis submitted in partial fulfillment of the requirement for the Degree of Bachelor of Science in Physical Sciences of the Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka, Buttala, Sri Lanka.

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DECLARATION

I carried out the work described in this thesis at the Keels Business Systems Ltd and the Faculty of Applied Sciences under the supervision of Mr.B.Shaiskandan and Mr.Yves Noel. A report on this has not been submitted to any other University for another degree.

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AFFECTIONATELY DEDICATED TO

MY EVER LOVING

PARENTS

ACKNOWLEDGEMENT

First I would like to give my special sincere thank to Mr. Upul Theverapperuma. Senior Manager InterNetworks Systems Keells Business Systems Ltd and Mr.Ushan Subasinghe, Manager of Premise Networks Systems Keels Business Ltda, for not only taking us under his management for the last three and half months but also for giving us interesting and useful training projects. They also allowed me to study their currently ongoing projects at their work sites. And also I wish to pay a special tribute to Mr. Shaiskandan, AssociateSystems Engeneer, Keells Business Ltd, My External Supervisor who advised me to get a good path to study the theoretical approaches and practical knowledge in Structured Cabling and related fields during my training periods. And also my deepest gratitude to Mr. Yves Noel, My internal supervisor, Computer Specialist, Department of Physical Sciences, Faculty of Applied Sciences, for his valuable guidance, encouragement and supervision given to me to complete this project to a success.

Then I must thank Dr. K.K.D.S.Ranaweera Dean, Faculty of Applied Sciences, Dr. D.B.Mahinda Wickramarathne Head, Department of Physical Sciences and the staff of the Faculty of Applied Sciences, and other staff members at Keells Business Systems whose help proved to be invaluable.

ABSTRACT

This document is submitted as to present the detailed description of the theoretical and practical experiences gained during survey period which I underwent at the work site of Keells Business System LTD. Actually preparation of this kind of report enables us not only to improve our presentation skills but also to concentrate all the work experiences gained during the training period into a single document.

The interior contents of the whole document may be classified into following major areas:

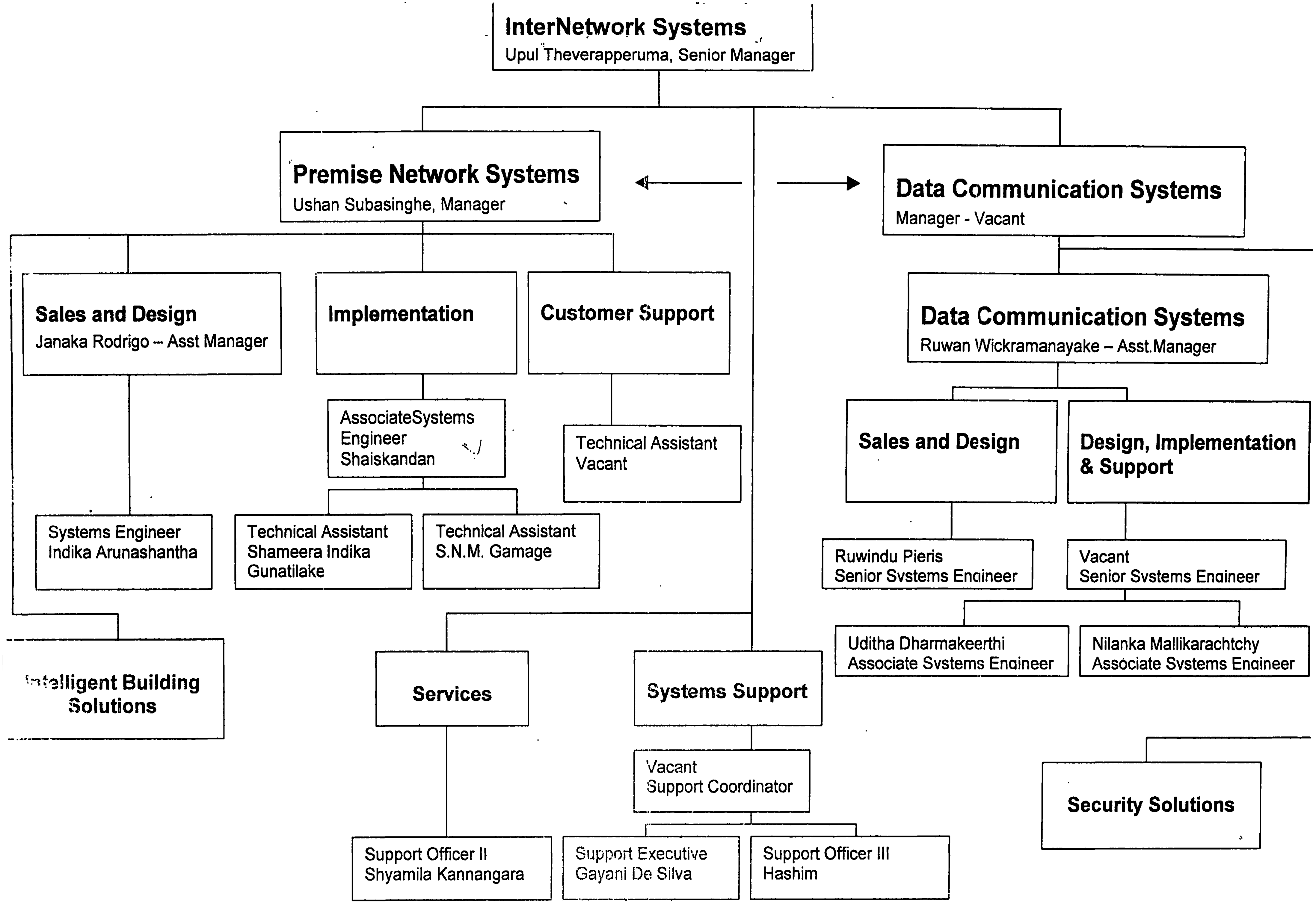
- Theoretical and practical knowledge gained on Information Technology field especially on Structured Cabling Data Communications Systems.
- Tackling and Troubleshooting of different kind of problems in InterNetworking.
- Methods of implementing networking systems.

The most difficult thing I encountered during preparation of this report was to compress all the detailed works carried out, into this kind of small document. But I hope my effort was successful and it will give you a better idea of my training experiences.

LIST OF CONTENTS

LIST OF FIGURES

CHAPTER-01


InterNetwork Systems
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Manager - Vacant
Sales and Design
Janaka Rodrigo – Asst Manager
Implementation
Customer Support
Data Communication Systems
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Nilanka Mallikarachtchy Associate Systems Engineer
Intelligent Building Solutions
Services
Systems Support
Vacant Support Coordinator
Security Solutions
Support Officer II Shyamila Kannangara
Support Executive Gayani De Silva
Support Officer III Hashim

About KBSL

Keells Business Systems Ltd (KBSL)

It was formed in 1987, it is one of the largest Information Technology Companies in Sri Lanka. They are a diversified outfit with a two pronged approach towards the market.

The Enterprise Technology Services - Which consists of the Telecom Division (Distributor for Lucent Enterprise PBX Solutions), Open Systems Division (IBM RS 6000 & CITIL Banking Software Division) and the InterNetwork Systems Division (Provide Structured Cabling / Power & Wide Area Connectivity Solutions).

The Personal Systems Group - Which consists of the IBM Desktop, Server, Mobile and Channels divisions. They have recently obtained the Distributorship for Symbol Technologies, which is an auto/ID integrator. The PSG Division is focused on the corporate market segment with channel division focused on value added resellers.

The 12000 sq. ft KBSL facility includes a 100 mbps network with Lotus notes providing the front end to intranet e-mail and a dedicated 64 kbps link via a proxy to e-mail, Internet & fax. An RS6000 Server / Informix Database with a NT Server provide the platform for the above.

KBSL has over 180 employees involved in Marketing, Engineering, Customer Support, MIS, Software and Accounts & Administration.

Strategic Alliances with Leaders of Technology

LUCENT TECHNOLOGIES INC.

There are enterprise distributors for Lucent Technologies Communications products and PBX solutions. Our product offerings range from voice telephony, call centers, Customer Relationship Management, IP telephony, firewall solutions, access servers and switched solutions.

IBM WORLD TRADE CORP.

They have been IBM Business partners since 1987 and continue to have a very strong relationship with them. KBSL is an IBM Business Partner for RS/6000, Networking and ATM Products. KBSL is also the distributor for the IBM Personal Systems Group, which include Commercial Desktop, Netfinity Server & Think Pad Product Range.

KBSL is an IBM Authorized Service Center providing repair/ workshop facilities.

CISCO SYSTEMS INC.

They are currently resellers for Cisco Systems solutions and internetworking products. Our product offerings range from switches, routers, firewalls, voice over IP/frame relay/ATM, multi-service networking, etc.

BICC PLC.

They are authorized integrator for BICC range of structured cabling solutions and work with them very closely on fiber as well as copper cabling solutions.

APC INC.

They are distributors for APC's range of uninterruptible power supplies (UPS) and related network accessories.

LIEBERT LTD.

They are distributors for Liebert's range of uninterruptible power supplies (UPS) and related network accessories.

SYMBOL TECHNOLOGIES

KBSL is a distributor for Symbol, which is an auto/ID integrator.

CHAPTER-02

MANAGERIAL ASPECTS

I was assigned to PNS (Premise Network Systems). This is a sub division of INS (InterNetwork Systems). The primary objective of this division is to provide structured cabling solutions to its customers. This division has three times namely Sales Team, Implementation Team, Customer Support Team and Support Staff.

2.1 Sales Team

The Sales Team is responsible for designing and proposing infrastructure cabling solutions to its customers. Once the sales team wins the deal, they will raise the necessary documentation to buy required material for the project. Then the project will be handed over to the Sales Team for them to proceed with implementing the project.

2.2 Implementation Team

Once the project has been handed over to the implementation team. The Implementation Engineer will contact the labor contractor and the customer to agree on the start and the finishing dates of the project. The implementation team is responsible for continuous monitoring of the progress of the project and quality checking. Once the project is implemented, the implementation engineer will hand over the project report. The project report consist of the following:

1) Introduction
2) BOQ
3) Layout Diagrams
4) Cable certification Diagrams

CHAPTER –03

INTELLIGENT BUILDING SYSTENS (IBS)

3.1 Introduction Intelligent Building (IBS)

When the requirements increase people are trying to develop new technology to satisfy their requirements. When we consider the computer networks earlier people connected only the computer systems through a gateway (Router) to the outside world. But later they introduced the gateways which can supports the voice such as cisco 1750, cisco 2500 series. They connect their voice lines also with the data lines, which is called voice over data transmission technology.

But nowadays the new technology is started to improve from the networking field. The basic of that is to connect all Video, Voice, Data and HVAC systems to single network architecture.

Note:

Heat Ventilation air-conditioning Systems defines the HVAC systems.

In this survey has undergone how to design and implement intelligent building systems. Also it is expressing the possibility of implementation it in our country.

3.2 Intelligence Building Systems

During my training period I have undergone a new research about different structured cabling architecture called "Intelligent Building System Architecture". It is currently running in some countries but we consider that in Sri Lanka still nobody else have completely implemented it yet but in near feature definitely it will capture the entire structure-cabling field. The basics of an Intelligent Building is: "one that provides a productive and cost effective environment through optimization of its four basic elements structure, systems, services and management and the interrelation ships between them."

3.2.1 Definition of Intelligent building

An Intelligent Building should be able to integrate building control systems, information systems and telecommunications systems, using a structured cabling infrastructure. A building control system uses digital control (DDC) technology to provide heating, ventilation and air conditioning (HVAC), fire, security, lighting and energy management services.

3.2.2 The Main functions of the Intelligent Building Systems

Intelligent Building functions are performed by the Direct Digital Control systems (DDC), with appropriate sensors, and manageably software based facility management system for centralized control. In an Intelligent Building, the building control sub systems are integrated and able to communicate with each other. Intelligent devices such as sensors will gather and transmit data to the controllers to ensure continuous optimal building performance, using automated tools that detect, diagnose performance, and then take appropriate corrective action.

An integrated building control system will optimize operation across building control subsystems, optimize energy utilization, guide maintenance activities and report building performance, while meeting occupant needs for comfort, health, and safety at the lowest possible cost. An integrated building control system can share information between subsystems. For example, a smoke detector senses smoke, sounds an alarm, and, in turn, the fire control subsystem sends a message to the HVAC subsystem to close the air vents and prevent these smoke from spreading. It then sends a message to the security system to open the door locks so people can get out of the building. Another example is a light sensor in a room that sends a message to the lighting controller to close the light in the room if there is no one there. It then sends a message to the HVAC system to lower the temperature based on room occupancy.

3.2.2.1 The Cabling Infrastructure

The increase in DDC computing power has encouraged the use of standard LANs, structured cabling and other information technologies. As high-speed data communications and effective information sharing become increasingly vital, information, communications and control networks need a structured cabling infrastructure that supports all applications a mix of voice, data, and video and control applications. Structured cabling is the engineering and installation of a voice/data cabling system according to standards published by such bodies as TIA/EIA and ISO/IEC. The aim of this process is:

Important benefits of the Intelligent Building Systems

- Application independence
- Multiple logical topologies
- Easy MACS (moves, adds and changes) to cabling
- Reduced administration costs

Control system cabling tends to be unstructured when compared to voice/data cabling, making it

Inflexible, less reliable and less cost effective. The various control systems in a typical building use a different gauge of cabling ranging from unshielded twisted pair to coax, installed without integration. Equally varied system designs use different installation and administration methods. Appreciation of the Intelligent Building using a single, structured cabling network for a simple, cost effective communication infrastructure is growing. It integrates both telecommunications (voice, data and video) and control applications. The underlying common element is the cabling infrastructure. Each communication device, such as a voice, data terminal, sensor or camera, is connected to its own cable. However, a single structured cabling infrastructure integrates these applications. Integration of network and facility control management can be implemented on a single PC, or responsibilities can be divided between terminals. Structured cabling can also introduce significant 'future proofing' design and engineering decisions that aim to save money on future technology.

In next step we can move to the OSI Model (Open System Interconnection). This is the basic of all networks. Even though if we consider intelligent cable designing we must understand this model clearly.

3.2.2.2 The Open System Interconnection (OSI)

When we consider the structure cabling better to understand about the OSI model because all connecting devices such as Hub, Router, and Switches are directly involving in this mode. Most of those devices are involved with the physical layer, data link layer, and the network layers. When we briefly look to the OSI model we can understand those relationships.

3.2.2.2.1 OSI Model

In 1983, the International Standards Organization (ISO) developed a model, which would allow the sending, and receiving of data between two computers. It works on a layer approach, where each layer is responsible for performing certain functions.

When we think of how to send data from one computer to another, there are many different things involved. There are network adapters, voltages and signals on the cable, how the data is packaged, error control in case something goes wrong, and many other concerns. By dividing these into separate layers, it makes the task of writing software to perform this much easier.

In the Open Systems Interconnect model, which allows dissimilar computers to transfer data between themselves, there are seven distinct layers.

7. **Application Layer**

   Provides Applications with access to network services.

6. **Presentation Layer**

   Determines the format used to exchange data among networked computers.

5. **Session Layer**

   Allows two applications to establish, use and disconnect a connection between them called a *session*. Provides for name recognition and additional functions like security, which are needed to allow applications to communicate over the network.

4. **Transport Layer**

Ensures that data is delivered error free, in sequence and with no loss, duplications or corruption. This layer also repackages data by assembling long messages into lots of smaller messages for sending, and repackaging the smaller messages into the original larger message at the receiving end.

3. **Network Layer**

This is responsible for addressing messages and data so they are sent to the correct destination, and for translating logical addresses and names (like a machine name FLAME) into physical addresses. This layer is also responsible for finding a path through the network to the destination computer.

2. **Data-Link Layer**

This layer takes the data frames or messages from the Network Layer and provides for their actual transmission. At the receiving computer, this layer receives the incoming data and sends it to the network layer for handling.

The Data-Link Layer also provides error-free delivery of data between the two computers by using the physical layer. It does this by packaging the data from the Network Layer into a frame, which includes error detection information. At the receiving computer, the Data-Link Layer reads the incoming frame, and generates its own error detection information based on the received frames data. After receiving the entire frame, it then compares its error detection value with that of the incoming frames, and if they match, the frame has been received correctly.

A frame looks like,

Destination ID	Sender ID	Control	Data	CRC

Figure: 3.1 Data frame

The Data-Link Layer actually consists of two separate parts, the Medium Access Control (MAC) and Logical Link Control Layer (LLC). Example MAC layers are Ethernet 802.3 and Token Ring 802.5

3.2.2.3 Network Topologies

Network topologies describe the ways that computers and peripherals (nodes) are connected together in a network. There are basically 4 ways that a network can be organized. These are:

3.2.2.3.1 Bus Network

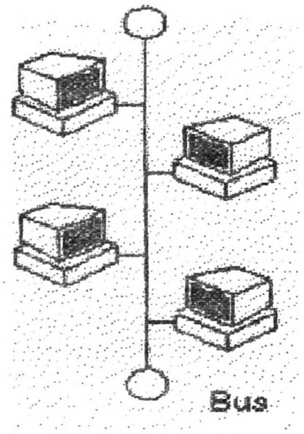


Figure: 3.2 Bus Network

In the Bus Network, messages are sent in both directions from a single point and are read by the node (computer or peripheral on the network) identified by the code with the message.

The purpose of the terminators at either end of the network is to stop the signal being reflected back.

3.2.2Star Network

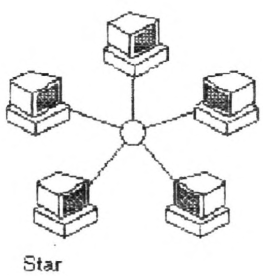


Figure: 3.3 Star Network

In a Star Network, all the nodes (PCs, printers and other shared peripherals) are connected to

the central server.
The advantage of Star Networks is that one node that is not working properly will not affect the rest of the network. It is very easy to add and remove nodes. It can be more expensive because it uses more cabling than other topologies. If the central server goes down, then no one can use the network.

3.2.2.3.3 Ring Networks

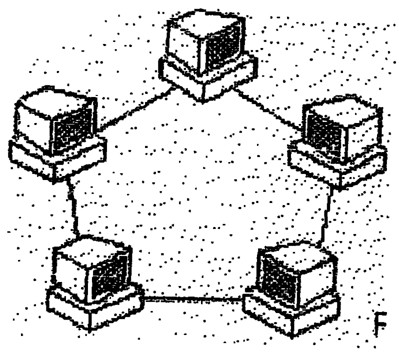


Figure: 3.4 Ring Network

All the nodes in a Ring Network are connected in a closed circle of cable. Messages that are transmitted travel around the ring until they reach the computer that they are addressed to, the signal being refreshed by each node. There may or may not be a fileserver.
The advantage of ring networks is that they can be larger than bus or star because each node regenerates the signal.

A disadvantage is that the network goes down if one node is inoperable. Data clashes can also occur if two machines send messages at the same time. Tokens or electronic signals that travel around the ring were invented to solve this problem. In a Token Ring Network, a computer can only send a message when the token is with it at the time.

3.2.2.4. Physical Layer

Controls the transmission of the actual data onto the network cable. It defines the electrical signals, line states and encoding of the data and the connector types used. An example is 10BaseT. Repeaters are an example of devices that work at the Physical Layer.

For Ethernet 802.3, the Physical Layer can be represented as

- 10Base5
- 10Base3
- 10BaseT
- 10BaseF

3.2.2.4.1 Sending Data Via the OSI Mode

Each layer acts as though it is communicating with its corresponding layer on the other end.

In reality, data is passed from one layer down to the next lower layer at the sending computer, till it's finally transmitted onto the network cable by the Physical Layer. As the data it passed down to a lower layer, it is encapsulated into a larger unit (in effect, each layer adds its own layer information to that which it receives from a higher layer). At the receiving end, the message is passed upwards to the desired layer, and as it passes upwards through each layer, the encapsulation information is stripped off .

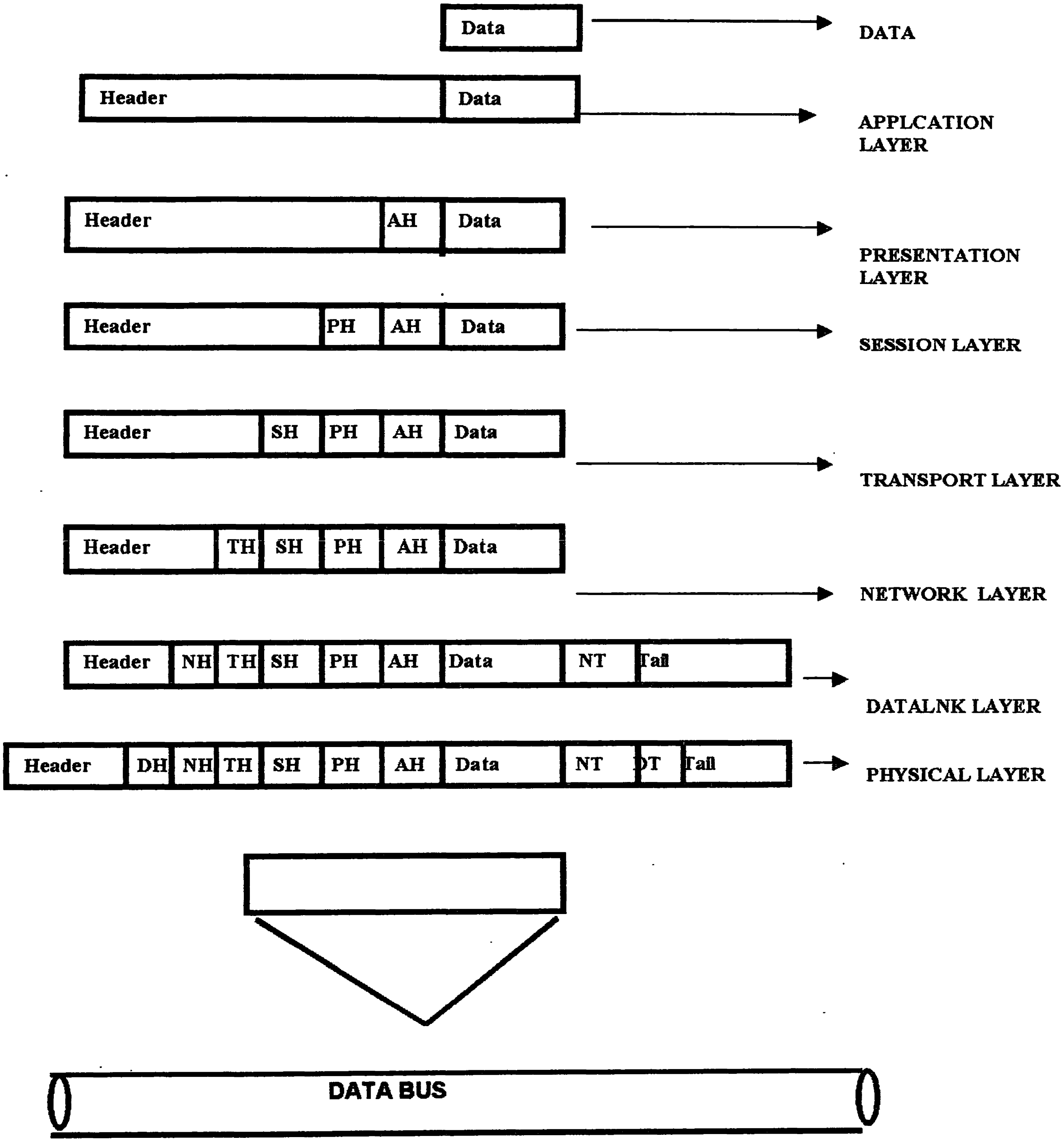


Figure: 3.5 Change of Data in Each layer

3.2.2.4.2 Network Cabling

Cable is the medium through which information usually moves from one network device to another. There are several types of cable which are commonly used with LANs. In some cases, a network will utilize only one type of cable, other networks will use a variety of cable types. The type of cable chosen for a network is related to the network's topology, protocol, and size. Understanding the characteristics of different types of cable and how they relate to other aspects of a network is necessary for the development of a successful network.
The following sections discuss the types of cables used in networks and other related topics.

3.2.2.4.2.1Unshielded Twisted Pair (UTP) Cable

Twisted pair cabling comes in two varieties: shielded and unshielded. Unshielded twisted pair (UTP) is the most popular and is generally the best option for school networks (See fig.4.6).

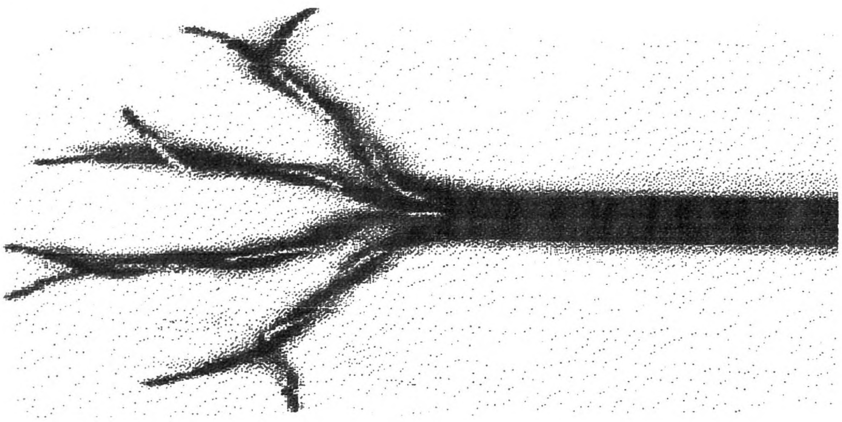


Figure: 3.6 Unshielded twisted pair

The quality of UTP may vary from telephone-grade wire to extremely high-speed cable. The cable has four pairs of wires inside the jacket. Each pair is twisted with a different number of twists per inch to help eliminate interference from adjacent pairs and other electrical devices. The EIA/TIA (Electronic Industry Association/Telecommunication Industry Association) has established standards of UTP and rated five categories of wire.

Table: 3.1 Categories of Unshielded Twisted Pair

Type	Use
Category 1	Voice Only (Telephone Wire)
Category 2	Data to 4 Mbps (LocalTalk)
Category 3	Data to 10 Mbps (Ethernet)
Category 4	Data to 20 Mbps (16 Mbps Token Ring)
Category 5	Data to 100 Mbps (Fast Ethernet)

One difference between the different categories of UTP is the tightness of the twisting of the copper pairs. The tighter the twisting, the higher the supported transmission rate and the greater the cost per foot. Buy the best cable you can afford; most schools purchase Category 3 or Category 5. Category 5 cable is highly recommended.

If you are designing a 10 Mbps Ethernet network and are considering the cost savings of buying Category 3 wire instead of Category 5, remember that the Category 5 cable will provide more "room to grow" as transmission technologies increase. Both category 3 and category 5 UTP have a maximum segment length of 100 meters. 10BaseT refers to the specifications for unshielded twisted pair cable (category 3, 4, or 5) carrying Ethernet signals.

Unshielded Twisted Pair Connector

The standard connector for unshielded twisted pair cabling is an RJ-45 connector. This is a plastic connector that looks like a large telephone-style connector (See fig. 2). A slot allows the RJ-45 to be inserted only one way. RJ stands for Registered Jack, implying that the connector follows a standard borrowed from the telephone industry. This standard designates which wire goes with each pin inside the connector.

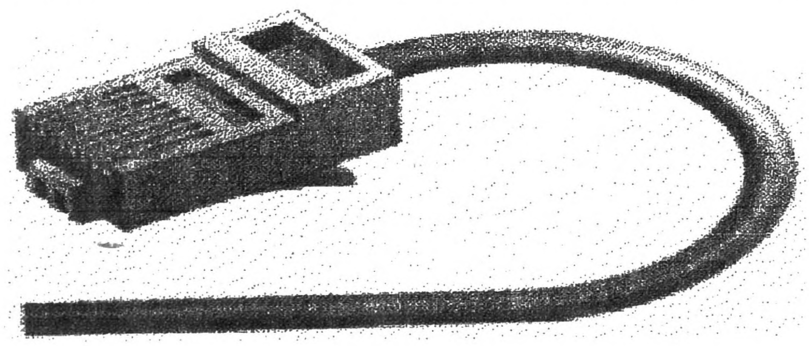


Figure: 3.7 UTP connector

3.2.2.4.2.2 Fiber Optic Cable

Fiber optic cabling consists of a center glass core surrounded by several layers of protective materials (See fig. 5). It transmits light rather than electronic signals, eliminating the problem of electrical interference. This makes it ideal for certain environments that contain a large amount of electrical interference. It has also made it the standard for connecting networks between buildings, due to its immunity to the effects of moisture and lighting.

Fiber optic cable has the ability to transmit signals over much longer distances than coaxial and twisted pair. It also has the capability to carry information at vastly greater speeds. This capacity broadens communication possibilities to include services such as video conferencing and interactive services. The cost of fiber optic cabling is comparable to copper cabling; however, it is more difficult to install and modify. 10BaseF refers to the specifications for fiber optic cable carrying Ethernet signals.

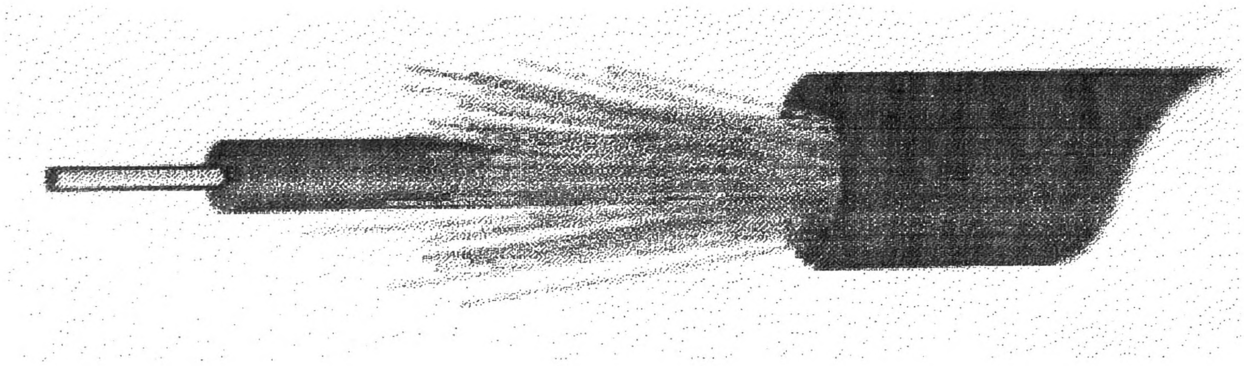


Figure: 3.8 Fiber optic cable

Facts about fiber optic cables:

- Outer insulating jacket is made of Teflon or PVC.
- Kevlar fiber helps to strengthen the cable and prevent breakage.
- A plastic coating is used to cushion the fiber center.
- Center (core) is made of glass or plastic fibers.

Fiber Optic Connector

The most common connector used with fiber optic cable is an ST connector. It is barrel shaped, similar to a BNC connector. A newer connector, the SC, is becoming more popular. It has a squared face and is easier to connect in a confined space.

3.2.2.4.2.3 Hubs/Repeaters

Hubs/repeaters are used to connect together two or more Ethernet segments of any media type. In larger designs, signal quality begins to deteriorate as segments exceed their maximum length. Hubs provide the signal amplification required to allow a segment to be extended a greater distance. A hub takes any incoming signal and repeats it out all ports.

Ethernet hubs are necessary in star topologies such as 10BASE-T. A multi-port twisted pair hub allows several point-to-point segments to be joined into one network. One end of the point-to-point link is attached to the hub and the other is attached to the computer. If the hub is attached to a backbone, then all computers at the end of the twisted pair segments can communicate with all the hosts on the backbone. The number and type of hubs in any one-collision domain is limited by the Ethernet rules. These repeater rules are discussed in more detail later.

A very important fact to note about hubs is that they only allow users to share Ethernet. A network of hubs/repeaters is termed a "shared Ethernet," meaning that all members of the network are contending for transmission of data onto a single network (collision domain). This means that individual members of a shared network will only get a percentage of the available

network bandwidth. The number and type of hubs in any one collision domain for 10Mbps Ethernet is limited by the following rules:

Network Type	**Max Nodes Per Segment**	**Max Distance Per Segment**
10BASE-T	2	100m
10BASE2	30	185m
10BASE5	100	500m
10BASE-FL	2	2000m

3.2.2.4.2.4 Media Converters

When extending distance in Fast Ethernet environments, Transition Networks' Media Converter is a full-featured solution. With connections for 100BASE-TX and 100BASE-FX this media converter is intended exclusively for the Fast Ethernet environment. It converts twisted pair to optical fiber and can be used to extend a Fast Ethernet network segment.

The typical application is to extend network distance in full-duplex networks between two full-duplex devices such as switches, bridges or any other full-duplex device. The Media

Converter can extend distances between two twisted pair devices up to 2 km over multimode fiber or up to 80 km over single mode fiber.

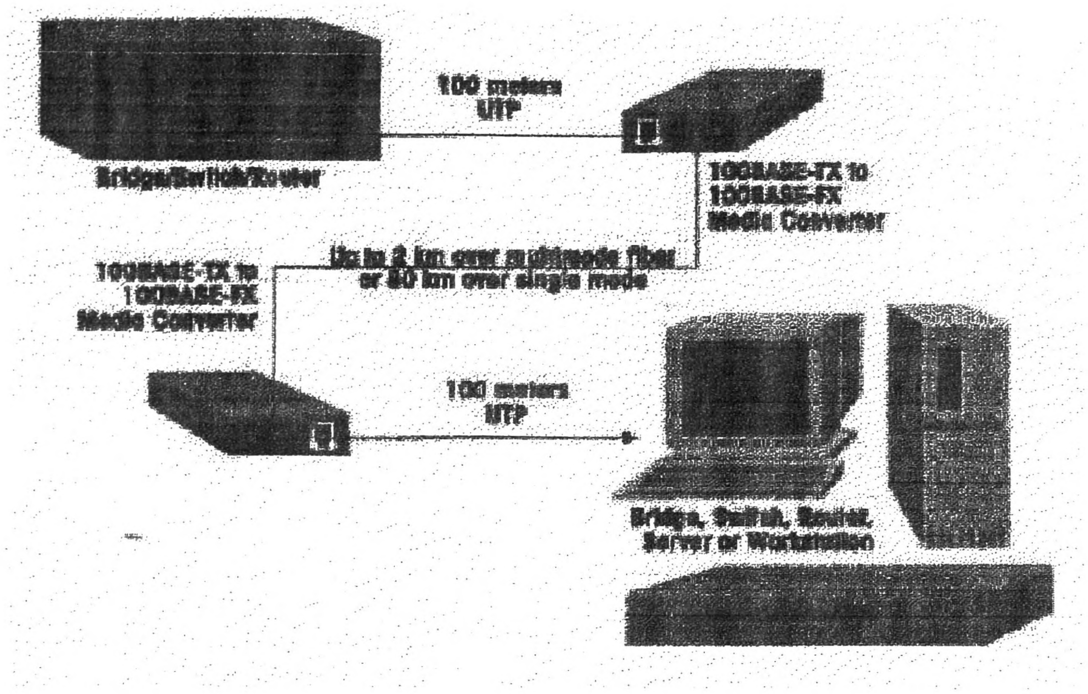


Figure: 3.9 Extending Distance Between Two Copper Devices

Transition Networks makes another media onverter for this application. The Just Convert-it series is an inexpensive no-frill easy-to-use 100BASE-TX to 100BASE-FX media converter, intended exclusively for the Fast Ethernet environment. The J/FE-CF-01 Media Converter converts twisted pair to optical fiber, and, typically, would be used to extend a Fast Ethernet network in a full-duplex environment up to 2 km.

3.2.2.4.2.5 Network Interface Cards

Network interface cards, commonly referred to as NICs, are used to connect a PC to a network. The NIC provides a physical connection between the networking cable and the computer's internal bus. Different computers have different bus architectures; PCI bus master slots are most commonly found on 486/Pentium PCs and ISA expansion slots are commonly found on 386 and older PCs. NICs come in three basic varieties: 8-bit, 16-bit, and 32-bit. The larger the number of bits that can be transferred to the NIC, the faster the NIC can transfer data to the network cable.

Many NIC adapters comply with Plug-n-Play specifications. On these systems, NICs are automatically configured without user intervention, while on non-Plug-n-Play systems; configuration is done manually through a setup program and/or DIPswitches.
Cards are available to support almost all networking standards, including the latest Fast Ethernet environment. Fast Ethernet NICs are often 10/100 capable, and will automatically set to the appropriate speed. Full duplex networking is another option, where a dedicated connection to a switch allows a NIC to operate at twice the speed.

3.2.2.5 Traditional Structured Cabling Design Architecture

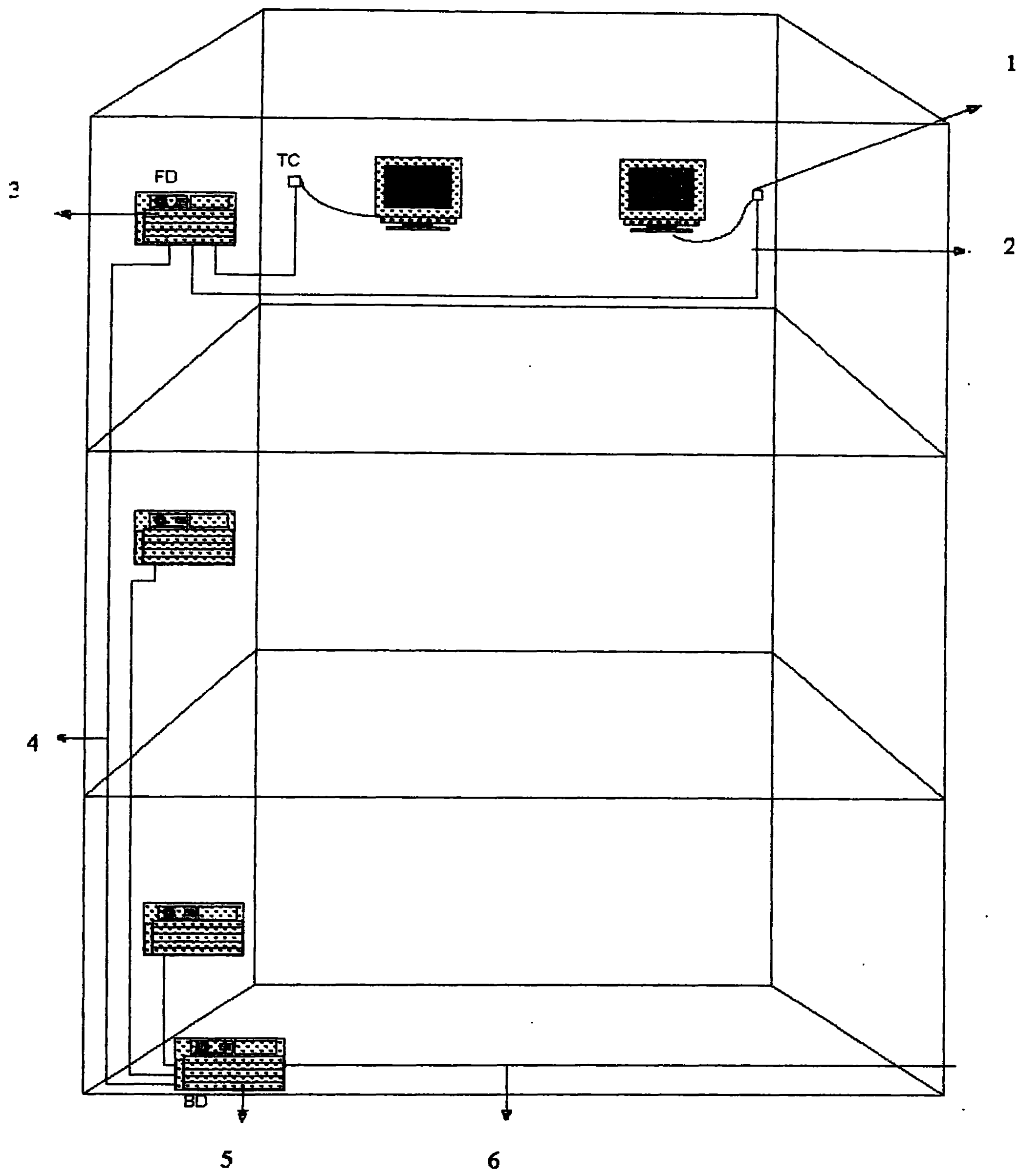


Figure3.10 Traditional structure cabling Architecture

1.Telecommunication Outlets

2.Horizontal Cable

3.Floor Distributor

4.Building Backbone/Cable

5.Building Distributor

6.Campus backbone cable

3.2.2.6 The stricture of Intelligent Building System

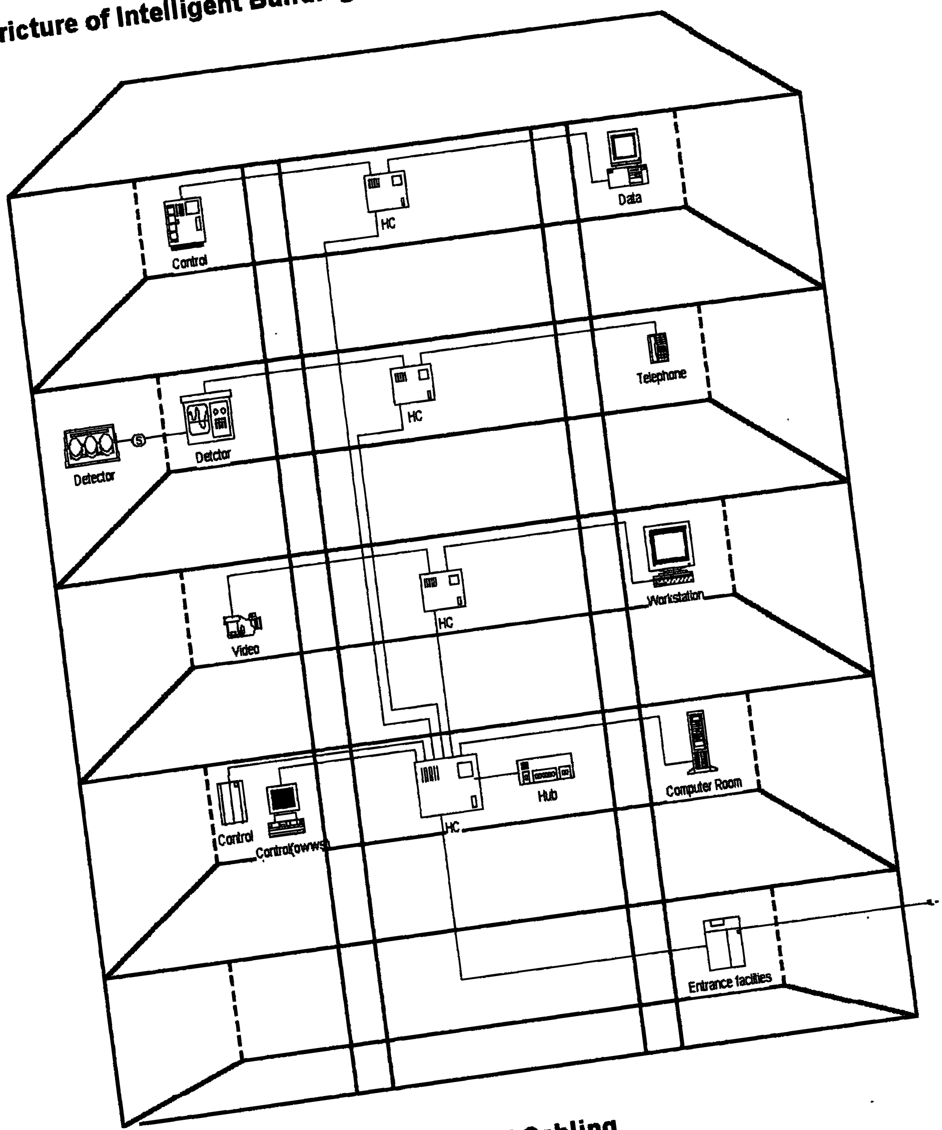


Figure: 3.11 Intelligent Building Structured Cabling

Legend:

ASC –Application Specific Control

Cabling

CR – Computer Room

HR – Horizontal Cross Connect

MR – Mechanical Room

Cabling

________________ Horizontal

________________ Backbone

3.3 Building Management Systems

The Building Management Systems(BMS) is the system that can control all the system in the whole building. Its categorize by two parts

1. Main building Administration systems(MAB)
2. Administration sub systems(ASB)

The Administration subsystems are basically placed in the each floor and its connected all other systems in the floor. That is each floor has HVAC systems, Energy Management Systems(EMS),Access Control Systems, Fire and life safety systems, security alarm systems, Lighting systems all these are connected to Administration sub systems. Finally all these systems are connected to the Main Building Administration Systems.

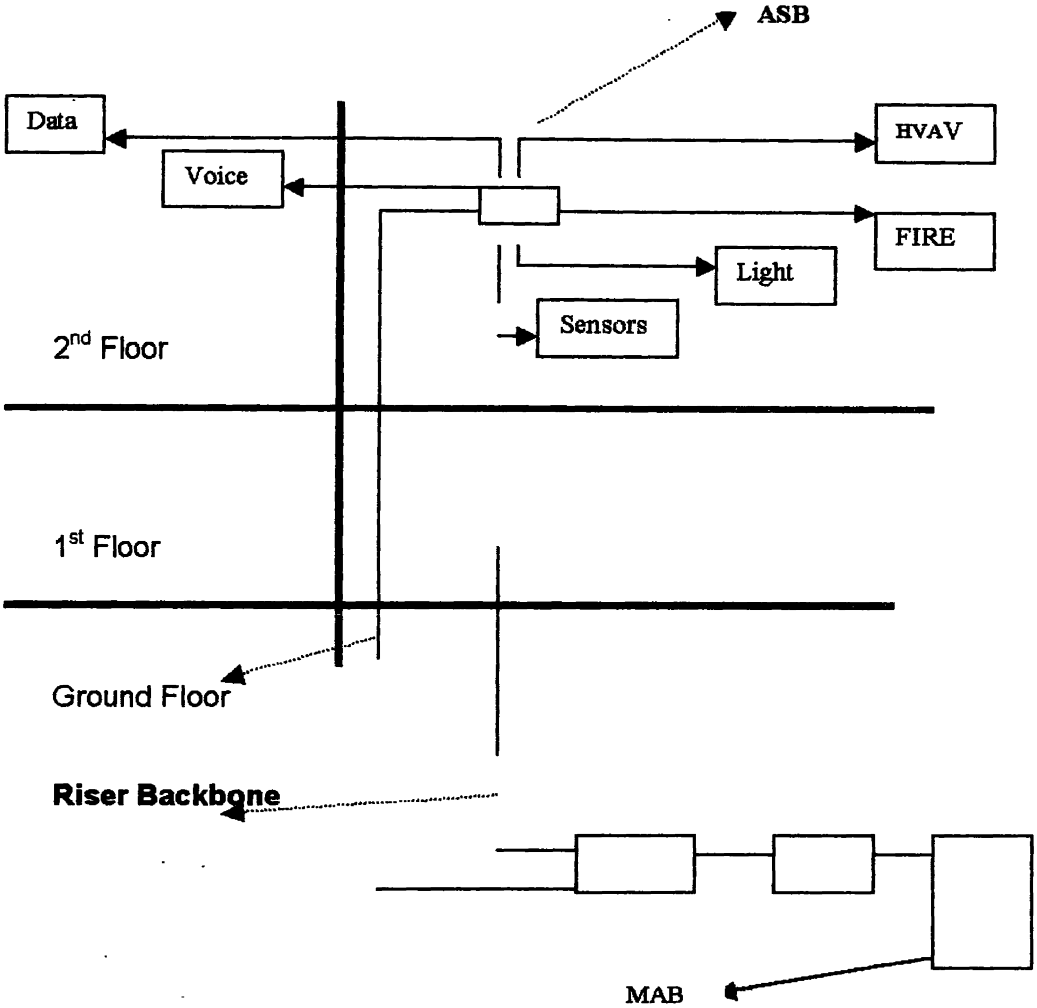


Figure: 3.12 The function of MAB and ASB

The function of the BMS is

1.centralized monitoring, Operation and management of whole building

2.Another goal of this to make efficient building operation in low cost

All of the subsystems are basically a on the microprocessors level controllers and these are programmed by users in the each level or it can be automatically control by the sensors for each devices. Also each controllers placed in each floors can communicate between themselves. It can be done by a gateway (Router) that connected to the controller in the each floor.

Finally by connecting a main gateway to the BMS we can connect the whole building administration to the Internet. This is a good feature to the remote accessing of the building.

The feature of zone level controller.

It is designed for specific application level requirements

Eg:

HVAC Terminal Unit that supply signals to the HVAC system which are at the various work area.

Control distributed uniformly for each equipments, such as Variable Air Volume (VAV), Fan coils Heat pumps etc.

Zone level controllers are networked on a bus controllers it connects all sensors or VAV damper controller.

The Feature of the zone level controller

It is centrally located and control VAV supply units and Chiller plant and Boiler units.

Also its having number of control programs which are responsible for all controllers by a controle interface through I/O to sensors.

PC base workstations

It is connected on each floor with the controller. The purpose of this is a task management. That is to do operations by executing the application programs. It is done by this work station and it also control the execution of all programs.

3.3.1 LONWork Technology

It is referred by a set of components and tools. It is categorized by four parts.

1. A local operating network
2. LonTalk protocol
3. A neuron chips family
4. LONWork transceivers

Network

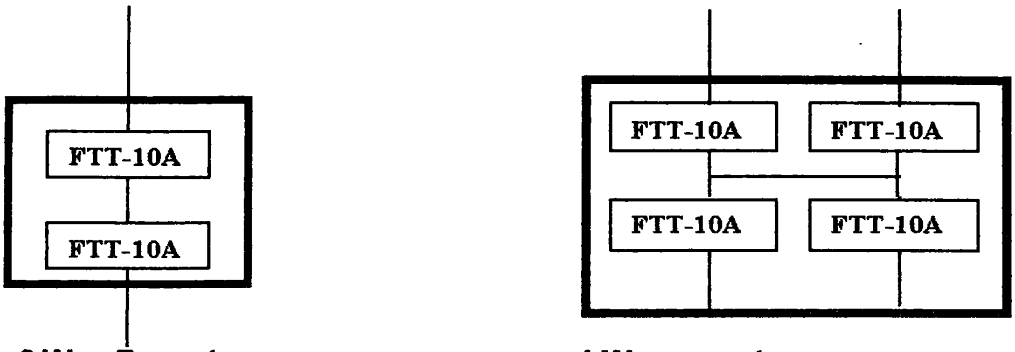
The nods can communicate with each other by using LONTalk protocol. The connecting media of the network is Cat-5 cables. The neuron chips which contain a processor it can be programmable to provide I/O control, monitoring, execute applications for a specific functions. Also it can provide memory to all the applications running in the system.

Transceivers

It can do encoding and decoding functions to received or transmitted data.
Eg: FTT-10A transceivers (twisted pair transceivers)

Repeater

There are 2 way repeaters and 4 way repeaters available. Each port of the repeaters can connect different FTT –10A channel segments. Only one repeaters can used per a channels but no limitations. If there high level traffic we can use LONRouters.



2 Way Repeaters **4 Way repeater**

Figure: 3.13 2 way 4 way Repeater

The workstation and FTT-10A controllers are the focal points for the(BAS) and centralized in MER. And all end point devices connected by horizontal wiring.

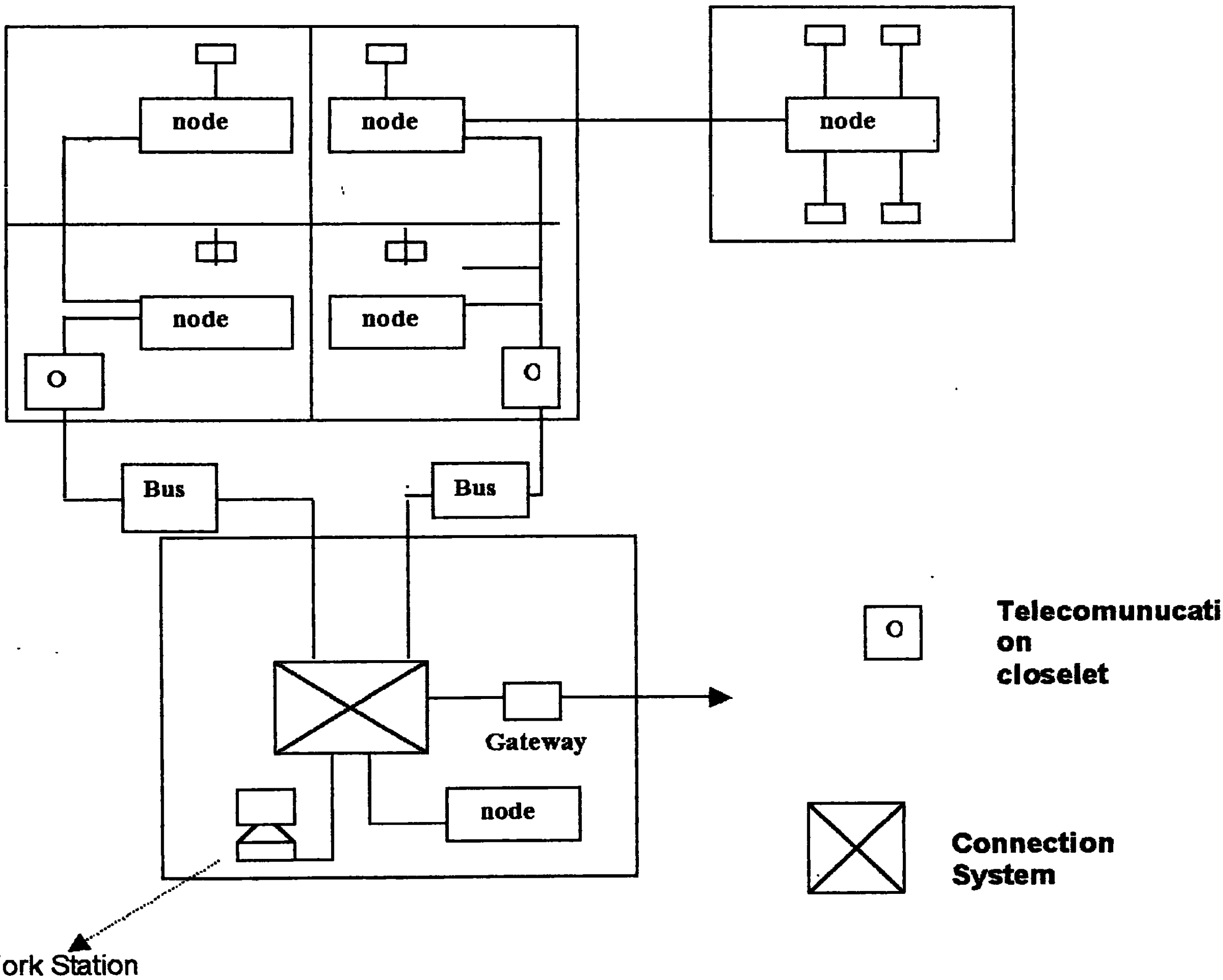
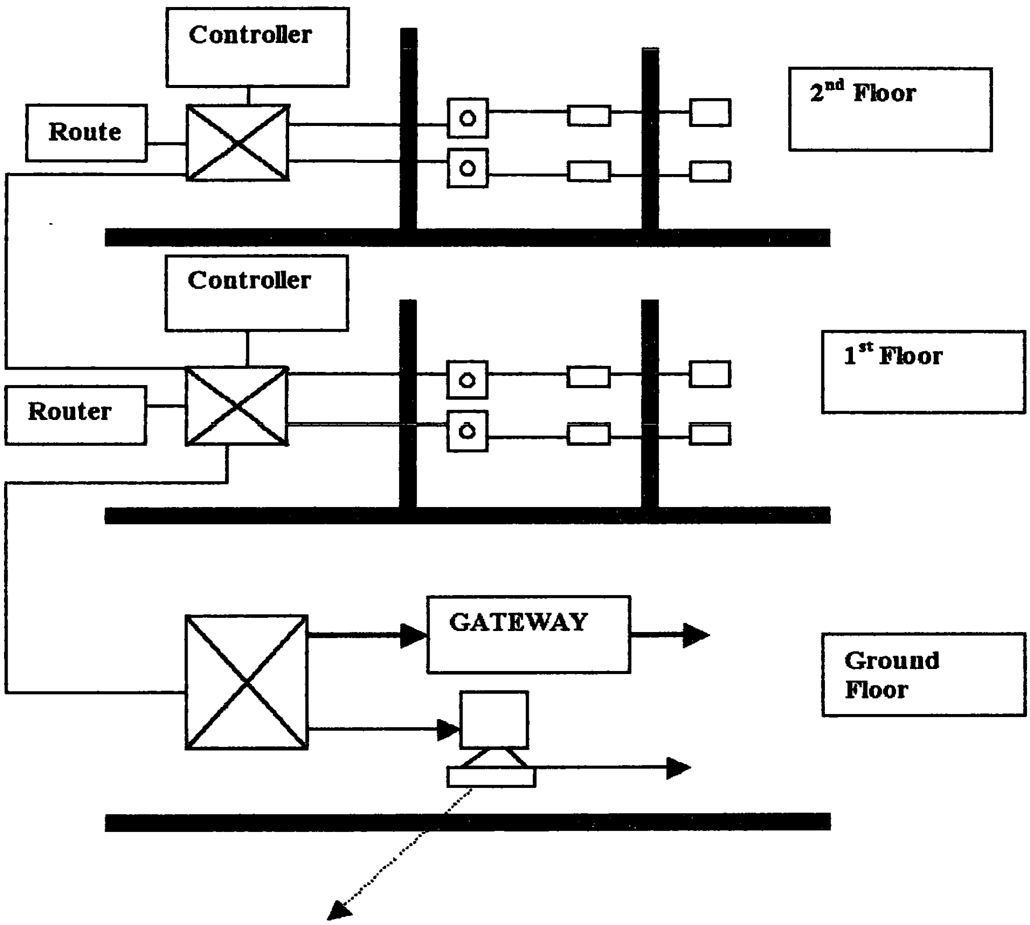


Figure: 3.14 Example for the connector system :110 Connector system.

Workstations of each flow can communicate through the gateway to server by using an Eathernet 10 BASE T LAN connection.



PC Work Station

Figure: 3.15 Node communication between different floor.

3.3.2 Topologies of wiring

There are different types of design to connect the devices to the network.

Point to point 1

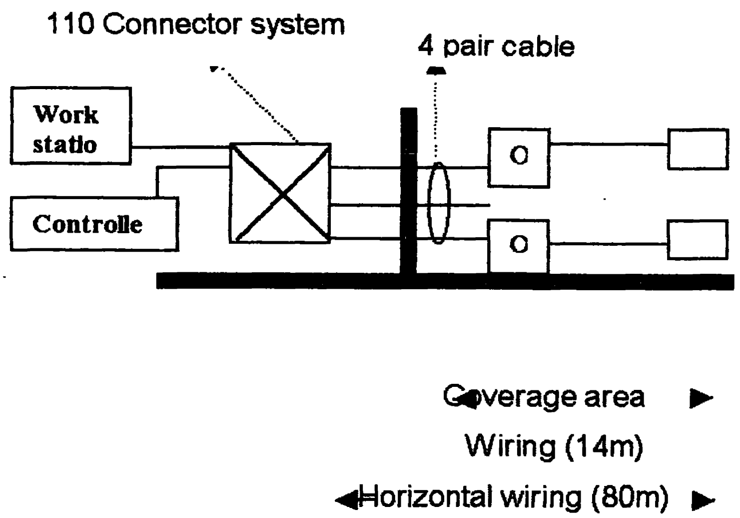


Figure: 3.16 Point to point wiring (Daisy chain)

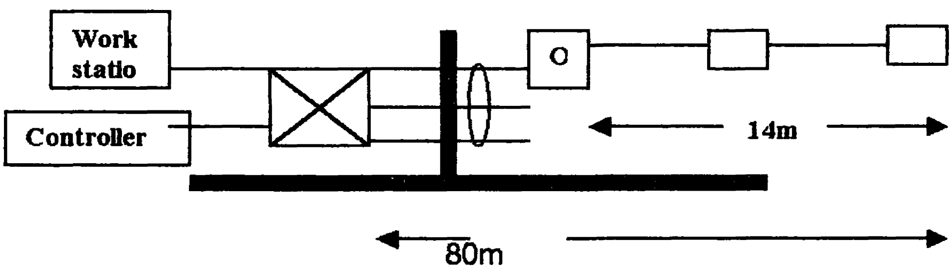


Figure: 3.17 Point to point wiring (Daisy Weel)

Star wiring

This wiring is important to connect branch devices.
We can follow two different methods to connect branches

1. Bridge the branches together
2. Chain the branches together.

Chaining branches together

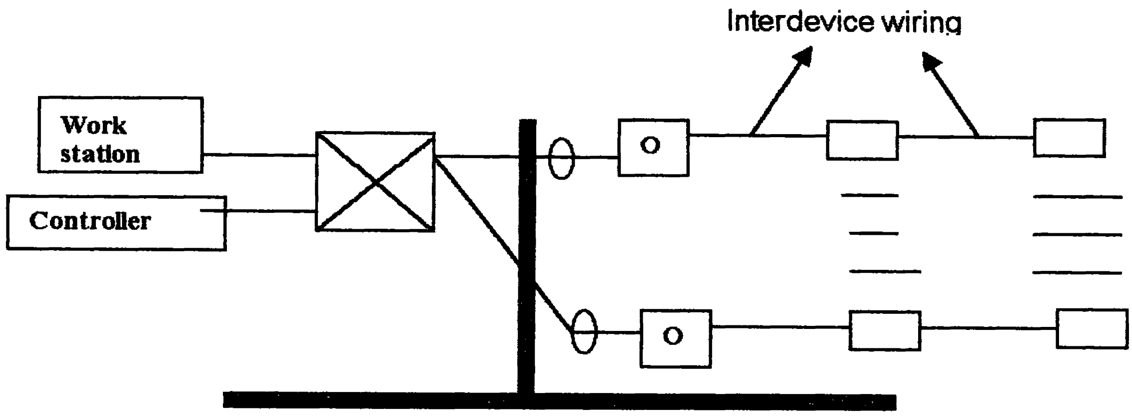


Figure: 3.18 Star Wiring

It is doubly terminated bus architecture.
The extension limit of the cable 900m(Max)cable type is 4pair
The maximum number of devices 64
Maximum no of branches 5
Maximum device to device distance 900m.

Bridging Branches

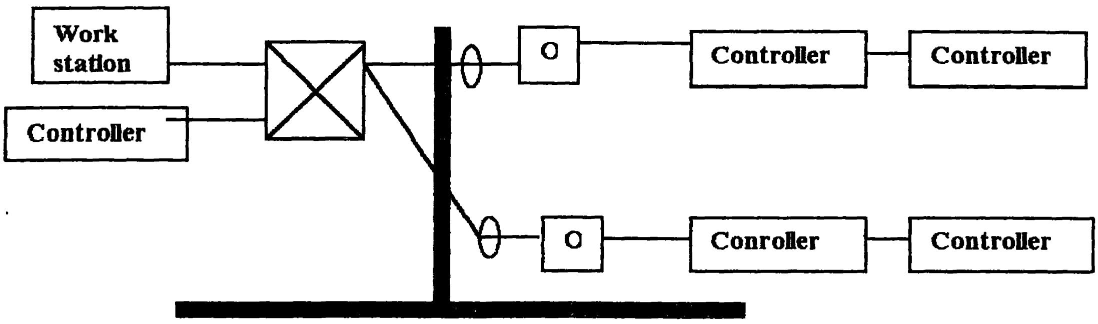


Figure: 3.19 Bridging Branches

*These are singly terminated bus. The total cable lenth 450m

*Maximum number of branches 4

*Maximum number of devices 64

*Maximum node to node distance 250M

Remote Star wiring

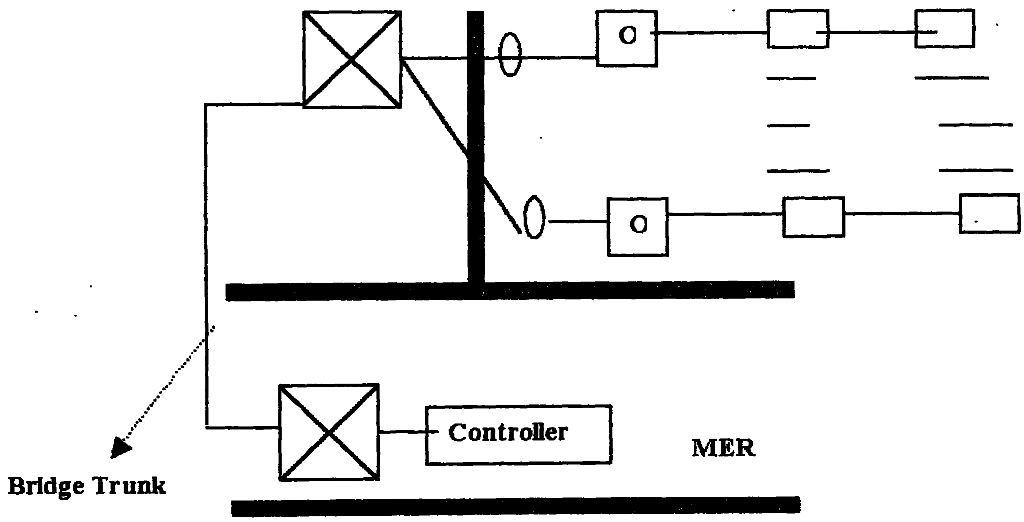


Figure: 3.20 Remote star Wiring

Controller panel

All controller and sensors connected to this controller panel.

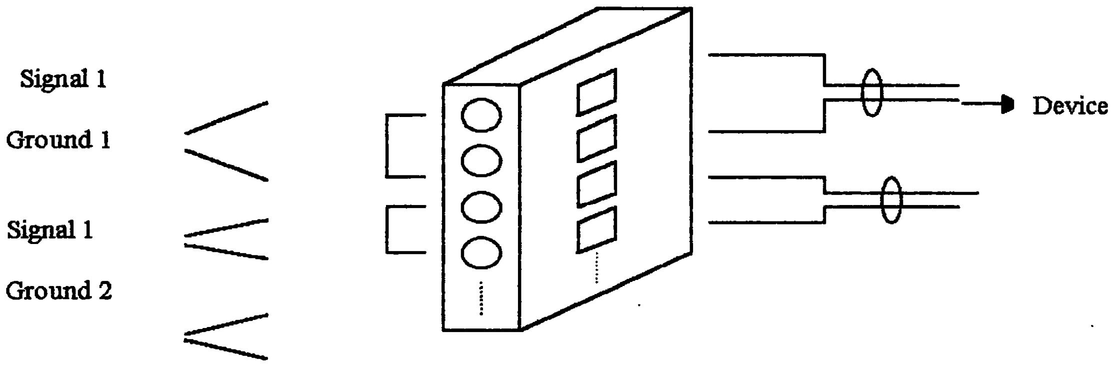


Figure: 3.21 Controller Panel

Information out lets to end point

It is the connecting point for all devices.

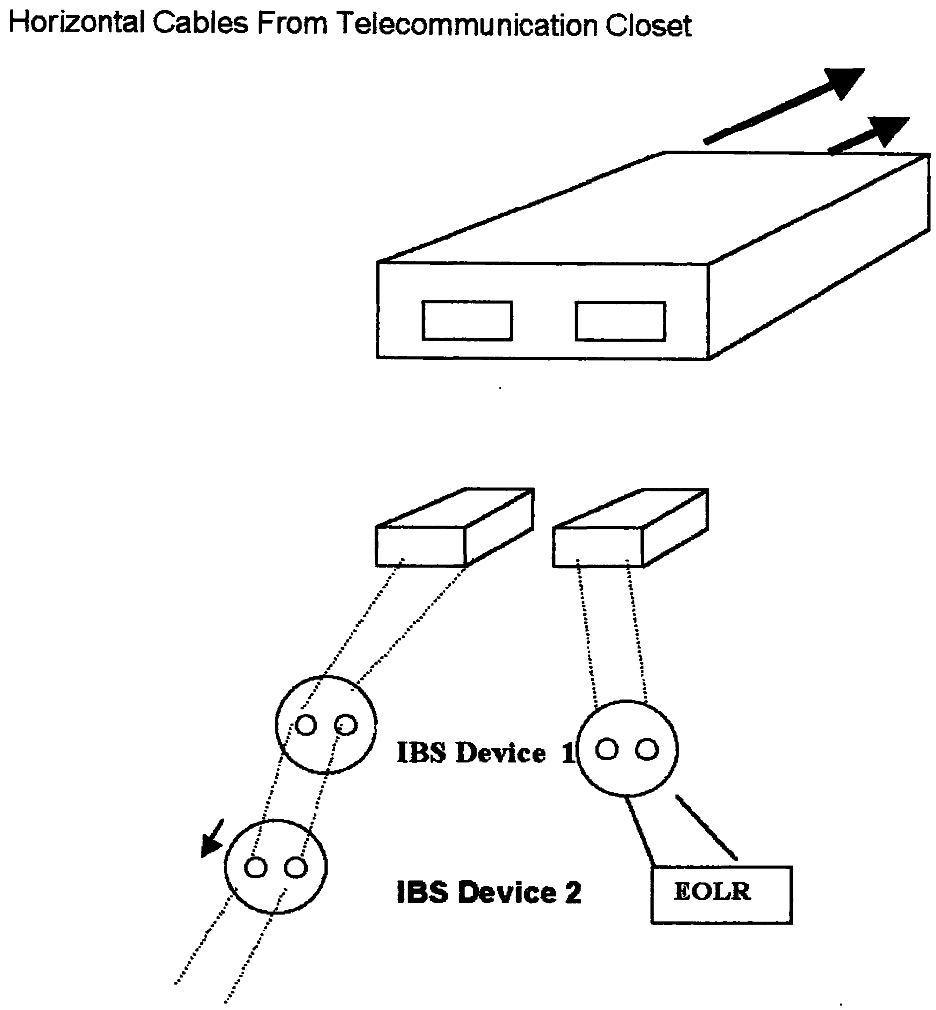


Figure: 3.22 Information Outlet

CHAPTER-04

DATA LINK AND NETWORK LAYER

Even though if we design Intelligent Building Systems we have to understand the layer 2 device, layer 3 devices to get better idea about design IBS devices in network anc presentation layer

4.1 Layer 2 Devices

4.1.1 Switches

Switching

Switches occupy the same place in the network as hubs. Unlike hubs, switches examine each packet and process it accordingly rather than simply repeating the signal to all ports. Switches map the Ethernet addresses of the nodes residing on each network segment and then allow only the necessary traffic to pass through the switch. When the switch receives a packet, the switch examines the destination and source hardware addresses and compares them to a table of network segments and addresses. If the segments are the same, the packet is dropped ("filtered"); if the segments are different, then the packet is "forwarded" to the proper segment. Additionally, switches prevent bad or misaligned packets from spreading by not forwarding them.

Filtering of packets, and the regeneration of forwarded packets enables switching technology to split a network into separate collision domains. Regeneration of packets allows for greater distances and more nodes to be used in the total network design, and dramatically lowers the overall collision rates. In switched networks, each segment is an independent collision domain. In shared networks all nodes reside in one, big shared collision domain.

Easy to install, most switches are self learning. They determine the Ethernet addresses in use on each segment, building a table as packets are passed through the switch. This "plug and play" element makes switches an attractive alternative to hubs.

Switches can connect different networks types (such as Ethernet and Fast Ethernet) or networks of the same type. Many switches today offer high-speed links, like Fast Ethernet or FDDI, that can be used to link the switches together or to give added bandwidth to important servers that get a lot of traffic. A network composed of a number of switches linked together via these fast uplinks is called a "collapsed backbone" network. Dedicating ports on switches to individual nodes is another way to speed access for critical computers. Servers and power users can take advantage of a full segment for one node, so some networks connect high traffic nodes to a dedicated switch port. Full duplex is another method to increase bandwidth to dedicated workstations or servers. To use full duplex, both network interface cards used in the server or workstation, and the switch must support full duplex operation. Full duplex doubles the potential bandwidth on that link, providing 20 Mbps for Ethernet and 200 Mbps for Fast Ethernet.

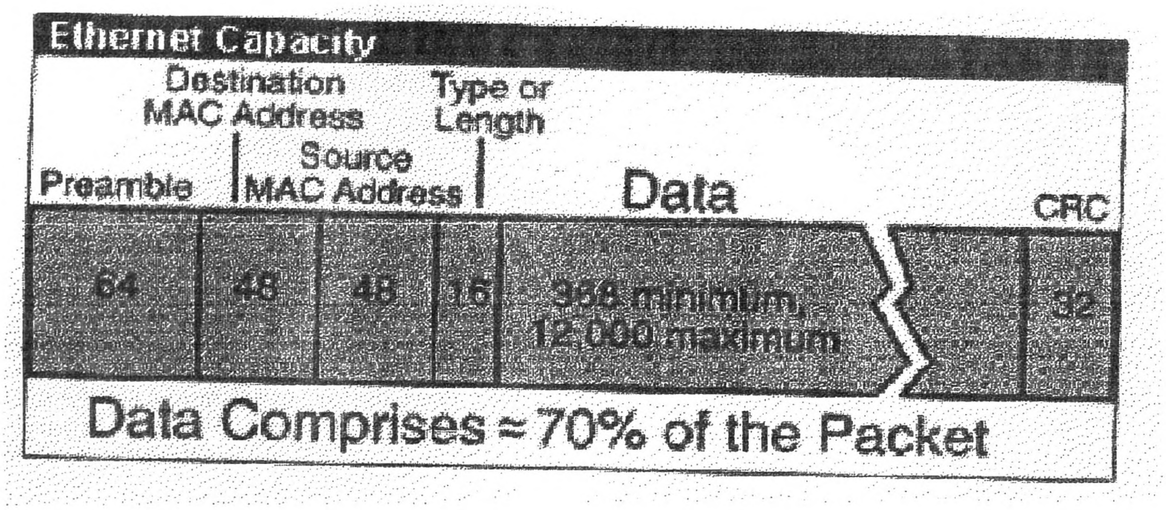


Figure: 4.1 Ethernet Capacity

Network Congestion

As more users are added to a shared network or as applications requiring more data are added, performance deteriorates. This is because all users on a shared network are competitors for the Ethernet bus. A moderately loaded 10 Mbps Ethernet network is able to sustain utilization of 35% and throughput in the neighborhood of 2.5 Mbps after accounting for packet overhead, interpacket gaps and collisions. A moderately loaded Fast Ethernet shares 25 Mbps of real data in the same circumstances. With shared Ethernet and Fast Ethernet, the likelihood of collisions increases as more nodes and/or more traffic is added to the shared collision domain.

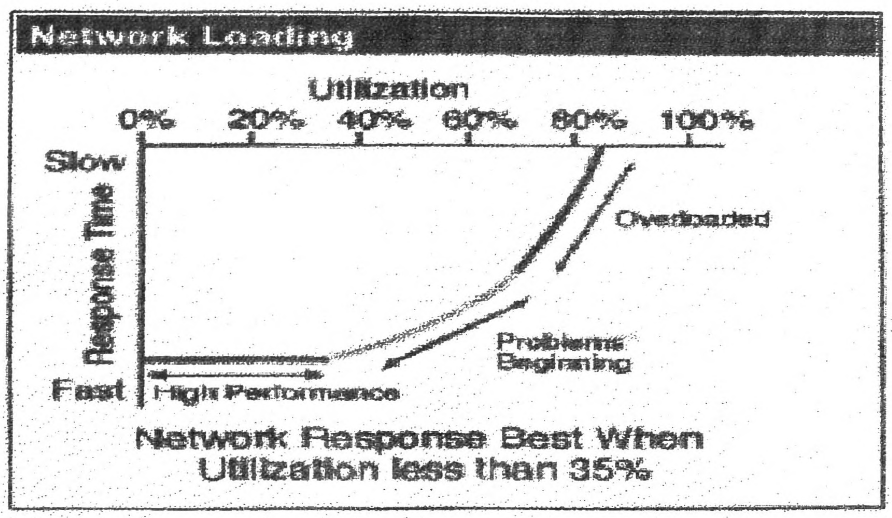


Figure: 4.2 Network loading

Ethernet itself is a shared media, so there are rules for sending packets to avoid conflicts and protect data integrity. Nodes on an Ethernet network send packets when they determine the network is not in use. It is possible that two nodes at different locations could try to send data at the same time. When both PCs are transferring a packet to the network at the same time, a collision will result. Both packets are retransmitted, adding to the traffic problem. Minimizing collisions is a crucial element in the design and operation of networks. Increased collisions are often the result of too many users or too much traffic on the network, which results in a lot of contention for network bandwidth. This can slow the performance of the network from the users point of view. Segmenting, where a network is divided into different pieces joined together logically with switches or routers, reduces congestion in an overcrowded network.

Collision rates measure the percentage of packets that are collisions. Some collisions are inevitable, with less than 10% common in well running networks.

The Factors Affecting Network Efficiency
- Amount of traffic - Number of nodes - Size of packets - Network diameter

Measuring Network Efficiency
- Average topeak load deviations - Collision Rate - Utilization Rate

Utilization rate is another widely accessible statistic about the health of a network. This statistic is available in Novell's Console monitor and WindowsNT performance monitor as well as any optional LAN analysis software. Utilization in an average network above 35% indicates potential problems. This 35% utilization is near optimum, but some networks experience higher or lower utilization optimums due to factors such as packet size and peak load deviation.

A switch is said to work at "wire speed" if it has enough processing power to handle full Ethernet speed at minimum packet sizes. Most switches on the market are well ahead of network traffic capabilities supporting full "wire speed" of Ethernet, 14,480 pps (packets per second).

Switch Benefits
- Isolates traffic, relieving congestion - Separates collision domains, reducing collisions - Segments, restarting distance and repeater rules

Switch Costs
- Price: currently 3 to 5 times the price of a hub - Packet processing time is longer than in a hub - Monitoring the network is more complicated

4.1.1.1 General Benefits of Switching

Switches replace hubs in networking designs, and they are more expensive. So why is the desktop switching market doubling ever year with huge numbers sold? The price of switches is declining precipitously, while hubs are a mature technology with small price declines. This means that there is far less difference between switch costs and hub costs than there used to be, and the gap is narrowing.

Since switches are self learning, they are as easy to install as a hub. Just plug them in and go. And they operate on the same hardware layer as a hub, so there are no protocol issues.

There are two reasons for switches being included in network designs. First, a switch breaks one network into many small networks so the distance and repeater limitations are restarted. Second, this same segmentation isolates traffic and reduces collisions relieving network congestion. It is very easy to identify the need for distance and repeater extension, and to understand this benefit of switching. But the second benefit, relieving network congestion, is hard to identify and harder to understand the degree by which switches will help performance. Since all switches add small latency delays to packet processing, deploying switches unnecessarily can actually slow down network performance. So the next section pertains to the factors affecting the impact of switching to congested networks.

Switching in the Network

The benefits of switching vary from network to network. Adding a switch for the first time has different implications than increasing the number of switched ports already installed. Understanding traffic patterns is very important to switching - the goal being to eliminate (or filter) as much traffic as possible. A switch installed in a location where it forwards almost all the traffic it receives will help much less than one that filters most of the traffic.

Networks that are not congested, it can actually be negatively impacted by adding switches. Packet processing delays, switch buffer limitations, and the retransmissions that can result sometimes slows performance compared with the hub based alternative. If your network is not congested, don't replace hubs with switches. How can you tell if performance problems are the result of network congestion? Measure utilization factors and collision rates.

Good Candidates for Performance Boosts from Switching
- Utilization more than 35% - Collision rates more than 10% Utilization load is the amount of total traffic as a percent of the theoretical maximum for the network type, 10 Mbps in Ethernet, 100 Mbps in Fast Ethernet. The collision rate is the number of packets with collisions as a percentage of total packages

Network response times (the user-visible part of network performance) suffers as the load on the network increases, and under heavy loads small increases in user traffic often results in significant decreases in performance. This is similar to automobile freeway dynamics, in that increasing loads results in increasing throughput up to a point, then further increases in demand results in rapid deterioration of true throughput. In Ethernet, collisions increase as the network is loaded, and this causes retransmissions and increases in load which cause even more collisions. The resulting network overload slows traffic considerably.

Using network utilities found on most server operating systems network managers can determine utilization and collision rates. Both peak and average statistics should be considered.

4.1.1.1.1 Replacing a Central Hub with a Switch

This switching opportunity is the typified by a fully shared network, where many users are connected in cascading hub architecture. The two main impacts of switching will be faster network connection to the server(s) and the isolation of non-relevant traffic from each segment. As the network bottleneck is eliminated performance grows until a new system bottleneck is encountered - such as maximum server performance.

Good Candidates for Performance Boosts from Switching
- Important to know network demand per node - Try to group users with the nodes they communicate with most often on the same segment - Look for departmental traffic patterns - Avoid switch bottlenecks with fast uplinks - Move users switch between segments in an iterative process until all nodes seeing less than 35% utilization

4.1.1.2 Advanced Switching Technology

There are some technology issues with switching that do not affect 95% of all networks. Major switch vendors and the trade publications are promoting new competitive technologies, so some of these concepts are discussed here.

Managed or Unmanaged

Management provides benefits in many networks. Large networks with mission critical applications are managed with many sophisticated tools, using SNMP to monitor the health of devices on the network. Networks using SNMP or RMON (an extension to SNMP that provides much more data while using less network bandwidth to do so) will either manage every device, or just the more critical areas. VLANs are another benefit to management in a switch. A VLAN allows the network to group nodes into logical LANs that behave as one network, regardless of physical connections. The main benefit is managing broadcast and multicast traffic. An unmanaged switch will pass broadcast and multicast packets through to all ports. If the network has logical grouping that are different from physical groupings then a VLAN-based switch may be the best bet for traffic optimization. Another benefit to management in the switches is Spanning Tree Algorithm. Spanning Tree allows the network manager to design in redundant links, with switches attached in loops. This would defeat the self learning aspect of switches, since traffic from one node would appear to originate on different ports. Spanning Tree is a protocol that allows the switches to coordinate with each other so that traffic is only carried on one of the redundant links (unless there is a failure, then the backup link is automatically activated). Network managers with switches deployed in critical applications may want to have redundant links. In this case management is necessary. But for the rest of the networks an unmanaged switch would do quite well, and is much less expensive.

4.1.1.3 Types of Switches

Store-and-Forward vs. Cut-Through

LAN switches come in two basic architectures, cut-through and store-and-forward. Cut-through switches only examine the destination address before forwarding it on to its destination segment. A store-and-forward switch, on the other hand, accepts and analyzes the entire packet before forwarding it to its destination. It takes more time to examine the entire packet, but it allows the switch to catch certain packet errors and collisions and keep them from propagating bad packets through the network. Today, the speed of store-and-forward switches has caught up with cut-through switches to the point where the difference between the two is minimal. Also, there are a large number of hybrid switches available that mix both cut-through and store-and-forward architectures.

Blocking vs. Non-Blocking Switches

Take a switch's specifications and add up all the ports at theoretical maximum speed, then you have the theoretical sum total of a switches throughput. If the switching bus, or switching components cannot handle the theoretical total of all ports the switch is considered a "blocking switch". There is debate whether all switches should be designed non-blocking, but the added costs of doing so are only reasonable on switches designed to work in the largest network backbones. For almost all applications, a blocking switch that has an acceptable and reasonable throughput level will work just fine. Consider an eight port 10/100 switch. Since each port can theoretically handle 200 Mbps (full duplex) there is a theoretical need for 1600 Mbps, or 1.6 Gbps. But in the real world each port will not exceed 50% utilization, so a 800 Mbps switching bus is adequate. Consideration of total throughput versus total ports demand in the real world loads provides validation that the switch can handle the loads of your network.

4.1.1.4 Difference Between Bridges and switches

Bridging is a method of communicating between devices at OSI layer 2, the data link layer. A bridge connects two networks together and acts as a traffic director. If traffic is destined to the other network, the bridge allows the traffic to pass. If the traffic is local to a single network, the bridge does not pass the traffic unnecessarily to the other connected network. The bridge makes this determination based on the Media Access Control (MAC) address of the workstations on the network. The bridge keeps an updated list of everyone active on the network, and uses this list to direct traffic from one network to another. This method of operation makes the network appear as a single logical network, since the only separation of traffic from one network to another is done at the MAC address level. There are many bridge manufacturers and bridge types on the market. The newest version of this bridging technology is called a DLC Switch or LAN Switch. These switches have a much higher port density than the older two or three port bridges, allowing for much more flexibility and network segmentation.

4.2 Layer 3 devices

4.2.1 Layer 3 Switches and Routers

4.2.1.1 Layer 3 Switching vs. Traditional Routing

By now, it should be clear that a Layer 3 switch can be deployed anywhere in the LAN where a traditional router can be or has been used.

Table 2 compares the two types of devices. The Layer 3 switch has been optimized for high-performance LAN support and is not meant to service wide area connections (although it could easily satisfy the requirements for high-performance MAN connectivity, such as SONET). This optimization boosts the performance of a Layer 3 switch to as much as ten times that of a legacy router, while driving the price down to as little as a tenth. This cost comparison does not include the lower training costs for Layer 3 switch administrators or the increased productivity of a high-performance network.

There is another major architectural difference between a Layer 3 switch and a router. A traditional router organizes bridging (Layer 2) and routing (Layer 3) as peers. A Layer 3 switch layers routing on top of switching, permitting a more natural networking architecture while greatly facilitating scalability.

Characteristic	Layer 3 Switch	Legacy Router
Routes core LAN protocols: IP, IPX, AppleTalk	Yes	Yes
Subnet definition	Layer 2 switch domain	Port
Forwarding architecture	Hardware	Software
RMON support	Yes	No
Price	Low	High
Forwarding performance	High	Low
Policy performance	High	Low
WAN support	No	Yes

Routing

The second method of 'converting' from Ethernet to Token Ring is called routing. Routing occurs at OSI layer 3, and separates physical networks into separate logical networks. This differentiates routing from bridging, since bridging maintains a single logical network. In a routed network, the sending workstation determines if outgoing traffic is local or remote. If the traffic belongs to another network, the originating station sends the frame directly to the router for further processing. Upon receiving the frame from the source workstation, the router examines the frame for the destination address. The router maintains a routing table, which is used to determine the final destination of the data packet through the router. Routing is the most common method of connecting Ethernet networks to Token Ring networks in most organizations. Most network operating systems have routing capabilities built into the servers. By placing a token ring and Ethernet card into a Novell NetWare 3.x/4.x or Windows NT v4.x server, the two topologies can communicate between each other. One caveat; some protocols are not routable. A good example is Microsoft's NetBEUI, which has no OSI layer 3 network address and therefore cannot be routed.

Protocols, which cannot be routed, must be bridged between physical network Overview of Basic Router Platform Architecture and Processes

To understand how switching works, it helps to first understand the basic router architecture and where various processes occur in the router.

Fast switching is enabled by default on all interfaces that support fast switching. If you have a situation where you need to disable fast switching and fall back to the process-switching path, understanding how various processes affect the router and where they occur will help you determine your alternatives. This understanding is especially helpful when you are troubleshooting traffic problems or need to process packets that require special handling. Some diagnostic or control resources are not compatible with fast switching or come at the expense of processing and switching efficiency. Understanding those resources can help you minimize their effect on network performance.

4.3 Wire Speed

Wire speed can be measured in Megabits-per-second or packets-per-second. Layer 3 devices are measured in packets-per-second, not frames-per-second. That's because routers operate at Layer 3, where packets are the norm, as opposed to Layer 2, where frames are the norm. A Layer 3 packet is always encapsulated within a Layer 2 frame, so packet and frame rates are the same. The frame is a little larger than a packet, because it contains some additional bytes like SA, DA, and preamble. In this context, you can use frame and packet interchangeably. Sometimes, pps is even used for Layer 2 devices, although that is technically not correct. This might occur to avoid confusion with video transmission, where frames-per-second is the prevalent way of measuring video transfer rates.

When comparing the performance of Ethernet Layer 3 switches, you need to know what packet size was used to measure the speed. Most labs stress-test switches for different packet sizes, ranging from the minimum to the maximum packet sizes. The minimum packet size of 64 bytes will result in the maximum packet rate, which is 100Mbps Ethernet 148,810 packets per second (fps) to be exact. This will stress a switch to the limit, as the switch will have to perform an IP routing function for every packet forwarded. For the maximum packet size of 1518 bytes, the packet rate is 8127 fps for 100Mbps Ethernet. For 10Mbps Ethernet, these numbers are one-tenth; for Gigabit Ethernet, the maximum packet rate can be an astounding 1.48 million packets per second.

The latency of Layer 3 switches is typically a few microseconds. The relevant IP information needs to be decoded before the frame can be forwarded. Most Layer 3 switches allow you to select store-and-forward or cut-through. If the switch operates in store-and-forward mode, the entire frame needs to be received, in which case the latencies can be as large as the longest frames encountered. In cut-through mode, the latency can be as low as a few hundred bit-times. For 100Mbps switches, this translates to a few microseconds.

4.4 Cable testing and Certification Reports

Cable testing is the important task to give the certification of the data points. Whenever we handed over the project to the customer that is impotent to give the certification reports for each data point wired by the implementation team. The testing device is called Penta scanner. It is having two parts one is Injector part and another parties scanner part. The scanner part has a small LCD screen and the outlet for the cat5 cables another outlet for the COM port. The COM port used to connect with the computer to download the tested result from the scanner to computer. Computer has a special application package called Hyper Terminal. It is provides the interface to the computer to do download the tested results. Otherwise the Penta scanner has small LCD screen to display its function. Whenever person does the testing at the same time he can store the tested result to the scanner. Otherwise the Penta scanner has small LCD screen to display its function. The function of the injector part is to injecting the signal to the scanner. Therefore we should connect the injector to the data outlet and detecting that from the other end of the cable may be from the patch panel side. Whenever the signal has injected by the scanner it will analyze the signal by various testing if the signal pass all testing the scanner will produce the pass test result even one test is failure the scanner can produce the failure results. It is important to the test5 procedure, first we have to do the calibration test to the injector. For further details of the cable testing and certification report see appendix.

CHAPTER-05

PROBLEMS ENCOUNTERED

Break Downs:

After we installed the net work we should maintain the networks. I.e. whenever the failure occur that particular company or organization where we installed the net work. They will call us to attend the problem. In that point engineering service creates order. In that case the company will assigned a person to attend that problem and send him to the site to solve that problem. In that way I have participated several break down in my training period and they assigned me to attend several problems.

In BASF, I have attended a problem one hub was failure. I went there and I released a new hub but there was no improvement. Therefore, I understood there was no failure in the previous hub also. Therefore, I tried to check the upper link for that. For that link I found it from the another hub. The upper link connected 8^{th} port of the hub (8 port hub). I inter changed the connection to one of the other port. At that time suddenly the link was got up. Therefore, I understood problem must be in the 8^{th} port. But getting a single port is impossible. Finally, the problem was recovered. When we connect two hub, we have to connect by using cross connection because both hubs should be either transmitting or receiving end normally find port of hub uses as cross connection earlier. It was connected as direct connection for the PC we interchanged the hub setting to cross connection. The problem was solved.

CHAPTER -06

ANALYZING THE POSSIBILITIES TO IMPLEMENT IBS IN SRI LANKA

In this part first we have to consider the companies, which are giving the products and the services, especially in maintenance to this related projects. In that case we are dividing this implementation part by two categories

5. To implementing structured cabling for the intelligent building
6. To getting control devices and other equipments for the intelligent building

When consider the structure cabling there are two companies popular in the world. One is Lucent's AVAYA Technologies and next one is NORDX/CDT Technologies. For the next step we must to consider their warranty period that they are giving for their cable products. In that case the Lucent Technology giving 20 years warranty periods to their products. And also their products installed everywhere in the world. Also when we considered the NORDX/CDT Technologies they are giving about 25 years warranty periods for their products and they also installed their products everywhere in the world. Therefore what we understand from this we can go either Lucent or NORDX/CDT Technology to provide intelligent cabling solutions to SriLanka.

When we consider the companies, which are providing control devices, and other, equipments there are so many companies providing these products. Some of the companies, which are giving these products to the world markets given below,

1. TOSHIBA Co.Ltd.
2. MOTOROLA Co.Ltd.
3. SHEVA
4. JOHNSON Control(s) Pte Ltd.
5. HONEYWELL

In the above companies the TOSHIBA, MOTOROLA, SHEVA are not much popular in the world compare with JOHNSON controls and HONEYWELL. When we compare the HONEYWELL and JOHNSON controls, HONEYWELL is a US$ 24 billion diversified

Technology and manufacturing leader, serving customers worldwide. Also there services not only limited to the IBS sides there are other services those their providing the world
Aerospace products services
The control services for the buildings, homes and industries.
Power generation system specialty chemicals fibers and electronic materials

The company has approximately 125000 employees in 95 countries. There fore it should be a big company.

If we compare with JOHNSON control it has 95000 employees world wide therefore it is small company than HONEYWELL.

The world wide branches for both companies are having branches in Asia specially in Singapore and India. Both having possibilities to get the products and the services to SriLanka. But HONEYWELL is having much more relationship with India than JOHNSON controls.

The relationships between India and HONEYWELL

*In Bangalore the HONEYWELL is estabilished Honey well India Software Operations (SHSO). This agreement has done between Network Solutions Ltd. and HONEYWELL. The idea of this to provides software base solutions and the products to India and the related countries in the Asia.
*The TATA HONEYWELL Ltd. at Pune they are joined venture for the HONEYWELL products.

*HONEYWELL's India headquarters Gurgaon. If we consider the information collected about above companies we can decides to making relationships with HONEYWELL company for the best choice of SriLankan customer.

CHAPTER-07

CONCLUSION

In my training period the reason that I have given more importance to this study, this is the one of currently developed new technology. The advance feature is the maintaining of the building is simpler and the operating costs are lower, and managing our building as separately for the power, lighting control, safety and security systems. This must be a very cost full for each administration. When we are adopt this new IBS system we can connect all above system under a single control. Therefore we can reduce the unnecessary maintenance charge much less than earlier and also can reduce the labor charge. Because of above good features of this systems, there is no doubt at the new future it will adopted by whole building owners all over the world.

Also during the stay at KBSL I obtained the better practical knowledge from the following areas:

1. Designing and implementing structure cabling.
2. Installing layer devices, such as hub MC, transceivers, repeaters and layer 3 devices. Installation and configuration such as switch and routers.
3. Fiber termination.
4. Trouble shooting for the breakdowns.
5. Designing networks proposal diagram by using Visio Software.

Under designing and implementation, we are considering the geography of the building and how many floors that living if it is a multi floor building. We have to propose how many back bones be have to install and where we are going to keeps the floor distribution, how many floor distribution from each floor, how we are going to inter connect all floor distribution to main distribution and what is the cable we are going to use for floor distributor and back bone.

Under the installation of layer devices we have to consider how many data we have to consider, how many data point we need for the customer because that is important to select a specific part for the hub. When we installing a hub we should consider cross connection and direct connection because if we want to connect the hub directly to the device we have to use direct cable for hub to device. If not we want to connect with another the hub we have to use for cross cable connection. If we use fiber media as backbone, transceiver has to be used to convert the optical signal to electrical signal.

The use of repeater is whenever our floor distribution become more than the length with is allowed (more than 90 m). We have to use repeater to concentrate the signal and re transmit back to the destination.

Function of the transceiver is also similar to the MC. Routers and switches work at network layer and these are responsible for traffic control. So, we should configure both devices for the fiber transmission. We are using specific fiber termination tool kit and following specific procedure to determine the fiber to the fiber connectors.

Under the trouble shooting techniques we are changing the faulty devices or we have to find out the failure of links between the devices up to the net work. All drawings, which are related to the network design, are doing by Visio software package. In that package we are using special stencils to design our structure.

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APPENDIX I

Sample Penta scanner certification report

KBSL

PENTASCANNER+ CABLE CERTIFICATION REPORT

*CAT5 Channel Autotest

Circuit ID:	C2-P3V3-3	Date:	22 Nov 2000
Test Result:	PASS	Cable Type:	*Cat 5 UTP
Link Performance:		NVP:	72
Owner:	MICROTESTER	Gauge:	
Serial Number:	38P96LB0258	Manufacturer:	
Inj. Ser. Num:	38T96H00996	Connector:	
SW Version:	V04.30	User: Hirdramani Head Office	
Building:		Floor:34th Floor	
Closet:			
Rack:		Hub:	
Slot:		Port:	

Test	Expected Results	Actual Test Results
Wire Map	Near: 12345678 Far: 12345678	Near: 12345678 Cable Skew (nS):3 Far: 12345678

			Pr 12	Pr 36	Pr 45	Pr 78
Length	m	0.0 - 100.0	9.1	9.5	9.3	9.0
Prop. Delay	nS	0 - 32767	42	44	43	41
Impedance	ohms	80 - 125	OVR	OVR	OVR	OVR
Resistance	ohms	0.0 - 18.8	2.0	2.4	1.4	1.8
Capacitance	pF	10 - 5600	441	455	464	442
Attenuation	dB		1.7	2.0	1.9	1.7
@Freq	MHz		94.0	94.0	93.0	94.0
Limit:	dB	Cat 5 Channel	23.2	23.2	23.1	23.2

PENTA Pair Combinations		12/36	12/45	12/78	36/45	36/78	45/78
NEXT Loss	dB	41.2	38.3	51.1	37.5	44.8	39.0
Freq(1.0-100.0)	MHz	96.1	97.7	63.5	87.9	97.9	95.5

Limit: Cat 5 Channel+0.0	dB	27.4	27.2	30.4	28.0	27.2	27.4
Active ACR	dB	39.3	36.6	49.9	36.0	43.1	37.2
Frequency	MHz	97.0	98.0	62.0	88.0	98.0	95.0
Limit: Derived	dB	3.7	3.5	12.2	5.6	3.5	4.1

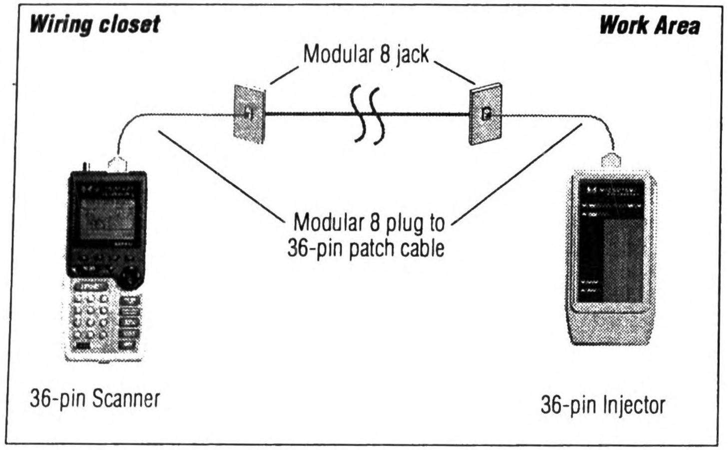
INJ Pair Combinations		12/36	12/45	12/78	36/45	36/78	45/78
NEXT Loss	dB	38.4	41.1	49.7	35.1	42.6	38.9
Freq(1.0-100.0)	MHz	97.4	81.4	61.8	87.2	96.2	94.6
Limit: Cat 5 Channel+0.0	dB	27.3	28.6	30.6	28.1	27.4	27.5
Active ACR	dB	36.7	39.5	48.4	33.8	40.7	37.0
Frequency	MHz	97.0	81.0	62.0	88.0	97.0	95.0
Limit: Derived	dB	3.7	7.6	12.2	5.6	3.7	4.1

Signature: ______________________________ Date: ______________

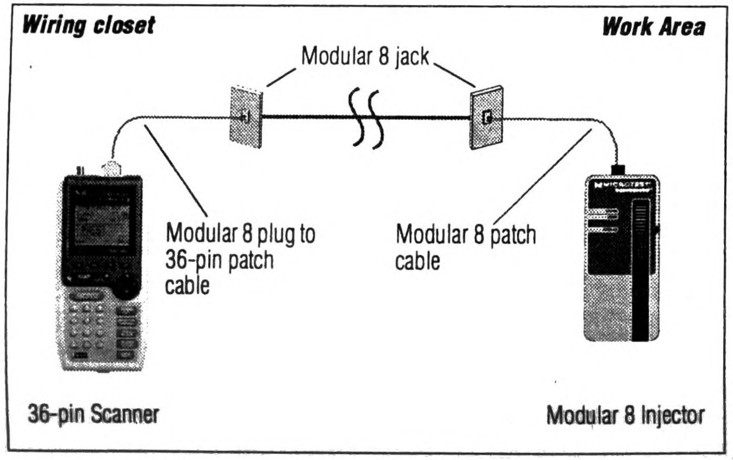
Basic Link with Modular 8 Jacks

The diagram below shows the connection of a ***PentaScanner+*** to a Modular 8 jack in the wiring closet and a ***2-Way Injector+*** or ***Super Injector+*** to a Modular 8 jack in the work area.

Use the *Modular 8 plug to 36-pin patch cable* to attach the ***PentaScanner+*** to the Modular 8 jack. At the other end of the link, use the *Modular 8 plug to 36-pin patch cable* to attach the Injector to the Modular 8 jack.

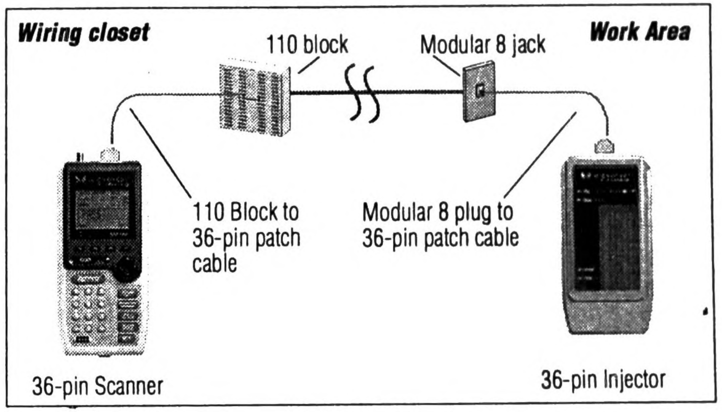


If you are using a ***Super Injector***, use the Modular 8 patch cable to connect the Injector to the Modular 8 jack as shown below:



Basic Link with IDC Block and Modular 8 Jack

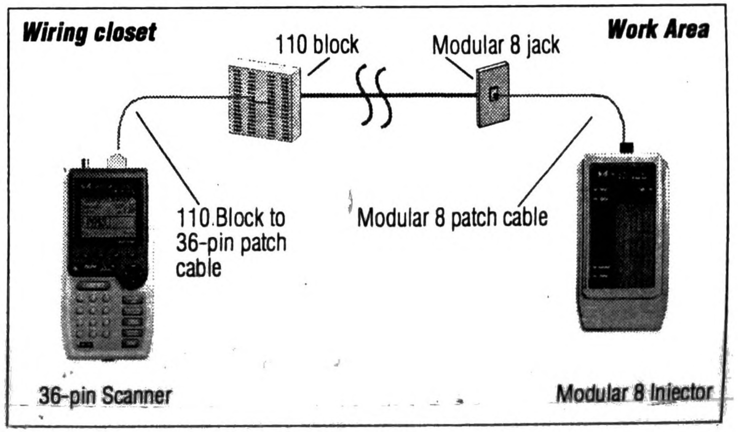
The diagram below shows the connection of a ***PentaScanner+*** to an IDC (110) block in the wiring closet and a ***2-Way Injector+*** or ***Super Injector+*** to a Modular 8 jack in the work area.



Punch Down Block Adapter kits are available (as optional accessories) to interface the Scanners with IDC (110) punch-down blocks. For the ***Penta-Scanner+***, order kit #8123-01. For the ***PentaScanner*** and ***PentaScanner Cable Admin***, order kit #8051-13.

Use the 110 Block to 36-pin patch cable to attach the Scanner to the 110 Punch down block. At the other end of the link, use the Modular 8 plug to 36-pin patch cable to attach the Injector to the Modular 8 jack.

If you are using a ***2-Way Injector*** or ***Super Injector***, use the Modular 8 patch cable to connect the Injector to the Modular 8 jack, as shown below:



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