

LOCAL AREA NETWORKS:
SELECTION CRITERIA AND PRODUCT DESCRIPTIONS

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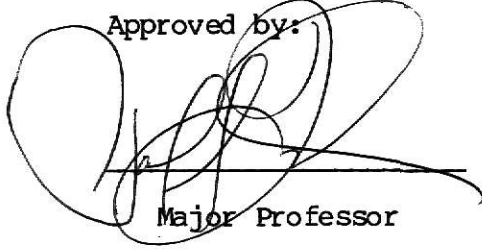
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CHAPTER 1: INTRODUCTION

1.0 PURPOSE

The local area network arena is sizzling with strong competition and new contenders are continually entering the market. Some firms are announcing complete systems and others are specializing in specific components.

Because of this influx of local area network manufacturers, it is becoming more difficult for businesses to determine which system or components to purchase or lease.

Generally, high level executives make all decisions which involve substantial expenditures. Most of these executives may not know what is meant by the term "local area network" much less know how to choose the right one for his or her purpose. Often the technical expertise which should be available in lower management positions is inadequate for major decisions because the expertise does not exist in new technologies. Relying on vendor opinions and suggestions can be unwise as vendors are inclined to fit the business needs to the system, while the executive should be concerned with finding the system which best serves the company's needs.

This report defines the terminology and explains the concepts which should be understood so that informed decisions can be made by non-technical high level executives. Also, twenty products currently on the market are described with emphasis on major local area network characteristics. Finally, the paper takes a look into the future to see how local area networks may be utilized.

1.1 LOCAL AREA NETWORK (LAN) DEFINED

Businesses are having to make crucial decisions in relatively short periods of time due to the state of the economy and the proliferation of governmental and regulatory mandates. Having access to reliable, current data from any physical area of the corporation is becoming necessary for survival.

This is the purpose of a local area network: to send, receive, process, and store useful information in co-operation with a central or neighboring site quickly and accurately.

A local area network can be described as a short distance data link network composed of lines, terminals, processors, and peripherals which create a resource sharing environment. The major elements of a LAN are:

- (1) A method to transport data from one location to another
- (2) A method to connect devices to the network
- (3) A set of rules essential for the efficient and reliable operation of the system.

Typical characteristics of a local area network include:

- (1) Single building or office complex residency
- (2) Data transmission rates from 100 thousand bits per second to 100 million bits per second
- (3) Maximum transmission distance of a few miles. (Currently, it is estimated that about 86 percent of all information needs fall within this distance constraint.)

In the past, local area networks have been privately developed within a business to meet specific needs which could not be fulfilled by outside vendors. Users have had control over the installation, operation, security requirements, and administrative tasks. At present, not all vendors are working toward common goals, such as system component compatibility. Plans for the future, however, include offering multi-vendor standardized networks which can be installed quickly and efficiently.

1.2 DEFINITIONS OF TERMS

This section contains definitions of terms used, but not defined elsewhere in this report.

- Address - An identification, as represented by a name, label, or number for a register, location in storage, or any other data source or destination, such as the location of a station in a communication network.
- Amplifier - A device which increases the magnitude of the signal on a transmission line.
- Baud - A unit of speed used to describe the rate at which data is transmitted. For every hertz of bandwidth, signaling rates of two bauds per second can be attained. The number of bits in a baud depends on the voltage level.
- Bit - A unit of information content. The smallest unit of information in a binary notation system. It is the choice between two possible states, usually designated one and zero. Bit stands for "binary digit".
- Block - A set of data, characters, or digits handled as a unit.
- Buffer - A temporary storage area between two computer devices, usually used to compensate for a difference in processing speeds between the devices.

Byte - A sequence of adjacent binary digits operated on as a unit usually eight, sixteen, or thirty-two bits long.

CCITTX.25 - A standard interface used in countries outside the United States and North America to link business machines and common carrier data links electrically to teleprocessing networks.

Central Site - Handles the network traffic between remote terminals. Also referred to as central controller, central facility, central host, and central hub.

Channel - The part of a communications system that provides a path along which data can be transmitted between computer devices.

Chip - A small rectangular piece of silicon on which an integrated circuit (IC) is implemented.

CRC - Cyclic-Redundancy-Check. A simple algorithm used to verify that information within a message is correct.

Emulation - The technique of using a hardware device and/or software program that permits programs written for one computer to be run on another computer in real-time.

FIFO - Stands for "first in, first out".

Firmware - Read only storage cards which when inserted become part of the circuitry. The cards usually contain programs written by the hardware manufacturer.

Hz - Stands for "Hertz" which is a measurement of bandwidth capacity of a facility.

K - A suffix meaning one thousand.

LSI - Large-Scale Integration. The technology of implementing several thousand transistors on a single circuit.

M - A suffix meaning one million.

Microcode - Usually refers to code written in firmware or ROM which cannot be changed.

Microprocessor - An LSI component which implements most of the traditional processor functions in one chip.

Modem - Stands for modulator/demodulator. A device that enables computer equipment to be connected to communication links.

Nanosecond (n) - One billionth of a second.

Node - Used interchangeably with the terms "station" and "terminal".

Noise - Interference picked up by a transmission medium.

Port - Usually an eight-bit connection which may be used for either input or output. A means of access to a system.

Process - A series of actions that constitute a task.

RAM - Stands for Random Access Memory. Storage locations can be accessed without reading an entire file. Standard RAMs lose the data when power disappears (volatile).

Remote Node - A node or station that is attached to a system through a data link.

Repeater - A device that attaches to communication transmission media which is used to restrengthen a signal.

ROM - Stands for Read Only Memory. Memory whose values cannot be changed. Memory is not lost when power disappears (non-volatile).

RS-232C - A binary serial interface. Defines standard interface transmission speed ranges from 100 to 9600 baud. Used principally by North American countries.

Transceiver - A radio transmitter-receiver that uses many of the same components for both transmission and reception.

1.3 ORGANIZATION OF THE REPORT

This report is organized into four additional chapters. Chapter 2 describes the ten major considerations of local area networks needed for a basic understanding. Chapter 3 describes twenty current local area network products. Chapter 4 looks briefly into how local area networks may impact and influence the future, and summarizes this report.

CHAPTER 2: SELECTION CRITERIA

2.0 INTRODUCTION

Selecting a local area network system or component can be traumatic if approached improperly. An adequate base of information is needed in order to compare and appraise local area network products fairly. A product which is good for Company X may prove a disaster for Company Y; therefore, a decision cannot be based on manufacturer or product popularity alone.

The features which business personnel should be familiar with in order to compare systems and components are:

- (1) Topology
- (2) Line types
- (3) Line sharing techniques and access methods
- (4) Physical limitations
- (5) Transmission media
- (6) Transmission mode
- (7) Data rate/Bandwidth
- (8) Length of signal
- (9) Protocol
- (10) Layered architecture

The remainder of this chapter describes the features listed above.

2.1 TOPOLOGY

Topology refers to the way a network is configured - its physical connectivity. Local area networks have five basic configuration patterns, as follows:

(1) Star Topology (Figure 2.1-1)

This configuration uses a central facility to control data transfer among satellite nodes. The design approach is easy and well-understood, but the limitations and reliability of the central hub determine all network performance characteristics. Connecting the central host to each user requires an abundance of cable and can, therefore, be more expensive in this aspect than other topologies. But, because there is a central controller, the attached stations can be "dumb" and less expensive. A major disadvantage of the star configuration is that it is extremely vulnerable to catastrophic failure since an outage at the central site wipes out the entire network.

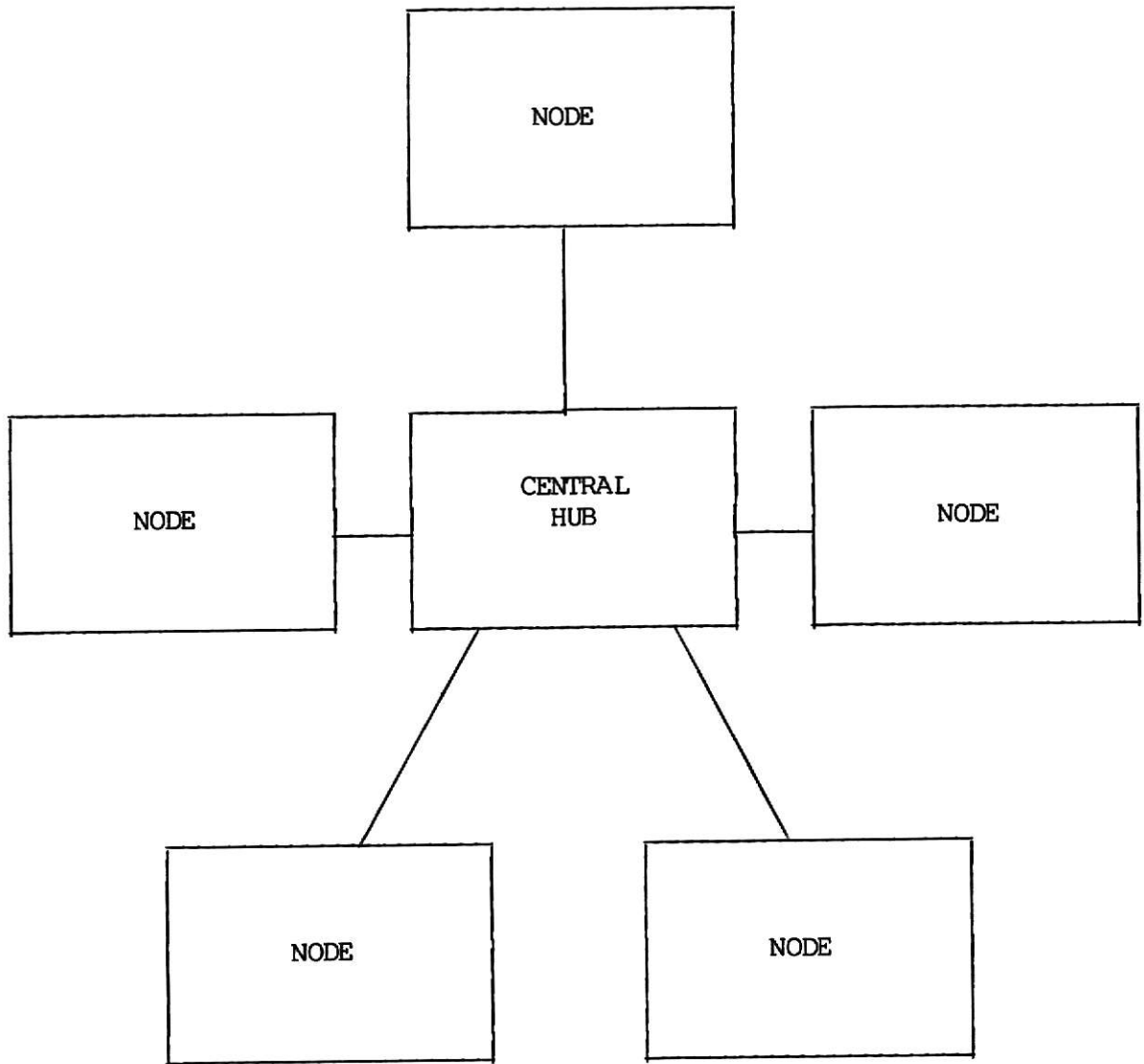


Figure 2.1-1 Star Topology

(2) Loop Topology (Figure 2.1-2)

The terms "loop" and "ring" are generally used interchangeably; however, some authorities make the distinction that loops have a central controller, while rings do not. Generally, they are both composed of one-directional transmission links where the nodes are connected in a circular fashion.

Loops transmit data by physically passing messages through each station toward the central controller. The controller begins all output traffic, which must pass through each station between the controller and the receiving node. Because messages travel through each node, the stations must be intelligent enough to handle message traffic.

Reliability problems are of paramount concern with loops as line, controller, or node failure can bring down the entire system. Bypass lines can be used to alleviate this problem, but this increases expense considerably.

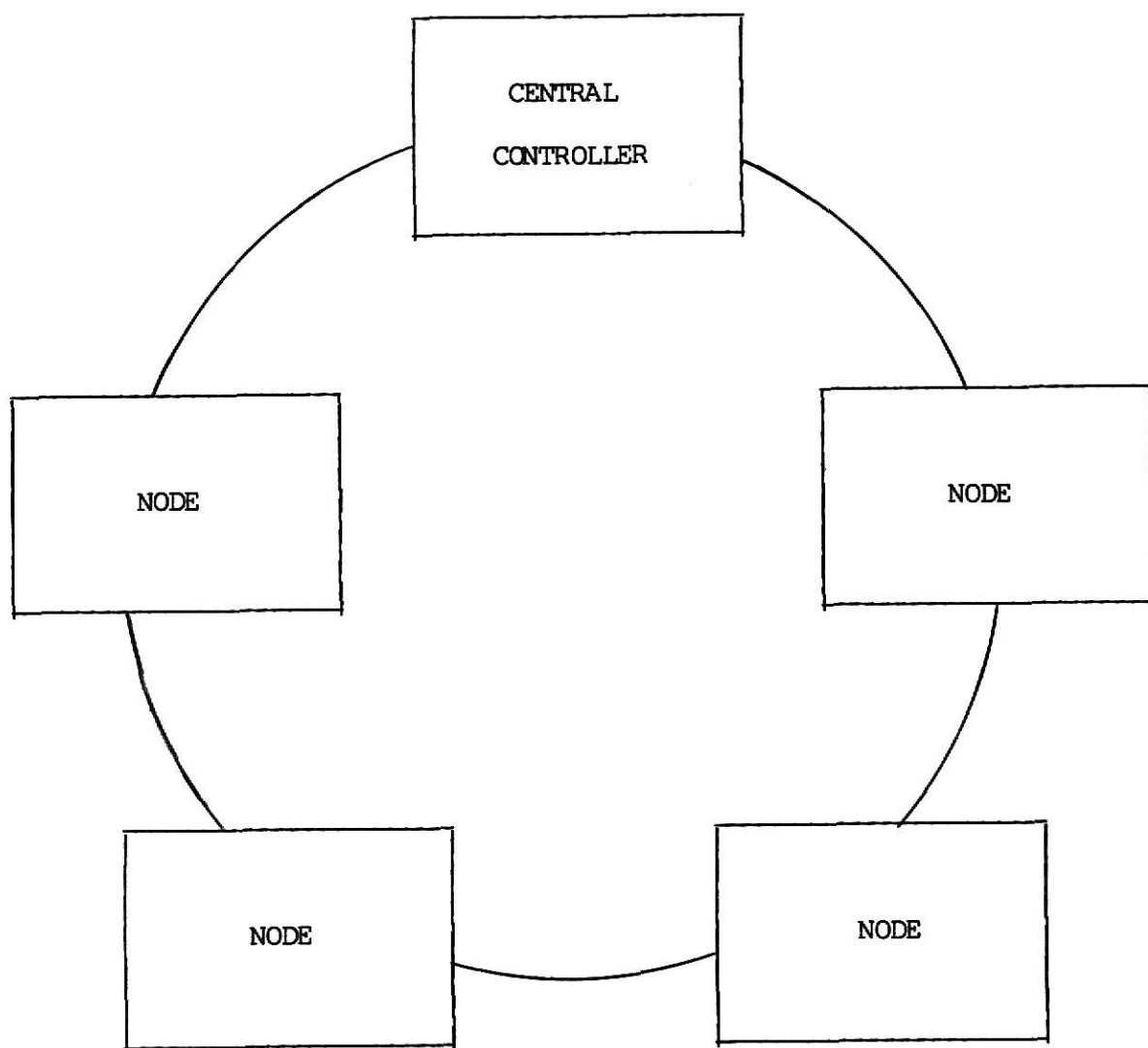


Figure 2.1-2 Loop Topology

(3) Ring Topology (Figure 2.1-3)

Rings have no central controller. This eliminates the problem of the central unit becoming a bottleneck, but at the same time requires each station to be intelligent enough to format messages and handle message traffic. Because these nodes are active, they are more difficult to modify. They are complex in that each message passes through each node on its way to its destination. Compared to the star, ring architecture is simpler and less expensive.

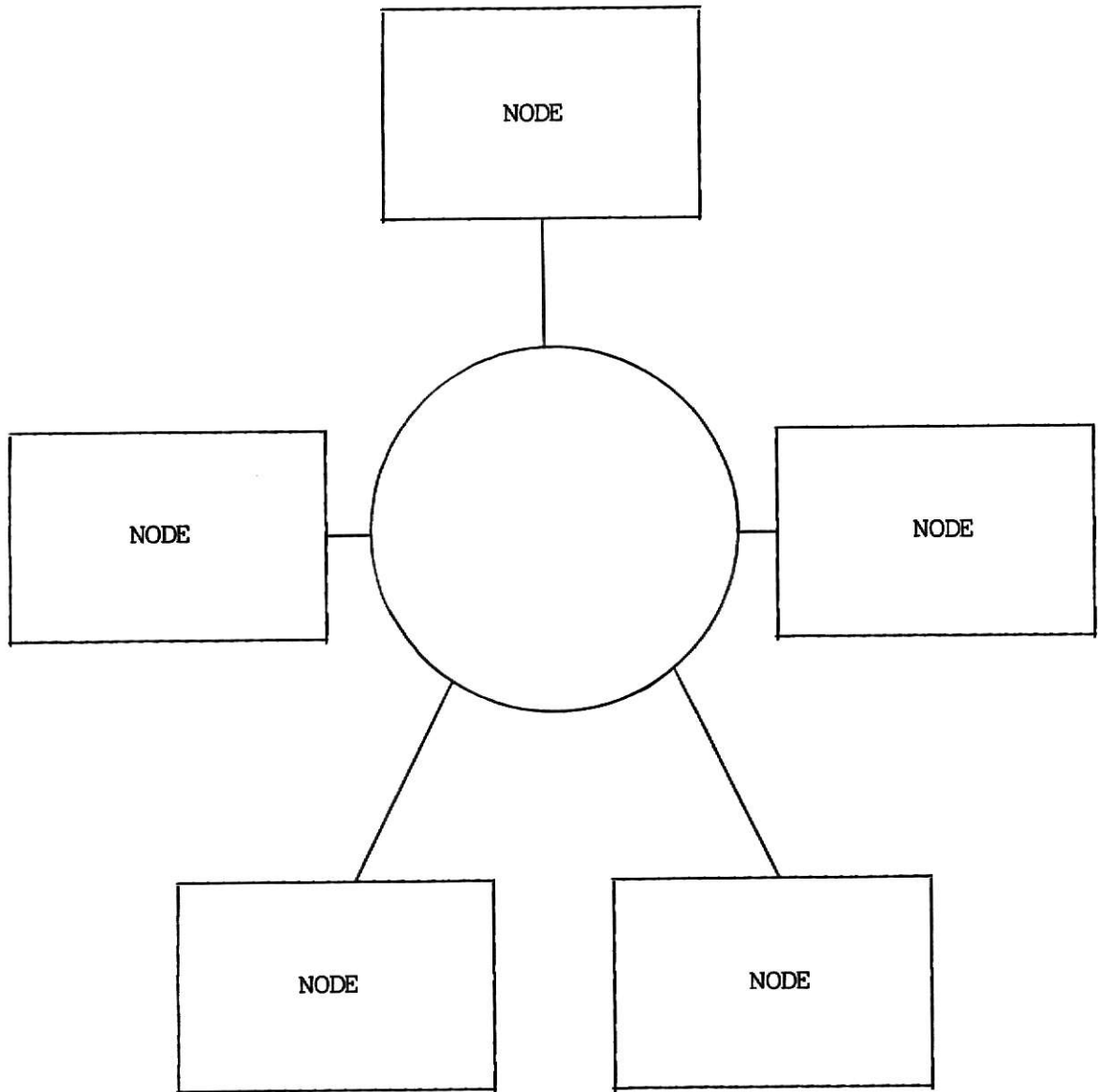


Figure 2.1-3 Ring Topology

(4) Tree Multidrop, Bus Multidrop Topology (Figure 2.1-4)

Within tree multidrop configurations every station has access to the cable but it may be through another station. Bus multidrop allows every station a direct access to the bus. All stations share a single high bandwidth serial channel. The bus is passive, while the stations are active. This necessitates intelligent stations. By using passive connections, it alleviates the reliability issue. Simpler transmission hardware can be used to access the bus. This method usually allows the simplest, least costly, and most reliable implementation. Nodes can be added or deleted without disturbing network operation. Also, node failure will not disturb the system. Even a break in the bus results only in the bus being separated into two subnetworks.

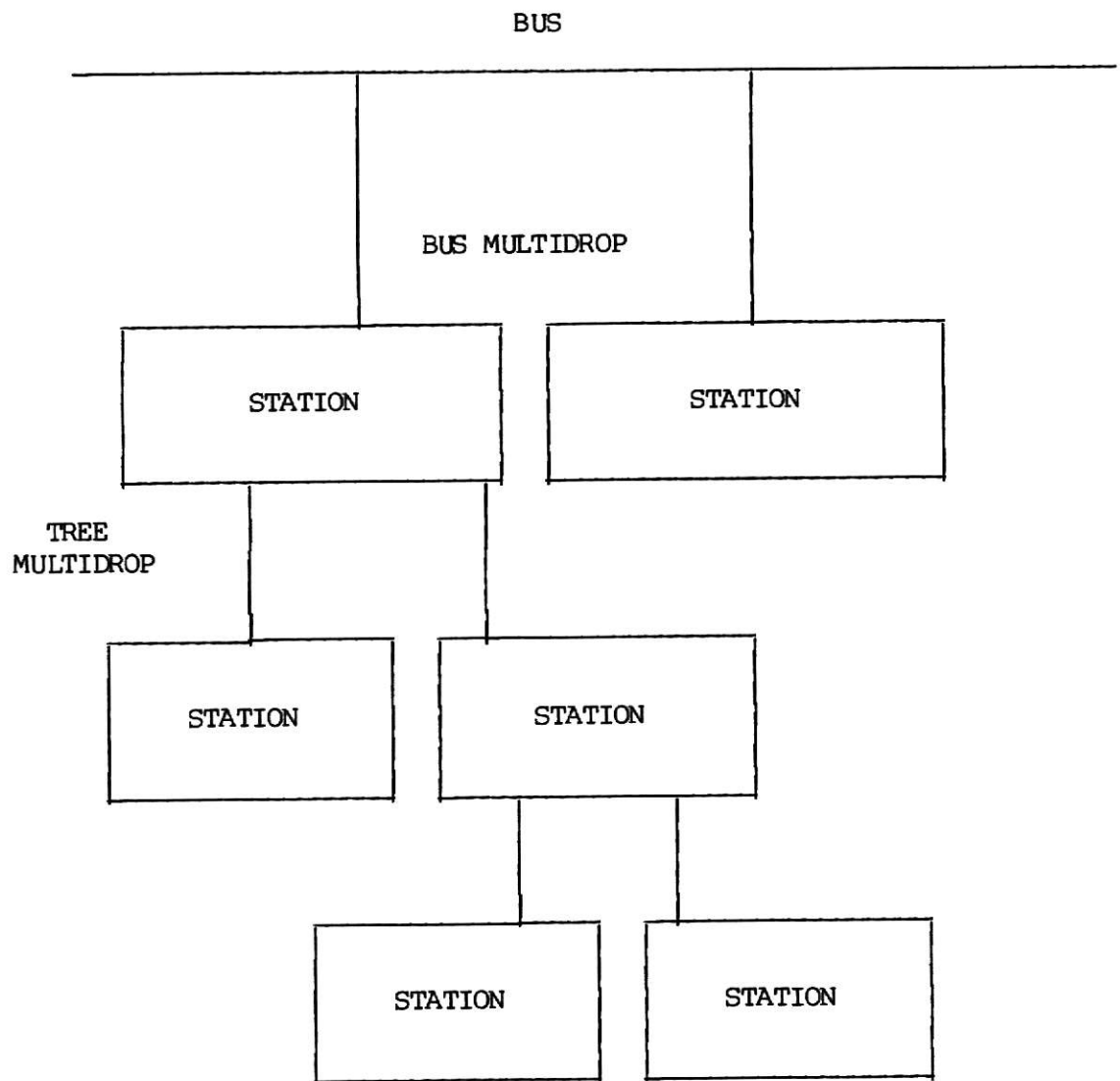


Figure 2.1-4 Tree/Bus Multidrop Topology

(5) Mesh Topology

Mesh topology refers to the fact that there is no pattern to the connections. Each node can have multiple paths to other nodes in the system. There are two basic types of mesh configurations.

(a) Irregular (Figure 2.1-5)

In this configuration not all nodes are connected to each other. Generally, stations that need more reliability have more connections so that chance of failure is lessened. Nodes which are not as critical will have fewer links to other nodes.

(b) Fully-interconnected (Figure 2.1-6)

As the name implies, all nodes in this topology are connected to each other. This is an expensive method as it requires much cable; however, the system can continue to operate when a link or node fails by finding another route.

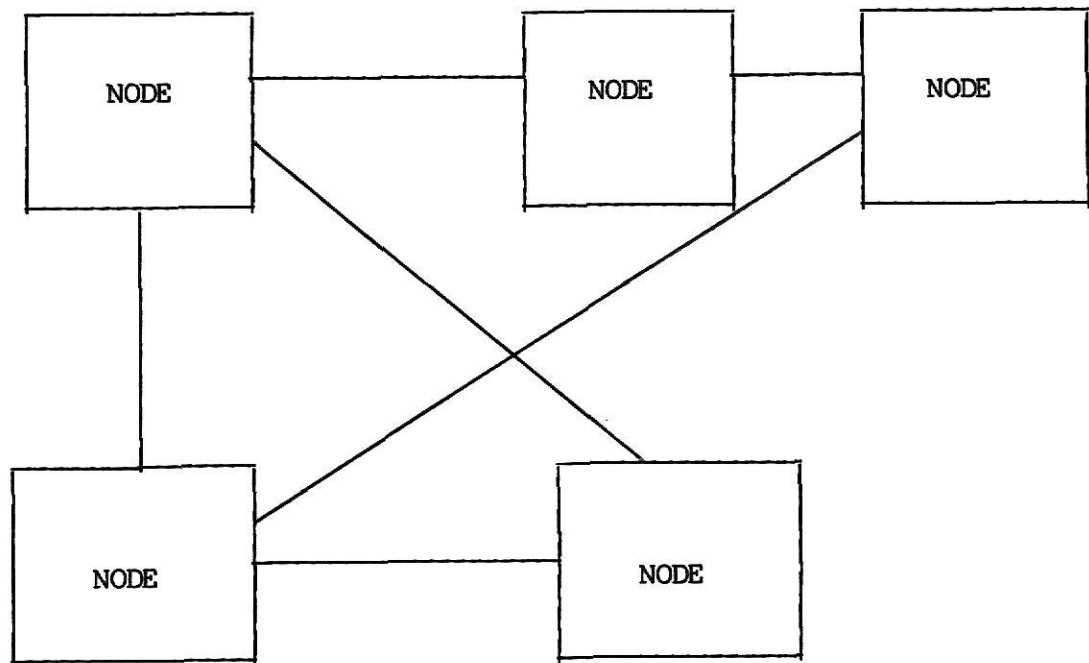


Figure 2.1-5 Irregular Mesh Topology

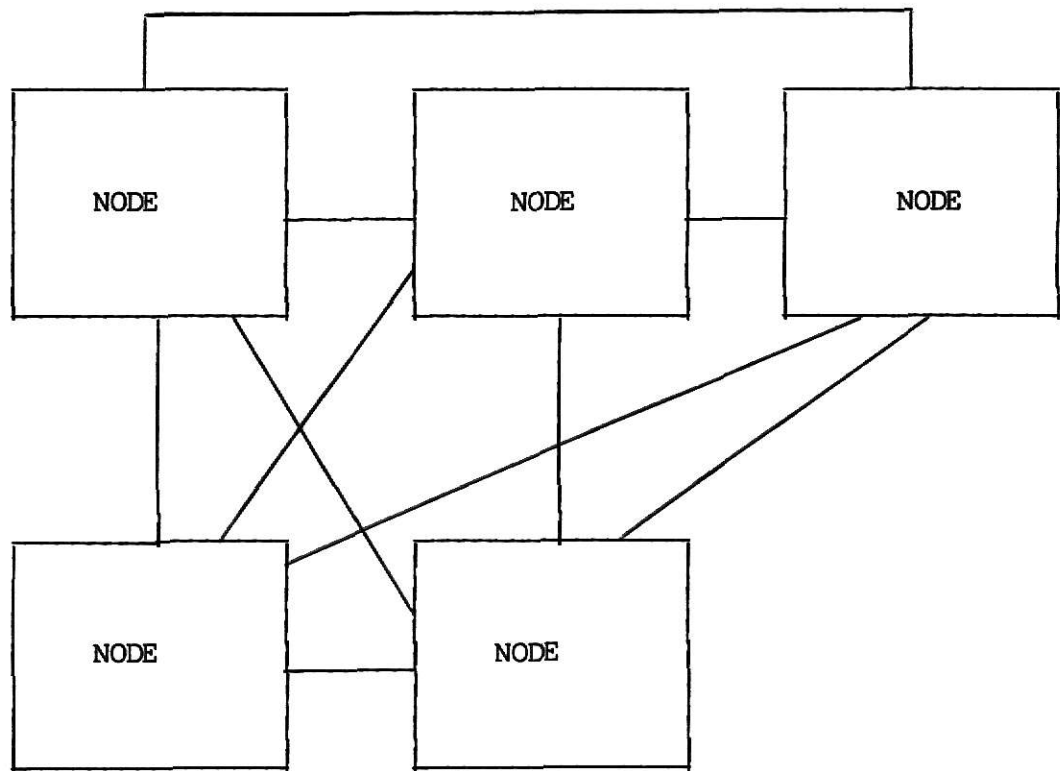


Figure 2.1-6 Fully-Interconnected Mesh Topology

2.2 LINE TYPES

Communication lines within a local area network can be point-to-point or multipoint lines. A point-to-point line operates between the nodes of a fixed origination - destination pair exclusively. Point-to-point lines may be either switched (dial-up) or leased (dedicated).

Switched point-to-point lines involve the use of a common carrier network such as the public telephone. The connection which is established over this type of line is supported only for the span of a single call. Normally, if modems are not obtained by the Bell System, a device called a Data Access Arrangement (DAA) is required for connection to the system because most leased voice-grade lines are four-wire circuits while a dial-up connection furnishes only a two-wire circuit.

Leased point-to-point lines provide for a perpetual connection between the origination - destination pair, regardless of whether or not the line is being used. Generally, the response is better for dedicated lines because there is no need to wait for access to the line; however, the cost associated with this type of line is much higher than the switched type.

Other advantages of leased lines include:

- (1) the chance of misconnection is greatly reduced
- (2) privacy is increased
- (3) the noise associated with switched lines is greatly reduced.

Systems have been designed which equip leased lines with a dial back-up to provide an alternative in case of dedicated line failure.

Multipoint lines are dedicated lines that are shared by more than one station. Only one node can transmit at a time so a polling list is generally necessary to determine which station is allowed access to the line. Signals transmitted from a modem are received by all stations; however, only the one with the correct address can accept the data.

Multipoint lines are generally less expensive than point-to-point lines because they require less modems and ports, and they also incur lower line charges. Their disadvantages include possible reduction in response time for each station added to the line, and a need for more software to control access to the line.

Dedicated point-to-point lines are used when high traffic volume is expected or when fast user response time is crucial.

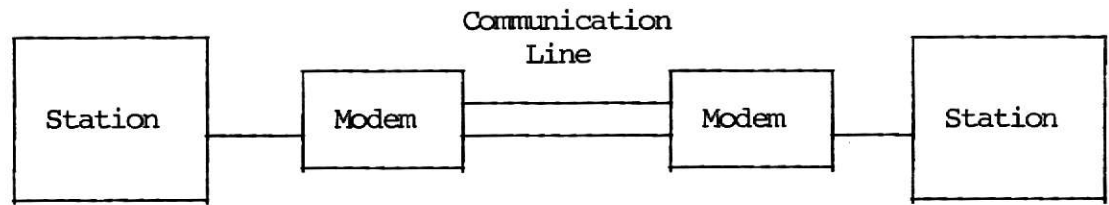


Figure 2.2-1 Point-to-Point Lines

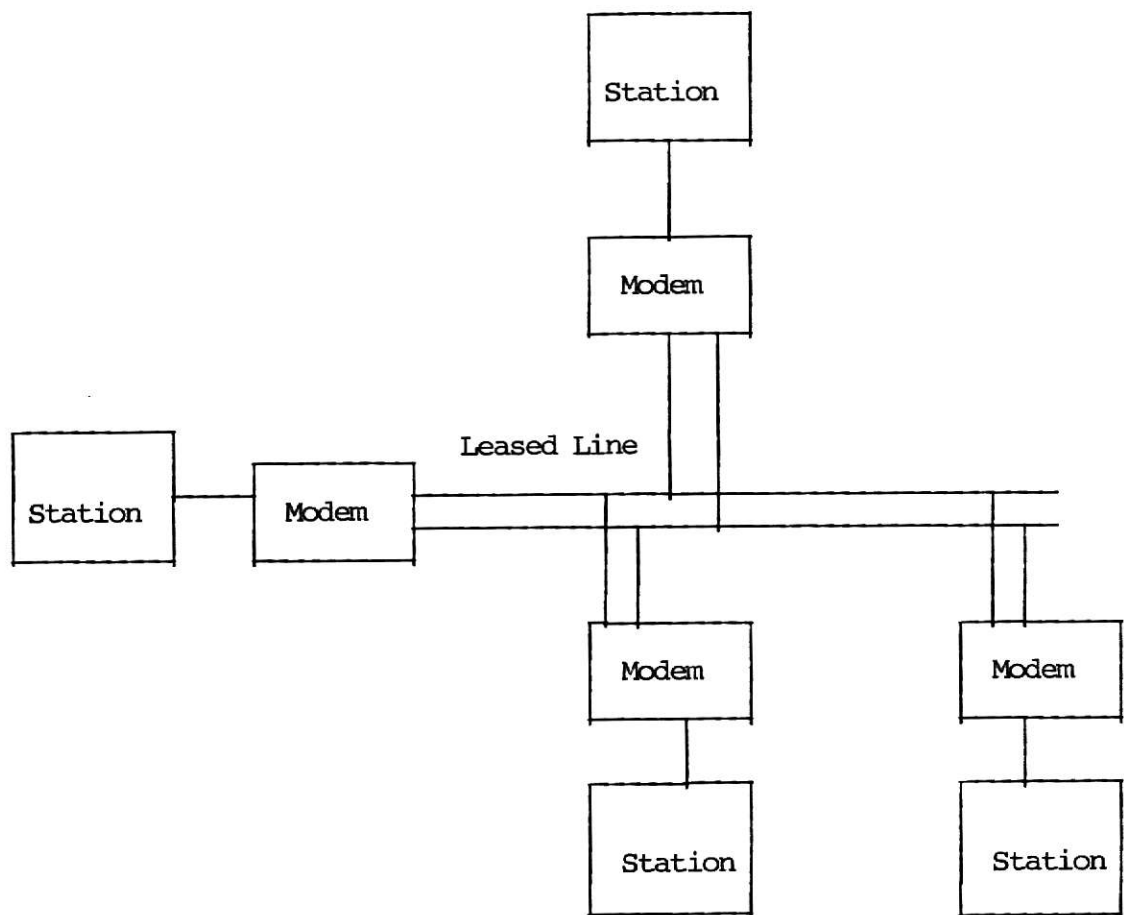


Figure 2.2-2 Multipoint Lines

2.3 LINE SHARING TECHNIQUES AND ACCESS METHODS

(1) Line Sharing Techniques

Multiplexing and concentration are the two types of line sharing techniques in general use today. Multiplexing is based on sharing schemes which allocate time slots or frequency bands in a fixed, predetermined pattern. Three multiplexing schemes are in general use.

- (a) Frequency-division multiplexing (FDM) divides a communication channel into lower speed subchannels. Each subchannel then operates within its own frequency allocation. Normally this method is used only with asynchronous devices where speeds of up to 150 bits per second and sometimes higher can be attained on voice-grade lines. Advantages to this method usually revolve around low cost where the total bit rate required of the channel is not too high. Modems can usually be eliminated with this method because the FDM device normally handles that function. Also FDM schemes allow for easy addition and deletion of nodes along the channel. Voice, data, and video can share a channel using FDM techniques. Probably the biggest limitation of this method is the need for safety areas between subchannels to prevent overlapping of the signals. This tends to reduce the efficiency of this system. Figure 2.3-1 depicts frequency-division multiplexing.

(b) Synchronous time-division multiplexing (STDM) establishes for each port (sharing a channel) a time slot or subchannel, shaves off incoming data bits, puts them into frames, and interleaves them onto a single high speed line. This method can be used for both asynchronous and synchronous devices. Speeds of 4800, 7200, and 9600 bits per second are possible on dedicated voice-grade lines. STDM can make use of the entire bandwidth which makes it generally more efficient than FDM (which may have frequency channels that remain idle for long periods of time). It is difficult to add or remove subchannels when using this method as compared to FDM because a complete STDM system must be added where the change is taking place. Figure 2.3-2 depicts synchronous time-division multiplexing.

(c) Statistical time division multiplexing (STATDM) actually combines multiplexing and concentration techniques since it assigns subchannels or time slots on a statistical basis. Only active ports are provided with time slots in this method which increases the efficiency of the system over both STDM and FDM. However, STATDM may be unable to meet the needs of systems with heavy loads. Costs are higher than with FDM and STDM due to the need for addressing and control circuitry and data buffers for message storage.

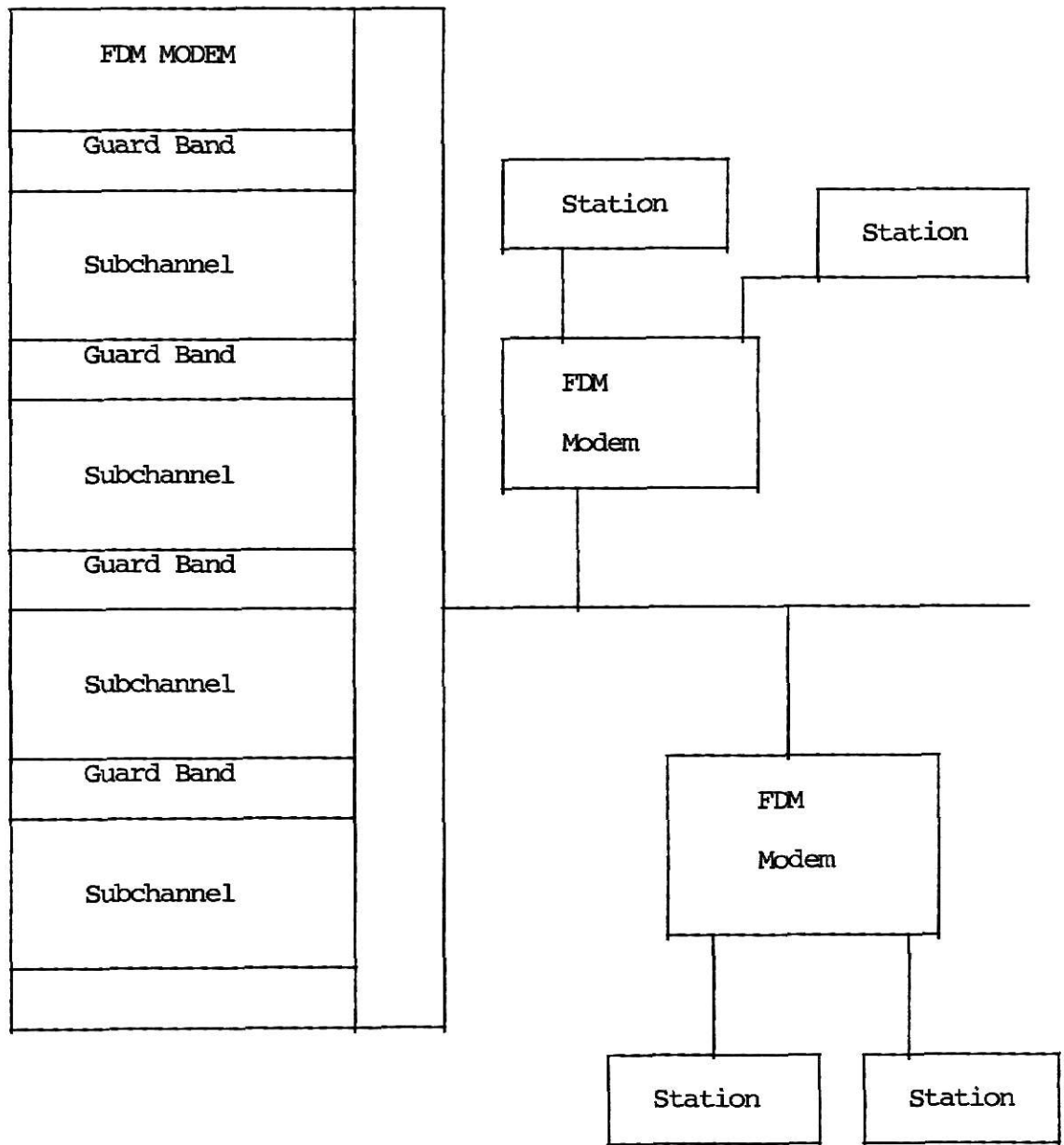


Figure 2.3-1 Frequency Division Multiplexing

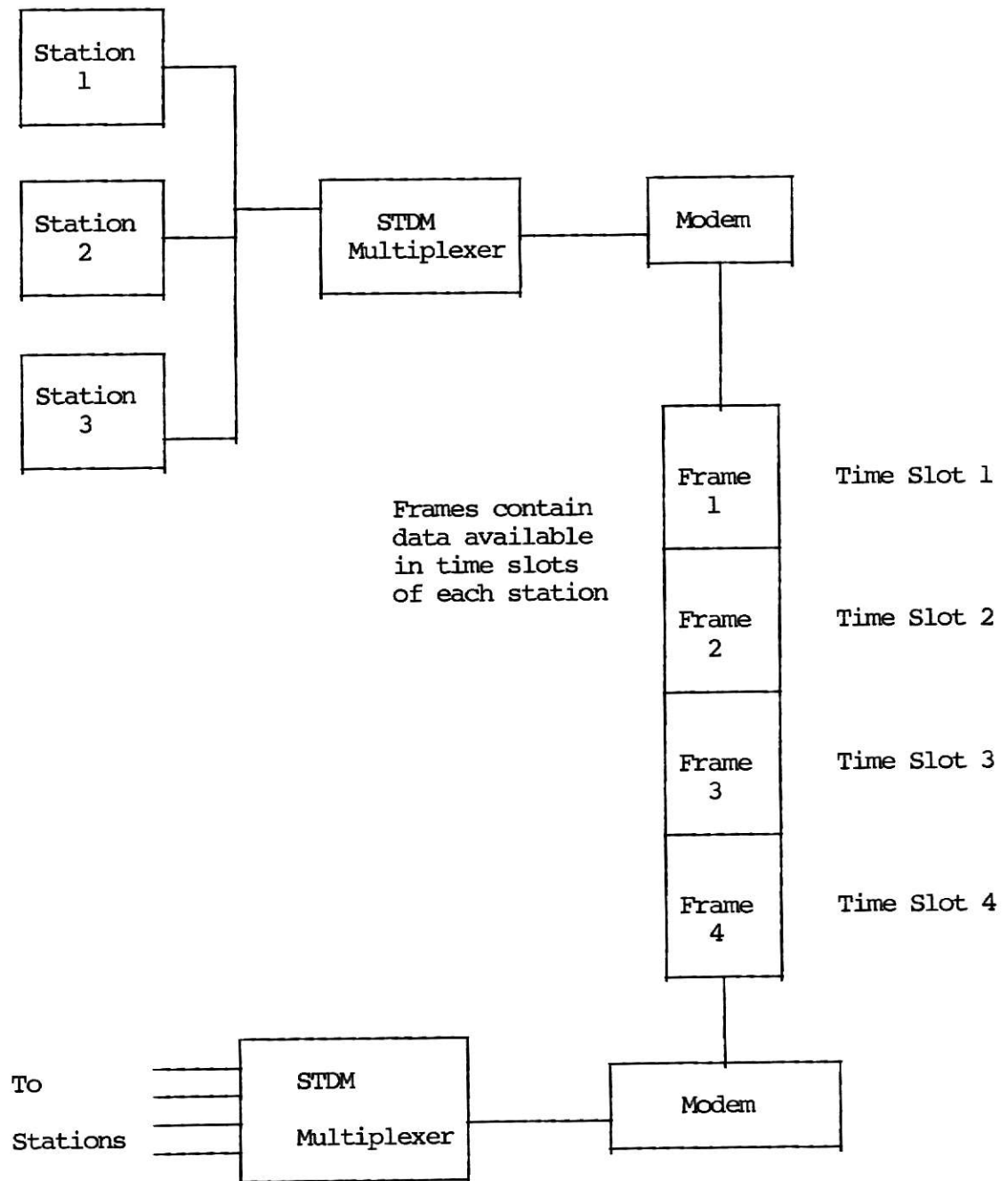


Figure 2.3-2 Synchronous Time-Division Multiplexing

Concentration describes schemes which provide a large number of input ports with a smaller number of output channels which are accessed on a demand basis. Input and output bit rates do not need to match in these schemes since the system queues and stores input traffic. There are two basic types of concentration techniques.

- (a) Message switching concentration (MSC) stores an entire block of data and prepares it for transmission upon the high speed line. Queues are established when necessary. Because these messages are variable length and can be quite long (which in turn can tie up the system) the second technique of concentration was developed.
- (b) Packet switching concentration (PSC) divides up long messages into packets. These packets are then interleaved onto the system. The packets are reassembled in the destination's buffer area. Packet switching concentration is illustrated in Figure 2.3-3.

Both concentration methods are instrumental in performing line control, code conversion, and error checking functions. Their disadvantages revolve around the need for more complicated software and more buffer storage. Also, reliability problems may result from the need for programmable computers at destination sites which, if they fail, can cause the entire system to become inoperative. Of course back-up units can be installed, but the cost of this may reduce the feasibility of implementing these techniques. In large networks, the flexibility and performance advantages may outweigh the cost disadvantages.

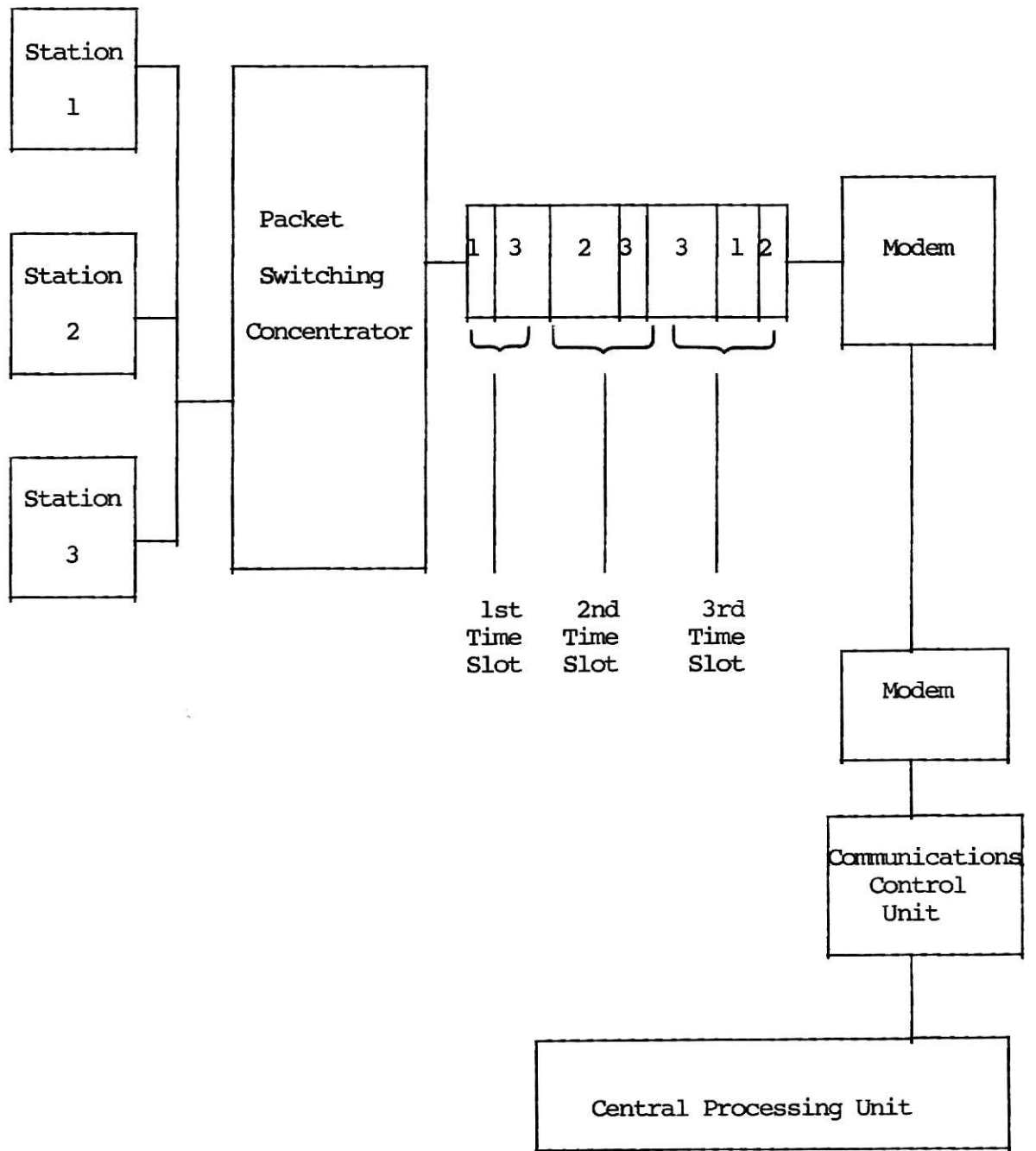


Figure 2.3-3 Packet Switching Concentration (DOLL78)

(2) Controlling Access to the Trunk

There are two basic approaches to controlling access to the trunk. Contention is the simplest type of line control which essentially involves all stations actively competing for access to the line. If the line is free, the node can transmit. If the line is busy, the node must wait and try again. If two nodes get on the line at the same time a "collision" results and both must stop sending and wait a random amount of time before trying again. This method is often referred to as Carrier Sense Multiple Access with Collision Detection or CSMA/CD.

Polling is the second technique which is used mainly on multipoint lines. There are several different types of polling including:

- (a) Roll call polling. This technique requires a central station to request messages of remote stations in a predefined order. If the remote station has something to send it is transmitted; if not, a control message is sent indicating there is no message and the next station is polled. Each station has a unique address which only it can respond to. General polling requests any device at a particular station to transmit while specific polling requests a certain device at a particular station to transmit.

- (b) Hub polling allows a station to send a message to the central station or pass the poll to the next station if there is no message. This requires more hardware and software but it can increase the efficiency of the system by eliminating the need to return a message to the central station when there is no transmission waiting. This method can be used effectively when terminals are generally inactive and lines are very long. Polling resumes at the next terminal so that one active node cannot monopolize the line. Terminals must be intelligent to use this method.

With polling techniques it is possible to increase the number of times certain stations are polled as compared with others so that those with higher priority can have more frequent use of the line. Possible disadvantages of polling are:

- (a) a high proportion of control messages must pass through the network which tends to lower the efficiency
- (b) the need for more intelligent terminals.

The choice between polling and contention depends generally on the network configuration, the relative activity of terminals, and the amount of time terminals are active. Generally, loops use polling methods, while bus configurations often rely on contention.

2.4 PHYSICAL LIMITATIONS

The following physical limitations may be of concern when researching local area network products.

(1) Maximum Number of Stations

The number of stations which can be supported by a LAN is of prime importance to a firm which expects their system to expand. LANs can range from accommodating a few stations to those which can handle several hundred.

(2) Maximum Cable Length

The maximum length of cable which can be used in a local area network is an important consideration if the physical environment may expand into other offices within a building or into an adjacent building. It is important to make certain the system will not be limited by the cable length.

(3) Maximum Distance Between Stations

The maximum distance between stations is an important consideration, especially if there is a necessity to locate some stations in distant areas of a building or in an entirely different building.

2.5 TRANSMISSION MEDIA

Several different types of transmission media are available for use in tying together the components of a local area network. The media include:

(1) Radio Broadcasting

This method is extremely flexible - anyone can talk to anyone else without going through a central site. For some applications this method may be feasible, but ordinarily business applications do not render themselves well to the lack of privacy and security which is inherent in this medium.

(2) Twisted Pair

The most prevalent type of transmission medium used within the last several years was the twisted pair. The "two twisted wires" approach made for a comparatively inexpensive, well-understood, easy to install (and add on to) line that could handle data sent over relatively short distances (several thousand feet at 9600 bits per second) without the use of modems. When short-haul modems and phone lines are used the distance can increase to several miles (at 9600 bits per second maximum). The drawbacks to this medium are its susceptibility to noise and its limited bandwidth.

(3) Coaxial Cable

This medium has become the most widely used in recent time. It is the same medium that is used in commercial Cable TV transmission. High data rates of 5 to 10 million bits per second (and sometimes higher) are common, and data can be transmitted relatively long distances. Bandwidths of 300MHz are standard. Coaxial cable is relatively inexpensive and immune to noise; however, security can be a problem as this medium is subject to wire taps. Also, the size and weight of the cable can be a problem at some sites. Repeaters are necessary to strengthen the signal at intervals which can escalate the expense involved in using this medium.

(4) Fiber Optics

This medium shows the most promise for the future of local area networks. It involves transferring data using streams of light which results in very high bit rates (in excess of 1000M bits per second), high noise immunity, low transmission loss (with transmission error rates of less than one in a billion bits), and small physical size. It can be used safely in hazardous environments as it does not arc or short-circuit. With a currently available bandwidth of up to 3.3GHz (billion cycles per second), this medium is practically impossible to overload. It also is virtually immune to wire tapping and does not need repeaters. The main problem with fiber optics is the difficulty involved in making multiple connections on the trunk of the line. This problem will eventually be solved by a breakthrough in technology. Other disadvantages with this medium are its high cost and lack of standards which can both be attributed to the fact that there is less mass production of this technology compared to the other media available.

2.6 TRANSMISSION MODE

Data is generally transmitted in bit-serial manner between modems in either asynchronous or synchronous mode. Asynchronous transmission employs a start bit and a stop bit on each character of data transmitted. This mode is most often used in applications which require up to 1200 bits per second data rate.

Synchronous transmission uses a constant rate clock to transmit data. The exact time at which bits are sent is determined by the clock. The modem at the receiving end must be set up with the same interval rate in order to determine the beginning of a character. Transfers of 2000 bits per second and higher are normal with this mode.

Data can also be transmitted in parallel by sending individual bits of a character simultaneously using independent subchannels.

Synchronous data transfer generally uses the line more efficiently than either asynchronous or parallel transmission.

Transmission mode is sometimes used to mean mode of station operation.

There are three types of station operation mode. The simplex mode allows for transfer of data in one direction only. This mode is not used very often as it is nearly always necessary to both send and receive signals in networking applications.

Half-duplex mode can transmit data in either direction but not at the same time. Either two-wire or four-wire facilities permit half-duplexing.

Full-duplexing (FDX) allows simultaneous transfer of data in both directions. Four-wire facilities are necessary for full-duplex mode since two separate transmission paths are necessary.

2.7 DATA RATE/BANDWIDTH

Bandwidth is an electrical property of a transmission facility which indicates the range of frequencies that the facility can successfully pass. Data rate is determined by the size of the bandwidth. The smaller the bandwidth, the slower the data rate. There are two common types of bandwidth used in local area network systems. They are called baseband and broadband.

Baseband transports digital data in a common channel and can support data rates of up to 10M bits per second. However, repeaters are necessary to keep the speed at this level over long distances since there is a definite speed/distance trade-off in transmission.

Broadband is capable of sending data at speeds of about 150M bits per second due to its wider frequency. This bandwidth allows for video, voice, and data transfers on the same cable by dividing the frequency signal into subchannels. Though broadband supplies a much higher total bandwidth, it usually offers lower subchannel bandwidth (1M to 2M bits per second at most). This is due in large part to the expense of modems which handle over 4M bits per second. Amplifiers can also be used in broadband lines to strengthen the signal over long distances.

2.8 LENGTH OF SIGNAL

The number of bits or characters that can be passed at one time may be important to the efficiency of the system. Generally, the longer the signal length, the faster the aggregate data rate of the system. However, during heavy traffic, long signals tend to tie up lines, thus causing slower response times to system users.

2.9 PROTOCOL

Protocols designate how nodes can communicate with each other in a network. They are the methods and rules used to maintain systematic interaction between processes.

Protocols ideally should provide for the following (STAC80):

- (1) flexibility (to accommodate new uses and features)
- (2) completeness (to properly respond to all relevant network conditions)
- (3) deadlock avoidance/backout mechanisms
- (4) synchronization mechanisms (for interprocess control)
- (5) error detection and recovery
- (6) buffer overflow avoidance
- (7) message sequencing assurance
- (8) duplicate message detection and recovery
- (9) permeance (to implement the protocol uniformly throughout the LAN)
- (10) priority mechanisms
- (11) accounting mechanisms
- (12) security mechanisms
- (13) message delivery guarantees
- (14) data code/format transformations
- (15) computer equipment feature compatibility
- (16) operating system feature compatibility
- (17) communications network feature compatibility

Elementary high level protocols are charged with the responsibility of making available to the entire network all the programs, routines, and operating services of a single system. There are three types of elementary high-level protocols generally referred to in current literature:

- (1) applications-oriented protocols
- (2) executive-oriented protocols
- (3) network-induced protocols

Applications-oriented protocols are responsible for allowing the programs in one node's files to be used by all nodes in the network. These programs include file transfer, editor, compile, execute, and debug operations.

Executive-oriented protocols apply to the operating system services provided by individual nodes. They normally include common operating services and other services which generally allow for printer, teletype, screen, and graphics capabilities. Once again the idea is to allow nodes in the system to access and use the capabilities within another node that is supplying those capabilities using pre-defined rules.

Network-induced protocols are used to smooth the way through the network so the above described protocols can function. They include network destination declaration, network access authorization, network directory service, network message exchange, multiple-node processes, and network maintenance and security services.

2.10 LAYERED ARCHITECTURE

Layered architecture of a local area network allows for distinctions between the physical and logical components of a system and therefore opens the door for multiple manufacturers' components to be integrated into a LAN. When layered architecture approaches are used, a subsystem in a hierarchical division interacts only with elements in the next higher or next lower division. Cooperation between entities in a layer is governed by a set of protocols specific to the layer.

The International Standards Organization (ISO) has specified the layers of a LAN that can be used as a standard when designing a system (Figure 2.10-1).

The layers included in the ISO model are:

(1) Layer 7 - Application Layer

This layer provides services necessary for the end user to interact within the network. Three protocols are defined for this layer.

- (a) system management protocol which oversees the open system
- (b) application management protocol which directs the application processes
- (c) system protocol which executes processes for the application.

All other layers of this model exist solely for the purpose of supporting the application layer.

(2) Layer 6 - Presentation Layer

This layer provides for the interpretation of data exchanged within the network. This job is divided into four steps.

- (a) a connection is established
- (b) interpretation options are selected
- (c) transfer of data is performed
- (d) the connection is broken

(3) Layer 5 - Session Layer

This layer assists in supporting cooperating nodes interaction by providing two services:

- (a) connecting and disconnecting the nodes
- (b) controlling data exchange, synchronizing data and supporting full-duplex, half-duplex, and simplex modes of operation.

(4) Layer 4 - Transport Layer

This layer provides for the transfer of data between session nodes. These services involve optimizing available communication services at minimum cost.

(5) Layer 3 - Network Layer

This layer provides for transparent routing and connections between two or more transport entities.

(6) Layer 2 - Data Link Layer

This layer hides the characteristics of the physical layer so that data links can be established between network entities.

(7) Layer 1 - Physical Layer

This layer provides for establishing, maintaining, and releasing physical connections.

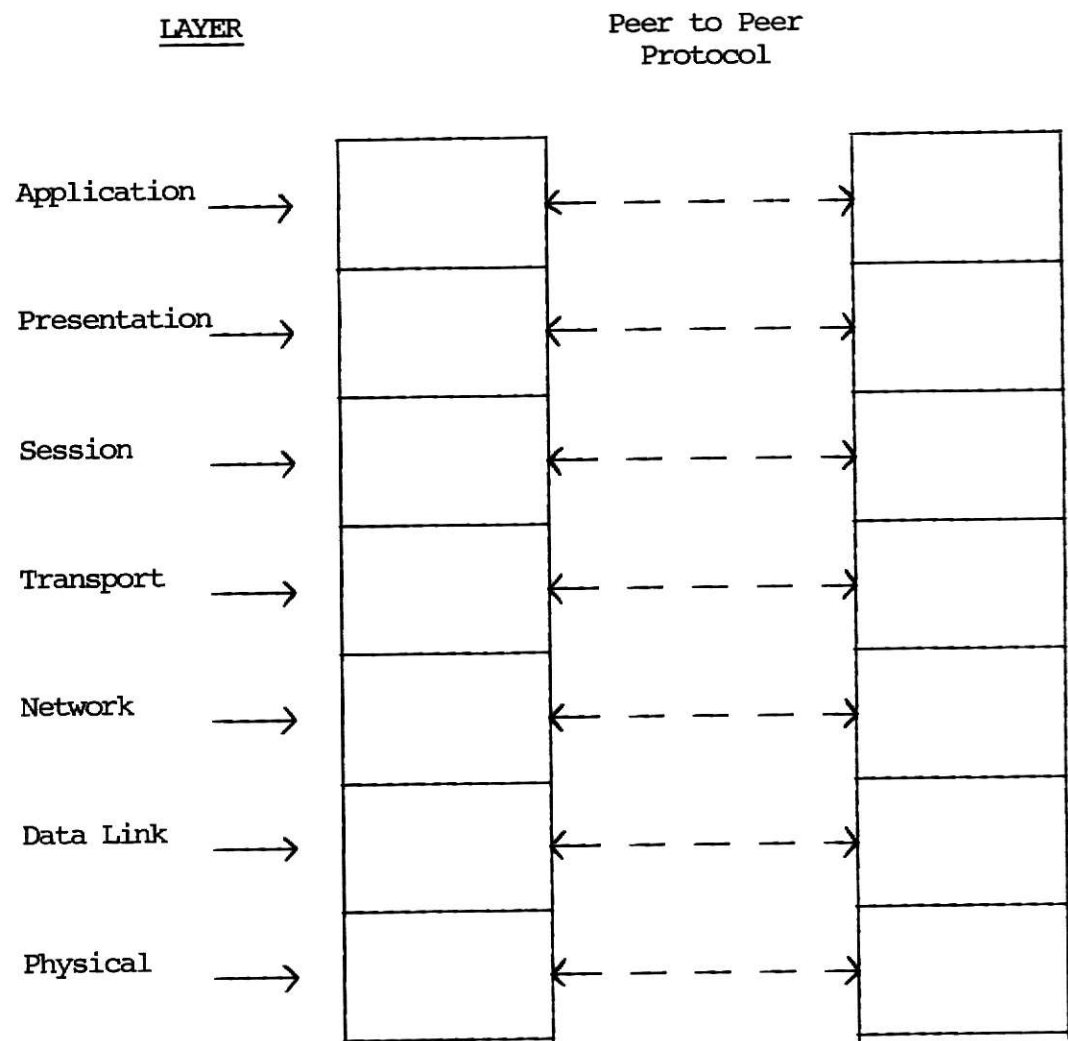


Figure 2.10-1 ISO Layered Architecture (ISO/79)

CHAPTER 3: CURRENT LAN SYSTEMS AND COMPONENTS

3.0 INTRODUCTION

This chapter presents twenty different LAN systems or components that are on the market today. When possible, the ten characteristics listed earlier are included in the description.

3.1 C/30 PACKET SWITCH PROCESSOR

BBN Computer, Manufacturer

BBN Computer designed this processor for a communications environment which utilizes medium speed and demands a fast, powerful CPU architecture. The central microprocessor performs much of the Input/Output logic and allows various devices to be microcoded as one basic I/O device.

C/30 systems can be easily connected to ARPANET software by utilizing a microcoded emulation of a necessary instruction set.

The C/30 includes 32 thousand words of 20-bit RAM memory with additional memory available in increments of 32 thousand words up to 128 thousand total words based on 16K memory integrated circuits. Access time is 405 nanoseconds. Error Detection and Correction (EDAC) is included.

The C/30 utilizes an adaptive routing technique which allows packets, even from the same messages, to follow different routes since the lines are not pre-allocated. This permits maximum efficiency while preserving network performance during a network component failure. The C/30 microprocessor automatically detects network failures and re-routes packets accordingly. When new nodes and lines are added to the system, they are automatically sensed by the CPU and incorporated into the network.

When messages are received, an acknowledgement is automatically returned to the sender. This end-to-end message control requires the sender to store only those messages which need to be re-transmitted.

The input/output system only performs simple tasks such as voltage conversion and serial to parallel conversion. It contains a FIFO buffer. The central processing unit performs all complicated logic.

Features of the C/30 Packet Switch Processor include:

- (1) 130 packets per second full duplex line throughput
- (2) 200 packets per second full duplex host computer throughput
- (3) ARPANET compatability
- (4) supports up to four ARPANET host computers
- (5) supports up to sixty-four medium speed synchronous or asynchronous terminals
- (6) supports up to 56 thousand baud speed for synchronous or bi-synchronous devices
- (7) supports serial communications line asynchronous devices from 50 to 19,200 baud
- (8) many functions are coded in firmware

3.2 CABLE ACCESS PROCESSOR (CAP)

M/A COM DCC, Inc., Manufacturer

This product is designed to allow easy and economical access to many different types of devices from many different manufacturers. It consists of a processor, a modem, and a power supply.

The CAP connects RS-232C devices to a single coaxial cable bus similar to Cable TV systems. The bus is accessed by the CSMA/CD technique. The CAP first senses the line to determine if signals are already present, and if not, begins transmitting. When two or more CAPs attempt to transmit simultaneously, all CAPs stop transmitting and randomly reschedule transmission to avoid collision again.

A typical network which uses the Cable Access Processor looks like Figure 3.2-1. This configuration is of the fully-connected mesh type. The connections between terminals and hosts appear to be simultaneous because of the very high data rates of the cable. Because of the CSMA/CD protocol, end-to-end error rates are virtually zero throughout the network.

CAP allows for wideband data bus compatibility by using a radio frequency signal to put data on and off the coaxial cable data bus. When attached to a CATV or similar type system, the CAP can transmit simultaneously with other signals on a non-interfering basis. Also, multiple local data networks can use the same coax cable simultaneously by changing frequencies.

Features include:

- (1) up to 16 thousand bytes of ROM
- (2) 16 thousand bytes of RAM standard
- (3) additional optional ROM or RAM in 16 thousand byte increments
- (4) digital data rate of one million bits per second
- (5) the ability to handle thousands of terminals
- (6) the capability of handling any popular asynchronous data format or byte-synchronous data by independent programming of each data port

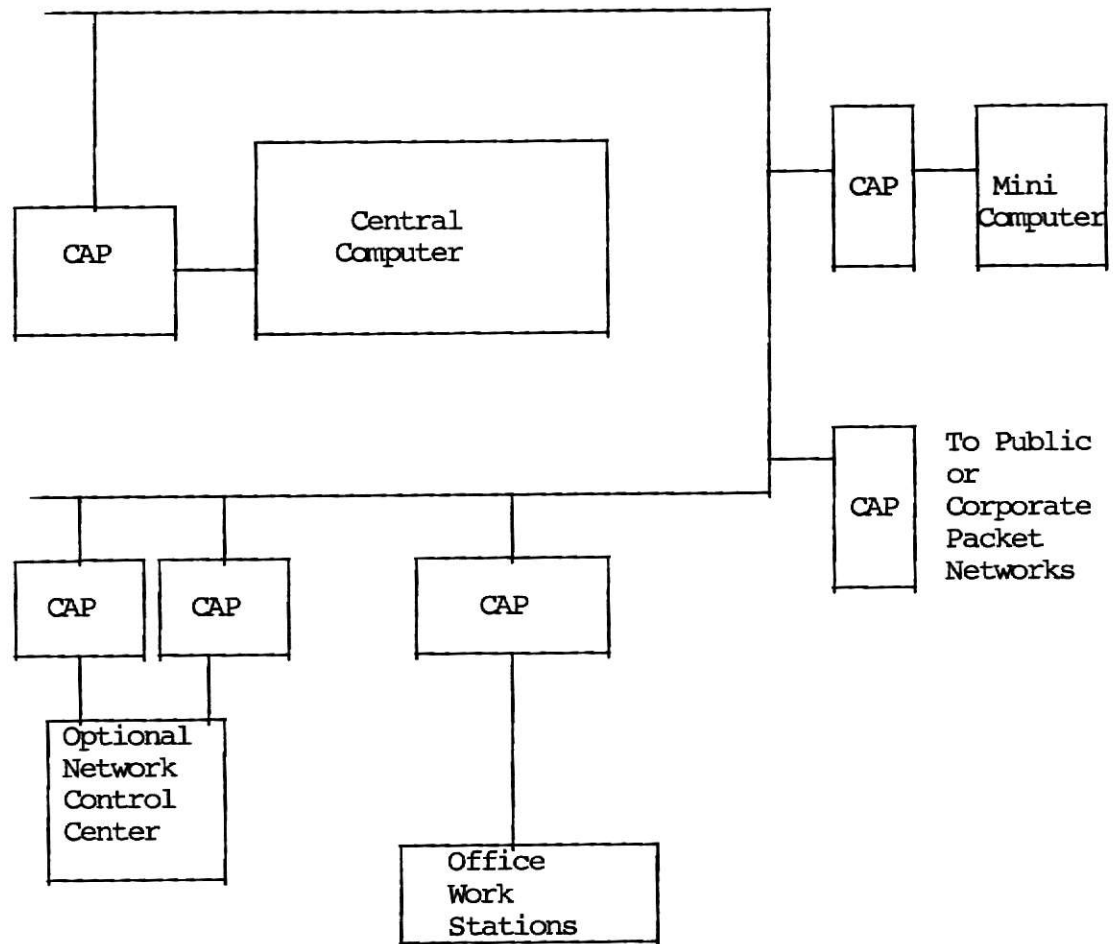


Figure 3.2-1 CAP System

3.3 INFOBUS

M/A - COM DCC, Inc., Manufacturer

INFOBUS (Figure 3.3-1) is a broadband coaxial cable LAN system which allows simultaneous voice, data, and video communications by utilizing frequency division multiplexing (FDM). Standard components of the system include dual cables, amplifiers, and connectors like those used in residential CATV systems.

INFOBUS can serve over one thousand devices and span over 75,000 square feet. INFOBUS utilizes the Cable Access Processor described previously as the interface between the system and terminals.

Communications is asynchronous and transfer speeds of one million bits per second are possible. Various manufacturer's hardware can be attached to INFOBUS.

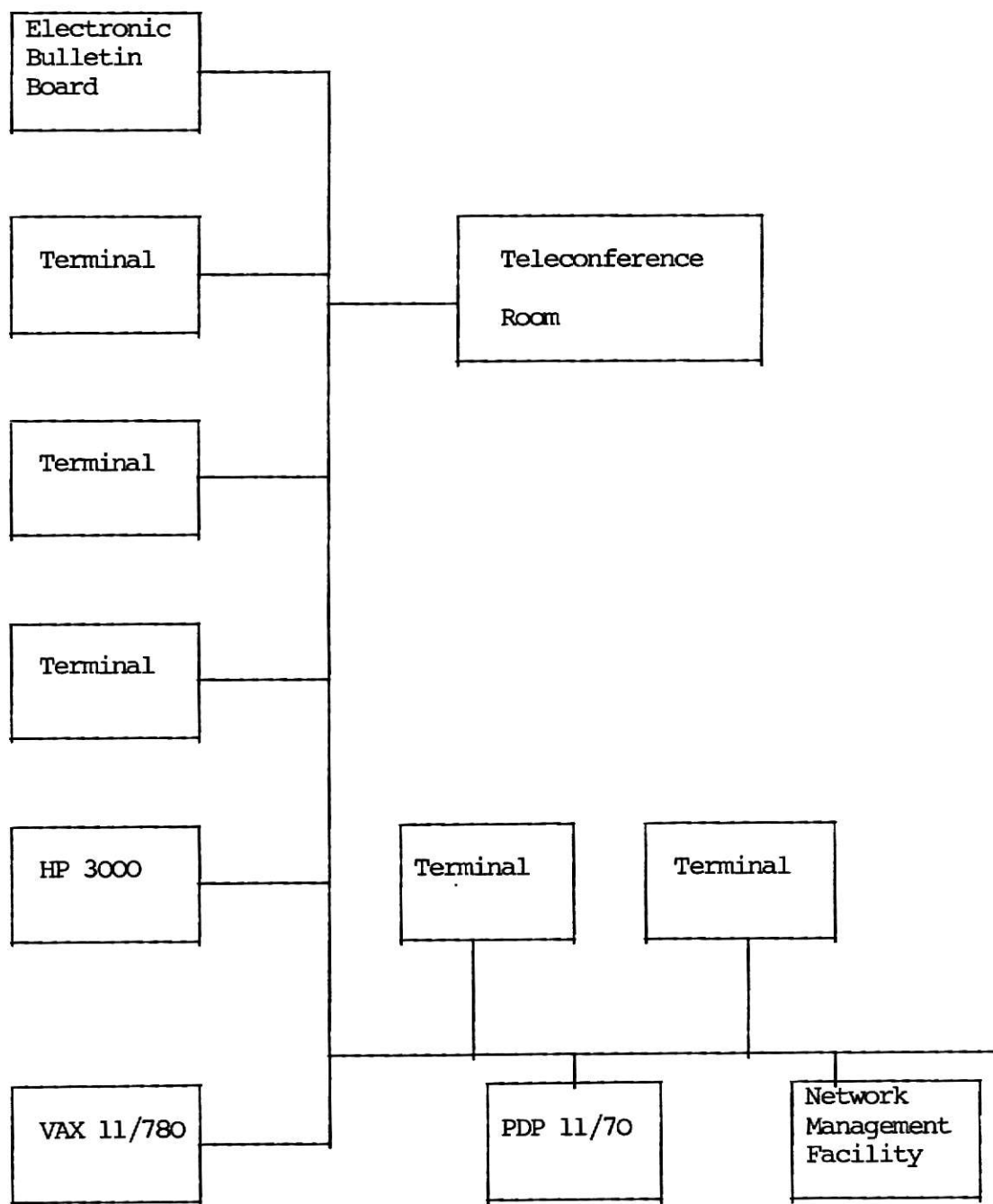


Figure 3.3-1 Infobus System

3.4 DATASWITCH

Develcon, Manufacturer

Dataswitch is an intelligent central switching facility that can handle up to 2016 subscribers. It uses an adaptive space-time-space division multiplexer (ASTSDM) bus which involves the use of line or circuit switching.

Dataswitch allows over two million types of point-to-point FDX communication links from which to choose since all subscribers can access each other.

Other features include:

- (1) 1008 simultaneous full-duplex connections
- (2) a prioritized queue for requesting subscribers where notification is given to the sender if the receiver is busy
- (3) asynchronous and synchronous data transfer
- (4) full-duplex or half-duplex modes
- (5) a data throughput rate of 2.4 million bits per second
- (6) both polling and contention access methods
- (7) 110 to 19,200 bits per second communication speeds

The Dataswitch operating system is stored in firmware. DSS (Dataswitch Supervisor) is responsible for allocating paths, maintaining queues, and requesting data from subscribers. The architecture is composed of three levels:

- (1) Directories - define the access channels for use by subscribers. There can be up to 63 directories which allow up to 63 different 25 character messages to be stored for use by the directories. Each directory has its own four character alphanumeric code for identification.
- (2) Groups - define a particular user group's characteristics, such as priorities, access restrictions, parity, and data rate. There can be up to ten groups per directory.
- (3) Lines - define group attributes. There is a maximum of 2048 lines per group. Each line can reside in only one group.

The Dataswitch topology is depicted in Figure 3.4-1. The expansion cabinets contain additional buffer cards and interface cards. There is no maximum number of expansion cabinets that can be added.

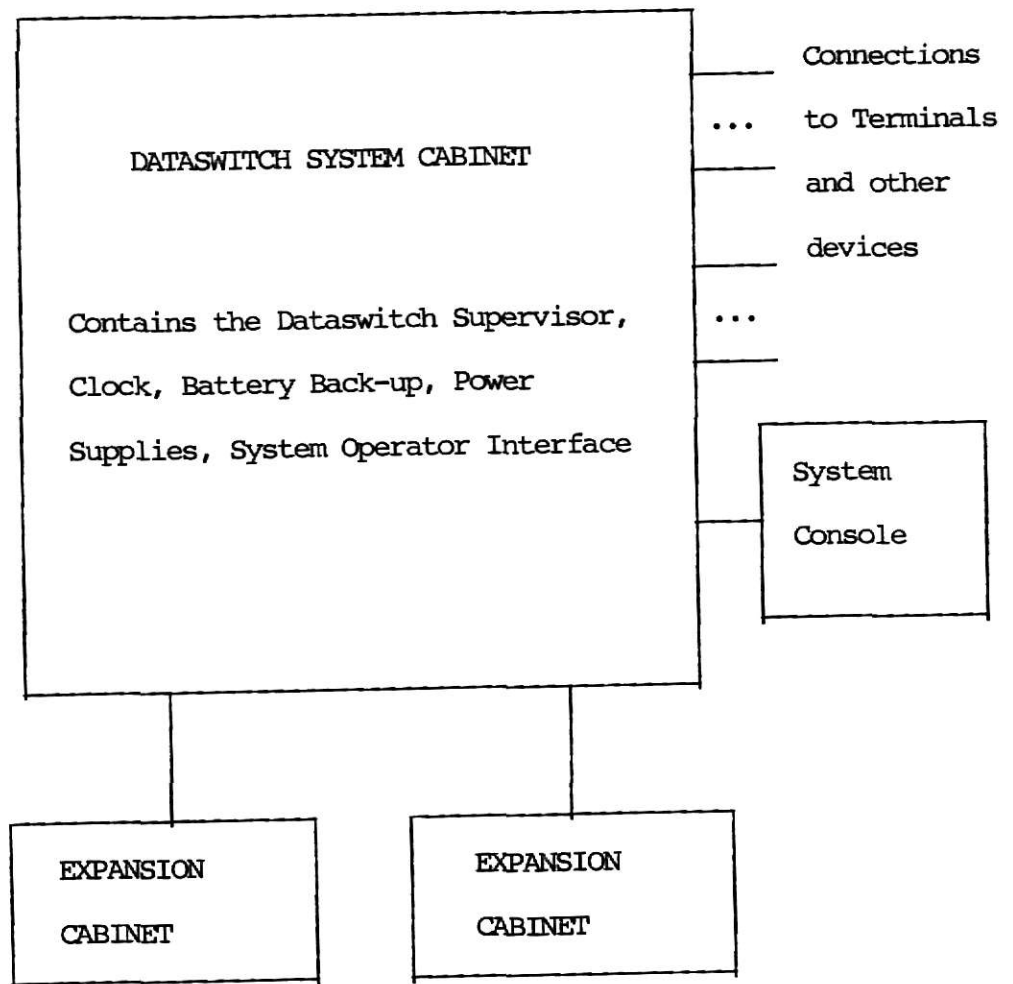


Figure 3.4-1 Dataswitch System

3.5 FIBER OPTIC CABLE

FIBER OPTIC MULTIPLEXER

Hewlett-Packard, Manufacturer

The HP39301A multiplexer was designed to take advantage of fiberoptics within local area terminal communications links. A pair of multiplexers are connected by an HP39200B fiberoptic cable. Up to eight devices can then be clustered within 1000 meters. Each channel allows for asynchronous data rates of up to 19.2 thousand bits per second. The multiplexer accepts and converts inputs to serial and transmits them over the cable to another multiplexer which reconverts the data to parallel RS-232-C lines. Both multiplexers are capable of full-duplex transmission and reception. System failures are isolated by use of a diagnostic loopback switch. The configuration is depicted in Figure 3.5-1.

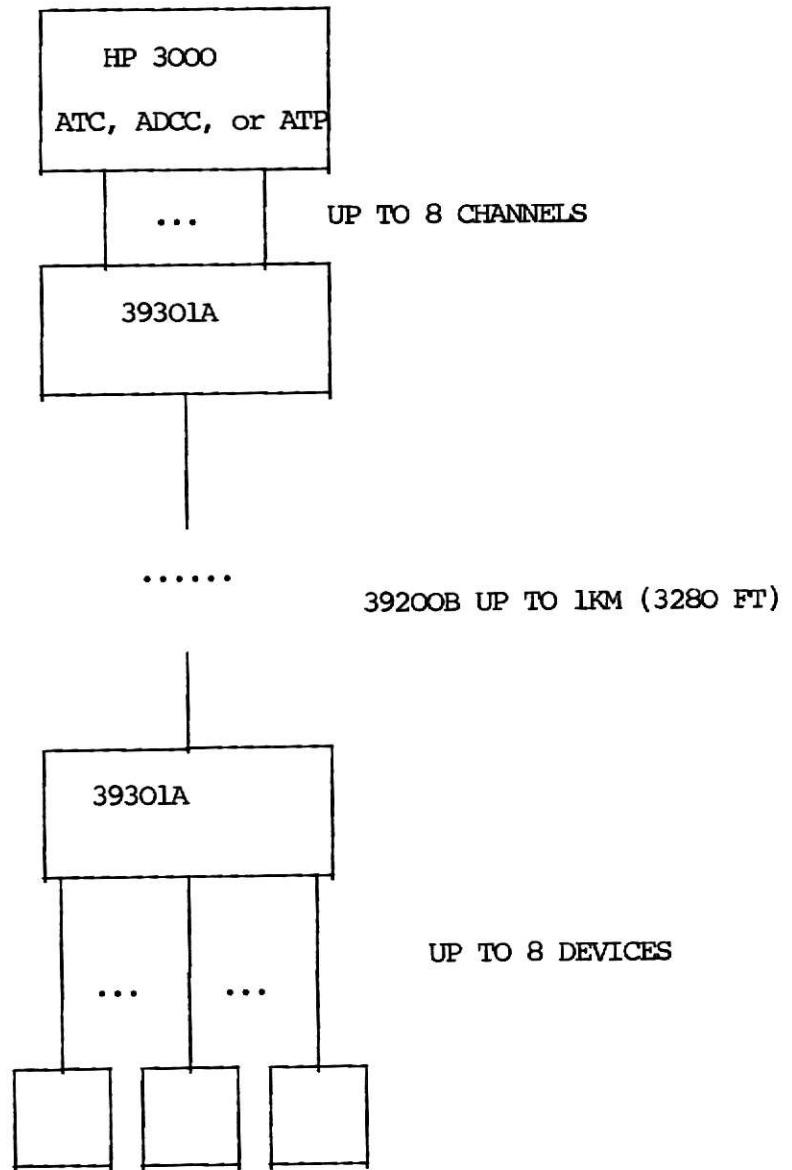


Figure 3.5-1 Fiberoptic Cable/Multiplexer System

3.6 DISTRIBUTED SYSTEMS NETWORK/DATA LINK

Hewlett-Packard, Manufacturer

The DSN/Data Link interfaces an HP3000 computer system with several secondary stations. It is composed of a single, twisted-pair cable in sections 100 or 300 meters long to which terminals can be attached up to 2.5 miles from the computer. There is no distance restrictions between terminals.

DSN/Data Link can be operated in electrically noisy environments due to its use of floating, differential signal lines and optical isolators in the link drivers/receivers. Features of this system include:

- (1) maximum data rate of 9600 bits per second
- (2) all data transmission is asynchronous
- (3) individual devices are polled
- (4) block data transmission

Each device has a unique address composed of a Group ID and a Device ID.

Figure 3.6-1 shows the configuration of this system.

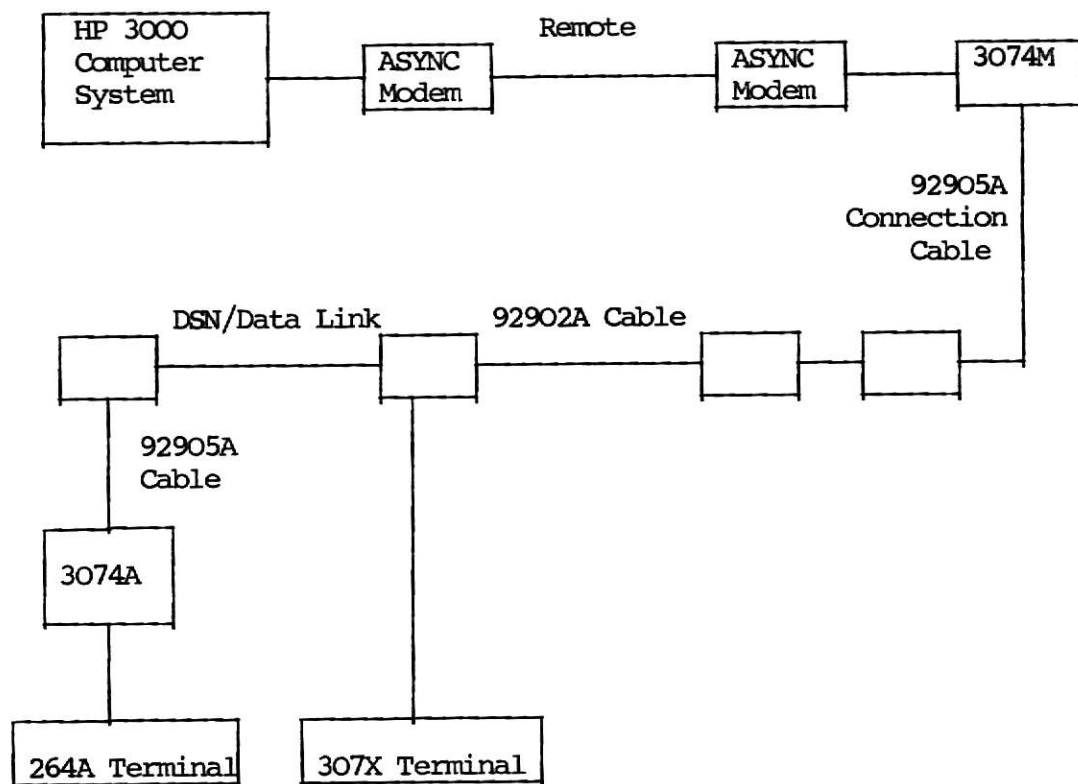


Figure 3.6-1 DSN/Data Link System

3.7 SUPERMUX 790

Infotron, Manufacturer

The Supermux 790 (Figure 3.7-1) is an intelligent network multiplexer which supports synchronous, asynchronous, dial-up, or dedicated inputs at maximum speeds of 9600 bits per second. It can concentrate up to 448 inputs using statistical techniques and transmit them to eight remote locations at speeds up to 72 thousand bits per second. Trunk access is controlled by contention techniques which improve system efficiency.

Supermux 790 employs a protocol similar to SDLC and CCITTX.25 Level 2.

Errors are handled as follows:

- (1) Data is temporarily buffered while a Cyclic Redundancy Check is performed. If errors are present, the receiving 790 issues an Automatic Request-for-Repetition (ARQ) and the data is retransmitted and rechecked.
- (2) Alternate routing is performed in the event of complete line failures.
- (3) Multiple link connections offer automatic load transfer when a failure is detected.
- (4) The system can be equipped to automatically dial back-up lines should a link fail and there are no alternate routing or multiple link possibilities.

Error protection can be eliminated when connected devices provide their own error handling capabilities.

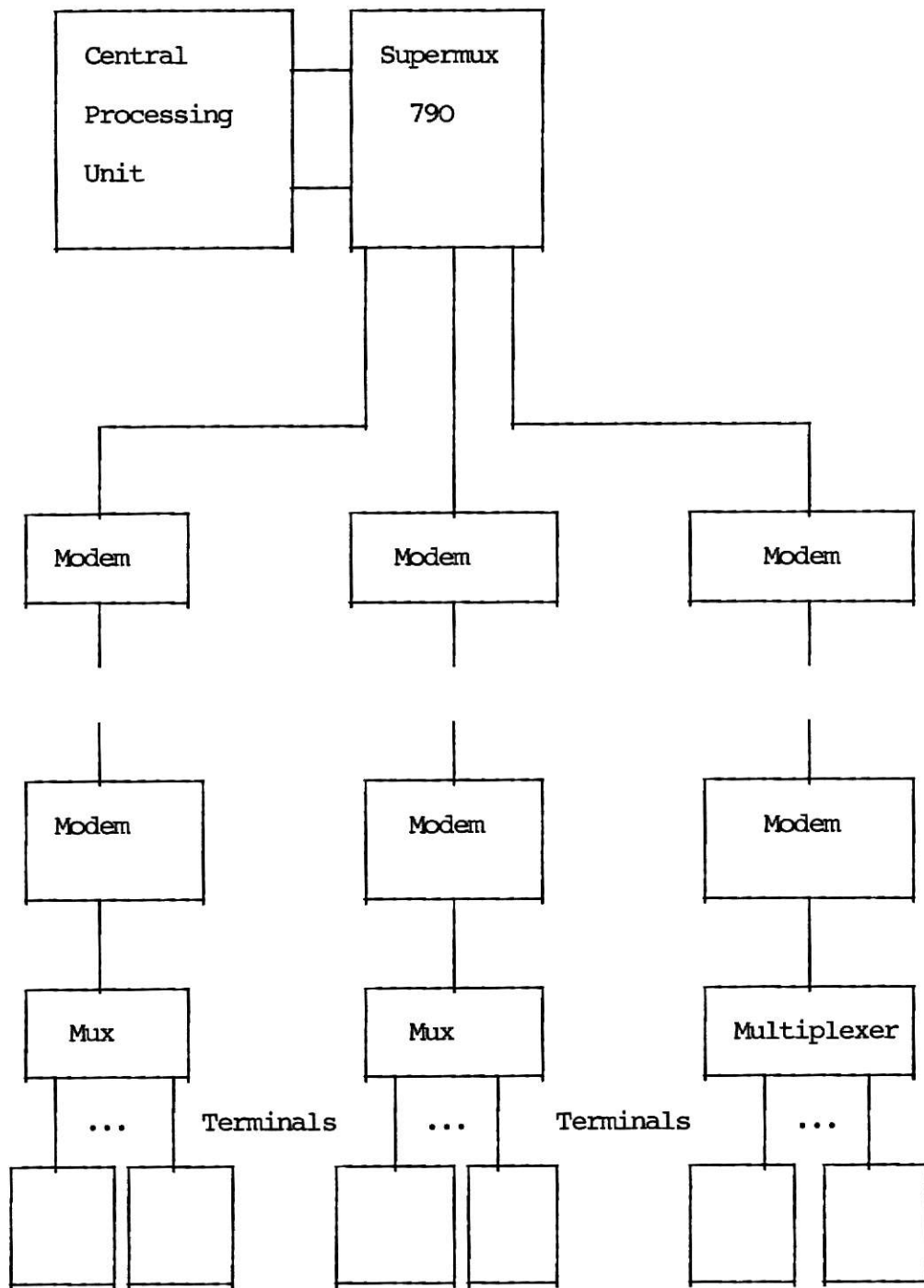


Figure 3.7-1 Supermux 790 System

3.8 IBX S/40

InteCom, Manufacturer

The IBX S/40 (Integrated Business Exchange) system allows for both voice and data switching on one system. It is capable of supporting many different office automation products in a multi-vender environment. This system's key characteristic is that its wires extend to virtually every desk in every office. Figure 3.8-1 depicts the system.

The IBX S/40 InteNet feature uses internal packet switching techniques to translate communication protocols and convert data formats. Two 32-bit processors perform system coordination. Lesser functions can be off-loaded to microprocessors distributed within the Switching Networks (SNs). SNs are attached by either optical fiber or coaxial cable up to 6000 cable feet. An Interface Multiplexer (IM) provides 256 ports and houses boards, card, and the InteNet Packet Controllers.

The bandwidth between a SN and IM exceeds 40M bits per second. Each processor can serve 4096 ports through 16 IMs. Links can be provided in duplicate to provide constant availability. Integrated Terminal Equipment (ITEs) are necessary for voice/data and sophisticated voice requirements. Voice can be encoded and decoded at 64 thousand bits per second and multiplexed with up to 57.6 thousand bits per second of digital data over 2500 feet of two-wire pair cable. Since IMs can be up to 6000 feet from a processor, two ITEs can be up to 17,000 feet apart. If only voice service is required standard telephone equipment can be used.

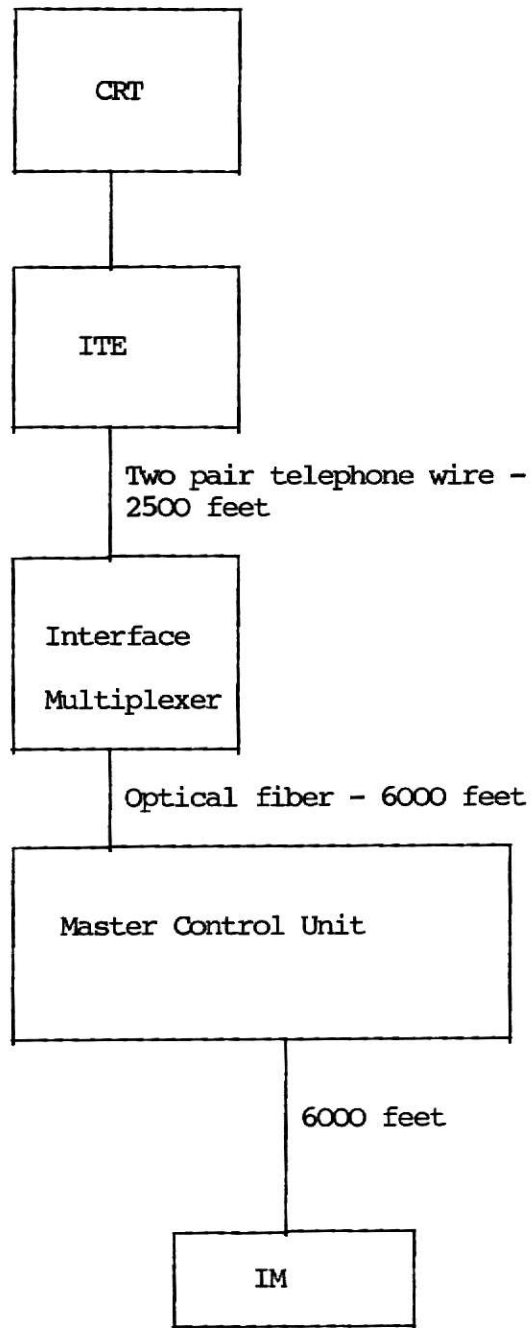


Figure 3.8-1 IBX S/40 System

3.9 SYSTEMS NETWORK ARCHITECTURE

IBM, Manufacturer

The Systems Network Architecture (SNA) is composed of Network Addressable Units (NAUs) which are sets of components that provide service that enable end users to send data through the network. The components are of three types:

- (1) Logical Units (LUs) - connect the end user to the network
- (2) Physical Units (PUs) - provide services used to control links, terminals, controllers, and processors in the network
- (3) System Services Control Point (SSCP) - manages the entire SNA network or a significant part of it called a domain. SSCP manages the resources of the network in accordance with commands issued by network operators. It also coordinates the activation of sessions between network addressable units and acts on the physical network when required to activate sessions. A session is a temporary connection which allows for the exchange of data.

Communication paths must be established between LUs. Each unit has a unique address with two parts. A subarea address directs the message to the proper group of nodes, while the element address states which NAU within the subarea is to receive the message.

Messages are put on a queue at each transmission group and sent until it reaches the destination. Message units which have high transmission priority are transmitted ahead of those having medium or low priority.

Sessions between NAUs are capable of bidirectional data movement, but there is a choice in case this feature is not needed. Full-duplex and half-duplex flip-flop mode (alternate sending of data) is available. Contention access methods are used in half-duplex mode.

SNA architecture is composed of the following layers:

- (1) NAU Services Manager Layer
- (2) Functional Management Data Layer
- (3) Data Flow Control Layer
- (4) Transmission Control Layer
- (5) Path Control Layer
- (6) Data Link Control Layer

This layered architecture has significance in that equivalent functions in the layer interact in a strictly defined way regardless of node or machine kind and changes that are made in one layer are isolated from functions performed in other layers. New functions can be added easily.

Figure 3.9-1 diagrams the SNA system configuration.

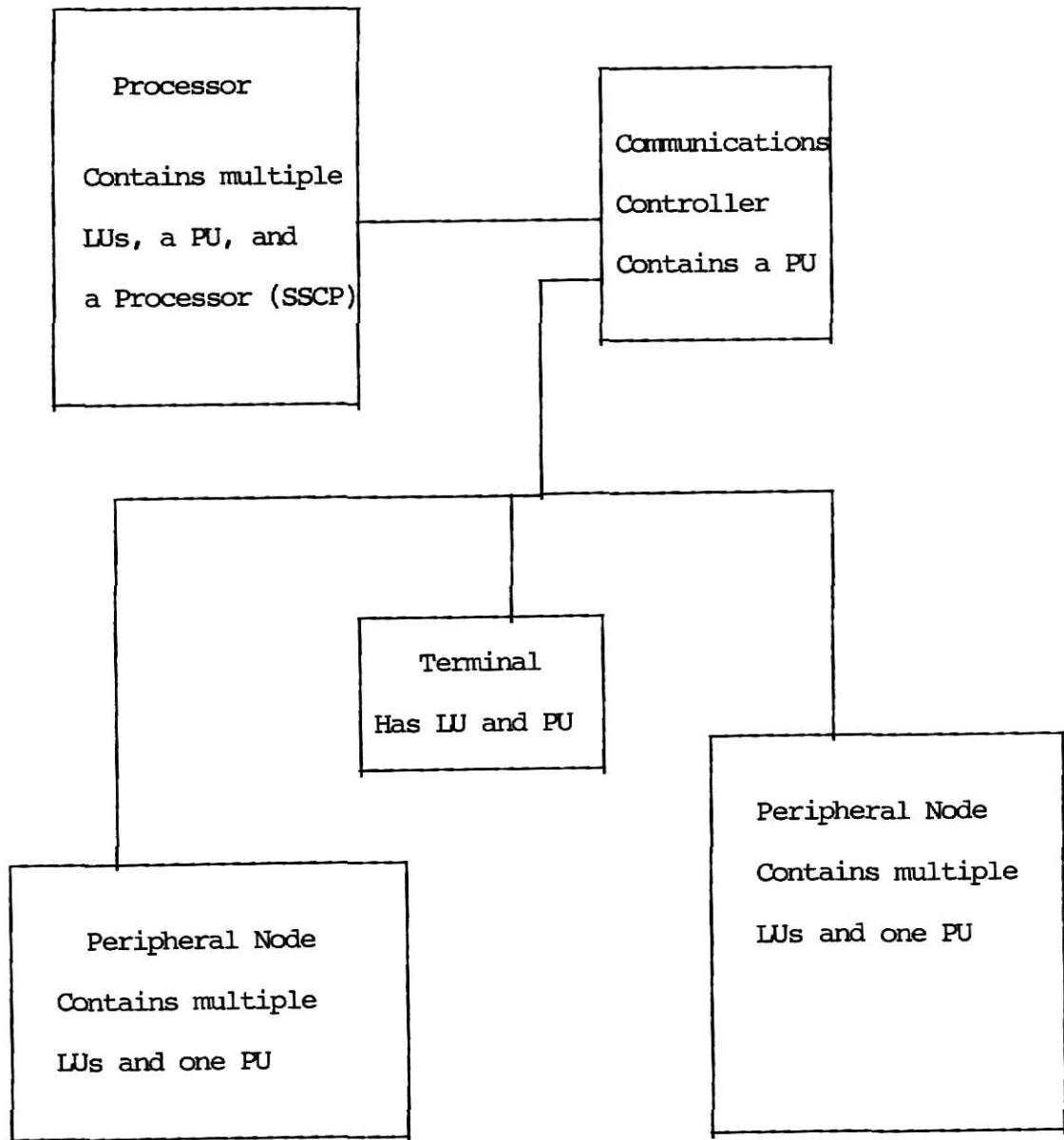


Figure 3.9-1 Systems Network Architecture System

3.10 HYPERCHANNEL

Network Systems Corporation, Manufacturer

HYPERchannel (Figure 3.10-1) is a coaxial cable bus LAN which provides channel-to-channel communications between any combination of peripherals and processors. HYPERchannel cable can be extended to a maximum of five thousand feet. It uses multidrop passive connections and broadcast transmits at baseband frequency.

Separate buses can be added to provide alternate paths and increase capacity and availability. Network adapters contain micro-processors which allow them to initiate, control, and monitor interfaces. The adapter contains a high speed buffer memory (4096 eight bit bytes) which allows for high data transfer rates, since the buffer memory has an aggregate bandwidth of 100M bits per second.

Every bus transmission is a serial bit string with a fixed format header, a message proper, and associated data. Messages can be variable lengths. An eight-bit destination address is always part of the message. A link level protocol provides immediate access to the bus in light message conditions, and changes to a priority scheme as the system approaches capacity. A contention algorithm is used to resolve access conflicts.

There can be sixteen adapters per trunk and equipment can be attached anywhere along the cable. Various manufacturer's products can be interfaced with the HYPERchannel local area network.

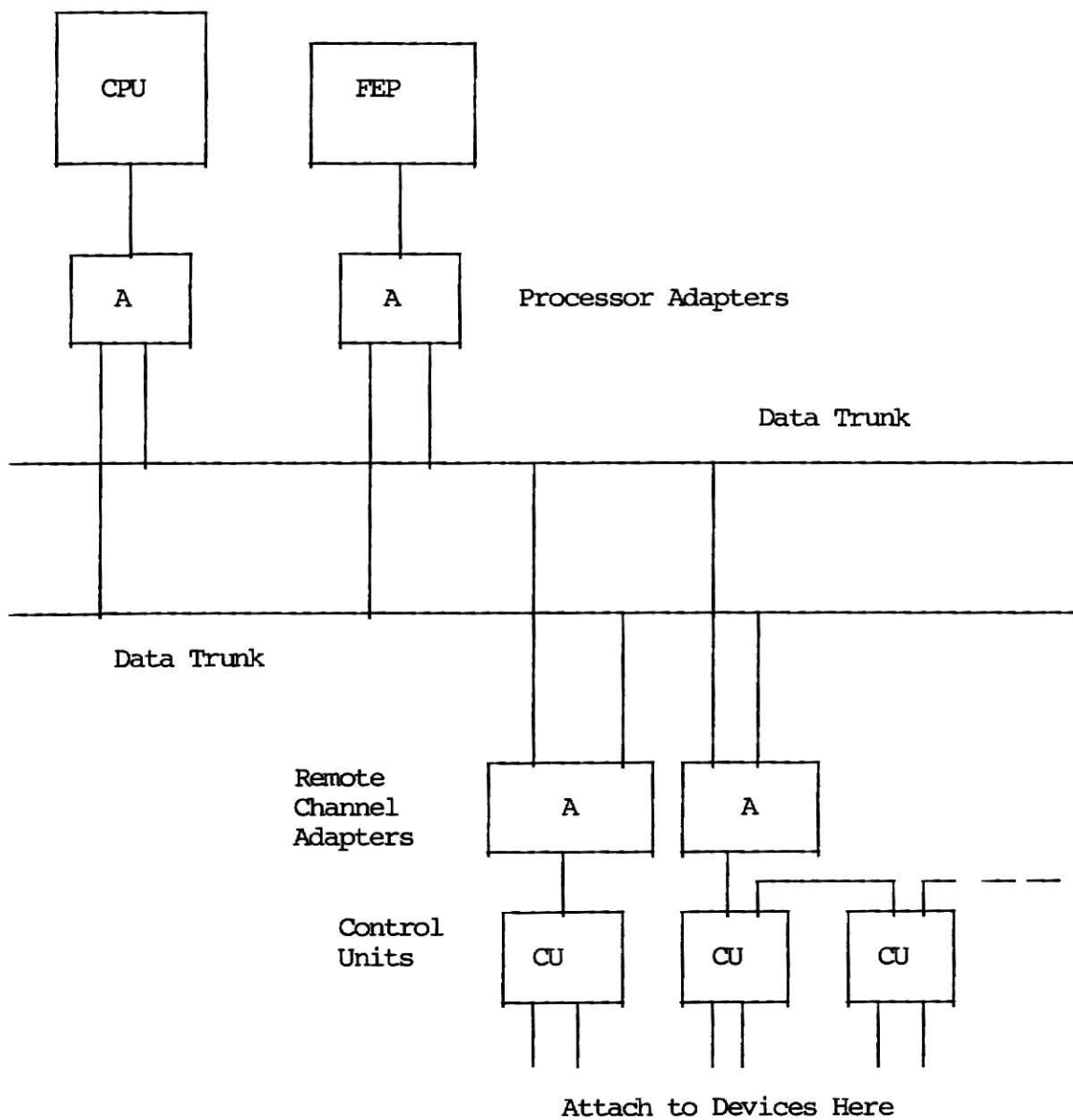


Figure 3.10-1 HYPERchannel System

3.11 HYPERBUS

Network Systems Corporation, Manufacturer

HYPERbus is a medium speed baseband local area network. The connection unit is called a bus interface unit (BIU) and contains a Motorola 6809 microprocessor. This system was designed particularly for non-compatible device interconnection.

The transmission medium can be multidrop coaxial cable or fiberoptic cable with in-line bus taps. Transmission speeds can run from 3 to 10M bits per second. HYPERbus trunk length is typically about 2400 feet. It is contention channel based with a SDLC based link protocol.

The BIUs can handle synchronous or asynchronous data and transmit it in either full or half-duplex mode. The address is hierarchical in nature with the basic address consisting of the BIU address (one byte), the BIU port address (one byte), and a link field. Single address messages can be consecutively switched across a series of BIU ports in order to find a free BIU or avoid a failed unit. End-to-end control is provided at the BIU level. Traffic priority is according to BIU mode. In each mode, devices can operate in an allocation scheme that represents absolute priority or a round robin.

Each BIU is double buffered up to 512 bytes. One buffer fills while the other is transmitting. Buffers are transmitted when full or at specified times for short messages.

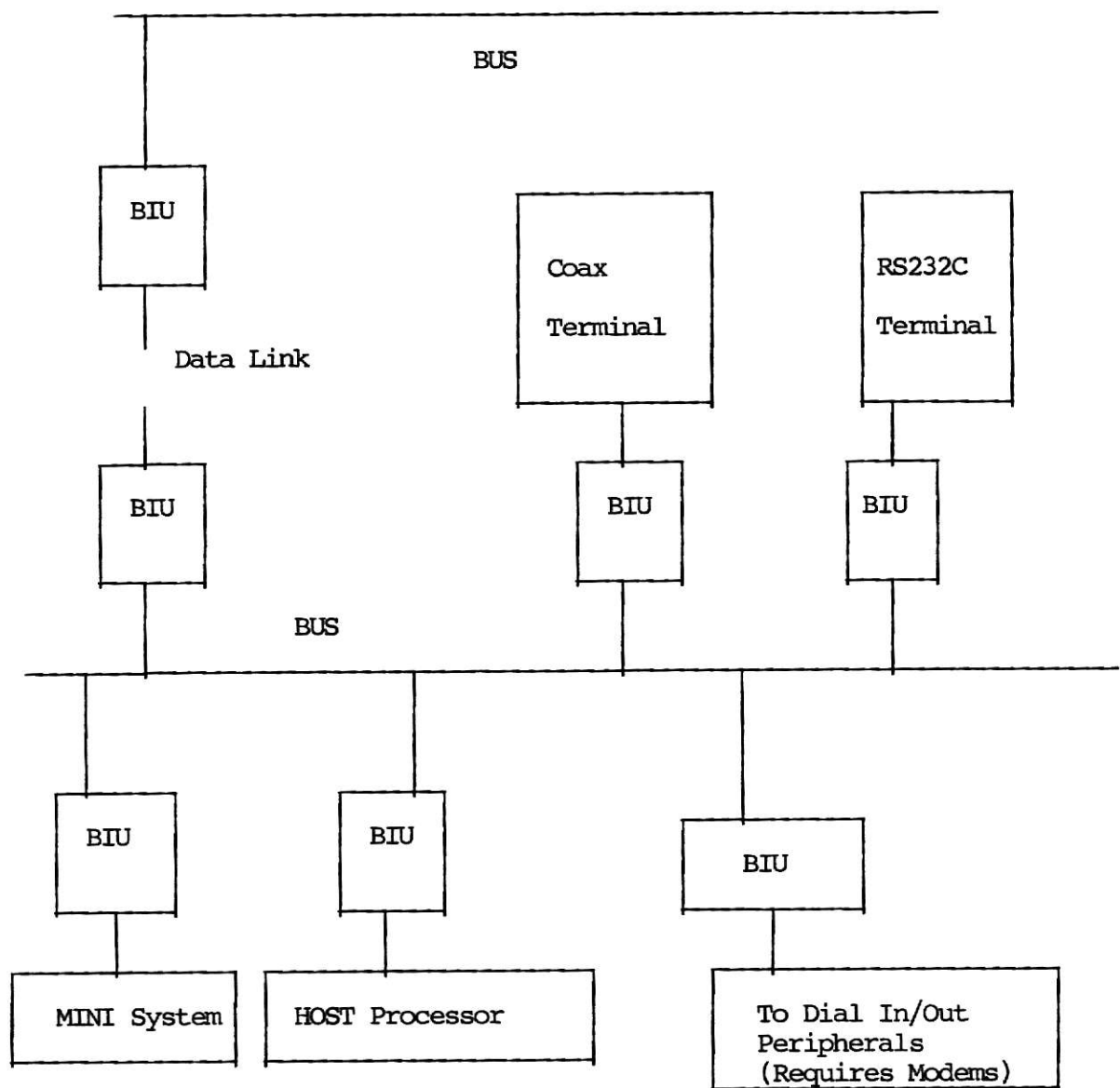


Figure 3.11-1 HYPERbus System

3.12 SL-1 BUSINESS COMMUNICATIONS SYSTEM

Northern Telecom, Manufacturer

The SL-1 digital business communication system serves as few as 100 lines to over 5000 lines. Voice and data can be transferred at the same time when a special hardware add-on device (ADM) is used. The SL-1 system hardware is modular in design so that it can be added to easily. The ADM is compatible with most RS-232 interfaced terminals, devices, or computer systems.

SL-1 transmits asynchronously in half-duplex, full-duplex, or reverse channel modes. Data transfer rates range from 50 to 9600 bits per second. Data is formatted as serial characters. SL-1 will operate at distances of up to 4500 feet on standard two-pair wiring.

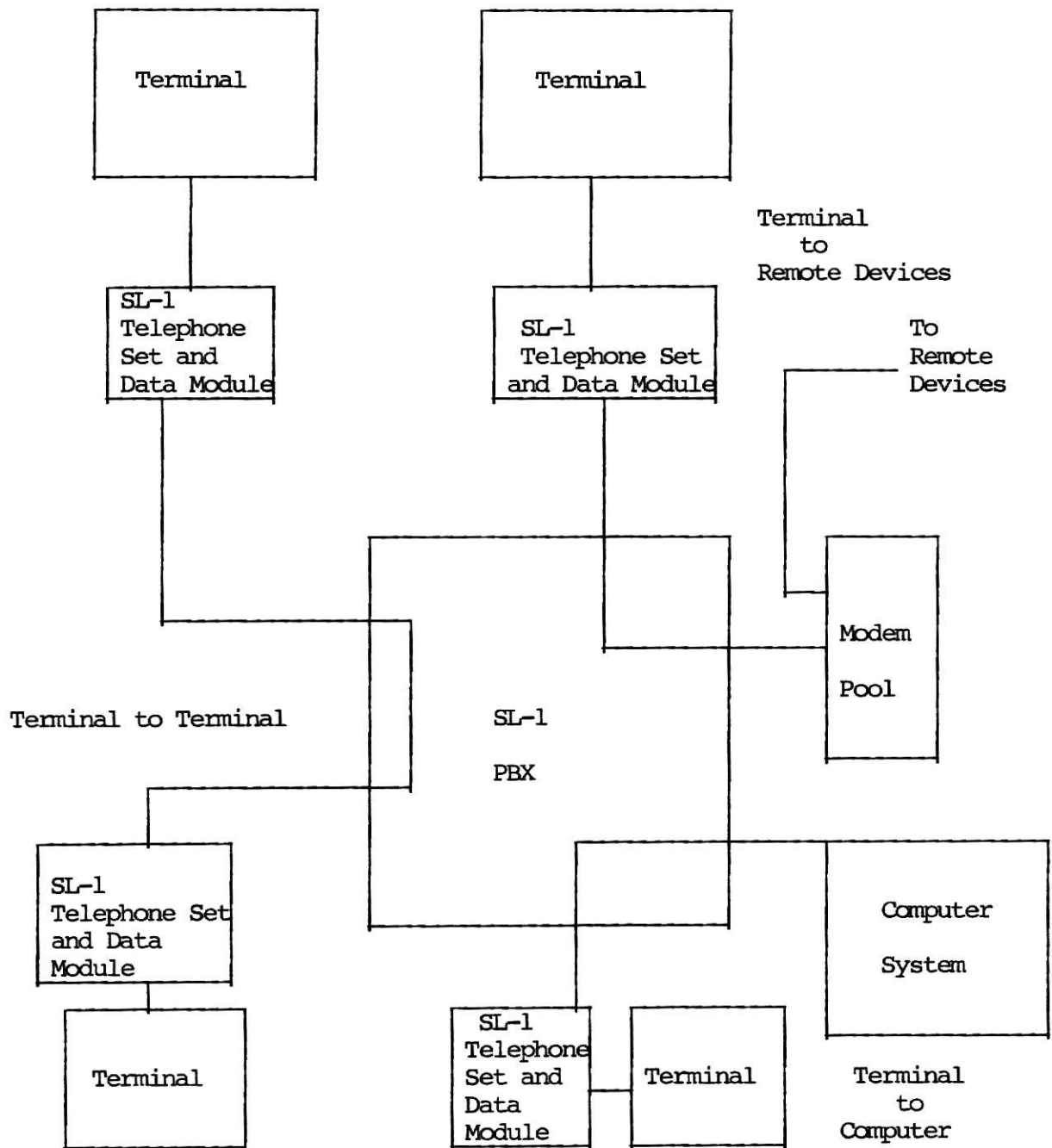


Figure 3.12-1 SL-1 Business Communications System

3.13 SL-10 PACKET SWITCHING SYSTEM

Northern Telecom, Manufacturer

An SL-10 node consists of multiple processors which accommodate hundreds of communication lines interconnecting a variety of host computers and terminals. It can interconnect a wide variety of terminals and computers that would otherwise require many separate transmission facilities.

Each SL-10 node assembles input data into packets that contain the data message, an address code, and an accuracy checking/verification code. Each packet is interleaved with other packets, and then transmitted via the most direct route to the receiving SL-10 node. Here the packets are verified and delivered to the receiving computer or terminal in the proper sequence.

If a trunk failure should occur, the transmitting SL-10 node automatically selects the next most direct route permitting uninterrupted transmission. The SL-10 features automatic error checking where as each data packet is transmitted through the network, it is held in memory until the accuracy of the transmission is automatically confirmed from one SL-10 node to the next.

The SL-10 system provides most standard and special interfaces to create network compatibility among a wide range of computer and terminal models.

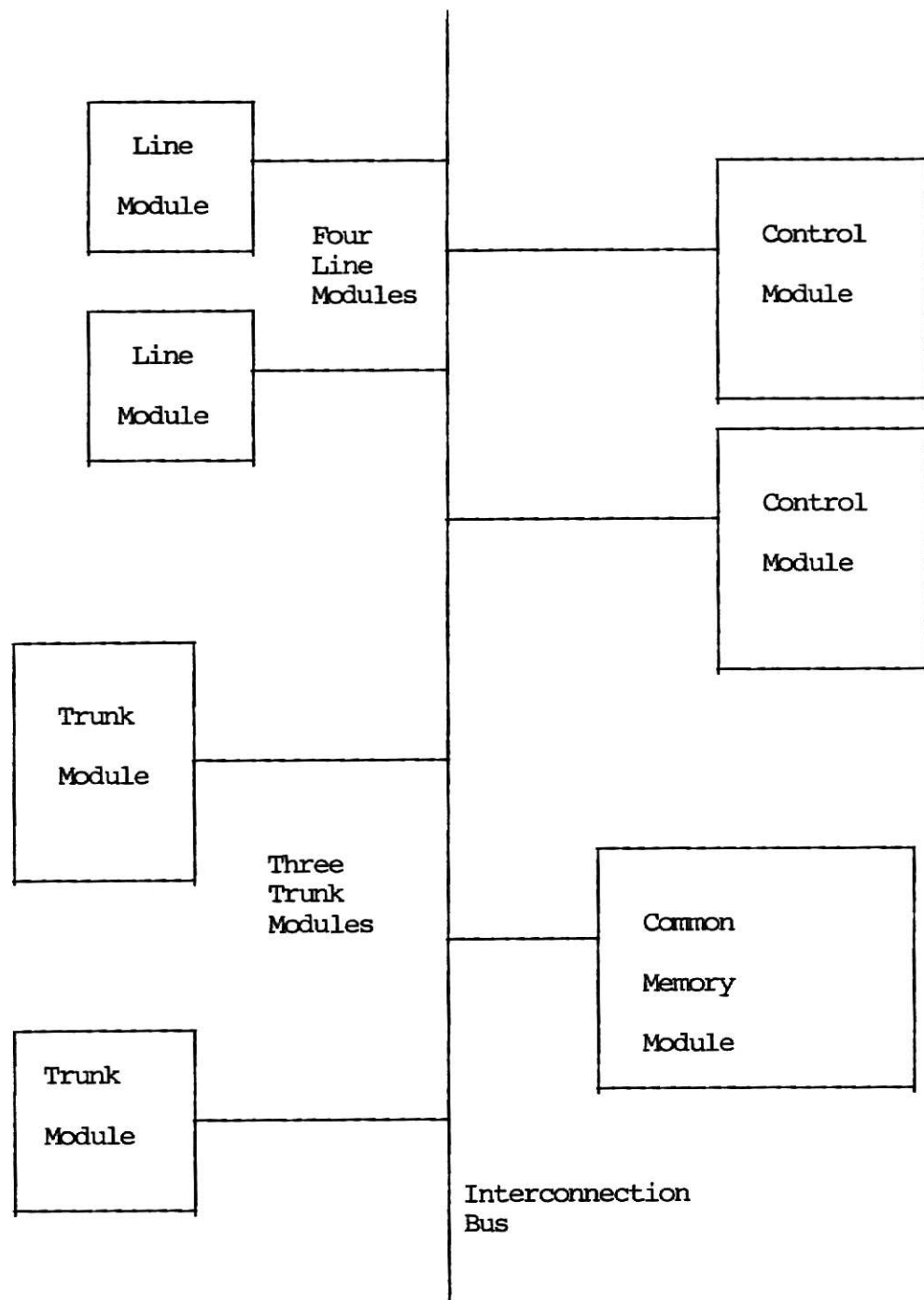


Figure 3.13-1 SL-10 Packet Switching System

3.14 PRIMENET NODE CONTROLLER

Prime Computer, Inc., Manufacturer

The Primeret Node Controller (PNC) is a link between local systems whose bandwidth can accommodate over 200 systems utilizing a ring structure. Primeret software currently allows only 16 systems on a ring to operate as a single local area network. Systems can be up to 750 feet apart connected by coaxial cable. Bandwidth is 8M bits per second. PNC networks can be fully connected for direct transmission. However, the PNC allows for connects and disconnects without service disruption to other systems.

Primeret architecture has four levels of facilities. The first three levels address the first three CCITT X.25 recommendations and relate to the network's electrical interface, link level protocols, and packet level procedures. The fourth layer provides user services, including interactive terminal support and remote file access.

Figure 3.14-1 depicts a typical Primeret Node Controller local area network.

3.15 CBX INTEGRATED VOICE AND DATA COMMUNICATIONS SYSTEM

ROLM Telecommunications, Manufacturer

This system boasts a fully digital, computer-controlled telephone system for 24 to 4000 extensions. By installing three components and special software the CBX communications system can be transformed into a data communications system. The three components are:

- (1) the Data Terminal Interface (DTI) which transmits asynchronous data over telephone wiring at up to 19200 bits per second for voice and at 9600 for data at distances up to 5000 feet from the CBX. It uses full-duplex line signaling protocol
- (2) the Data Line Interface (DLI) which supports 16 data channels
- (3) the Time Division Multiplexing Control Card which expands the traffic carrying capacity of the CBX by providing data submultiplexing. Submultiplexing divides the time slots so that up to 40 data connections can be established at speeds of up to 2400 bits per second.

This system uses an automatic queueing technique which informs the user of queue length during heavy traffic periods while automatically checking for an available modem and trunk line.

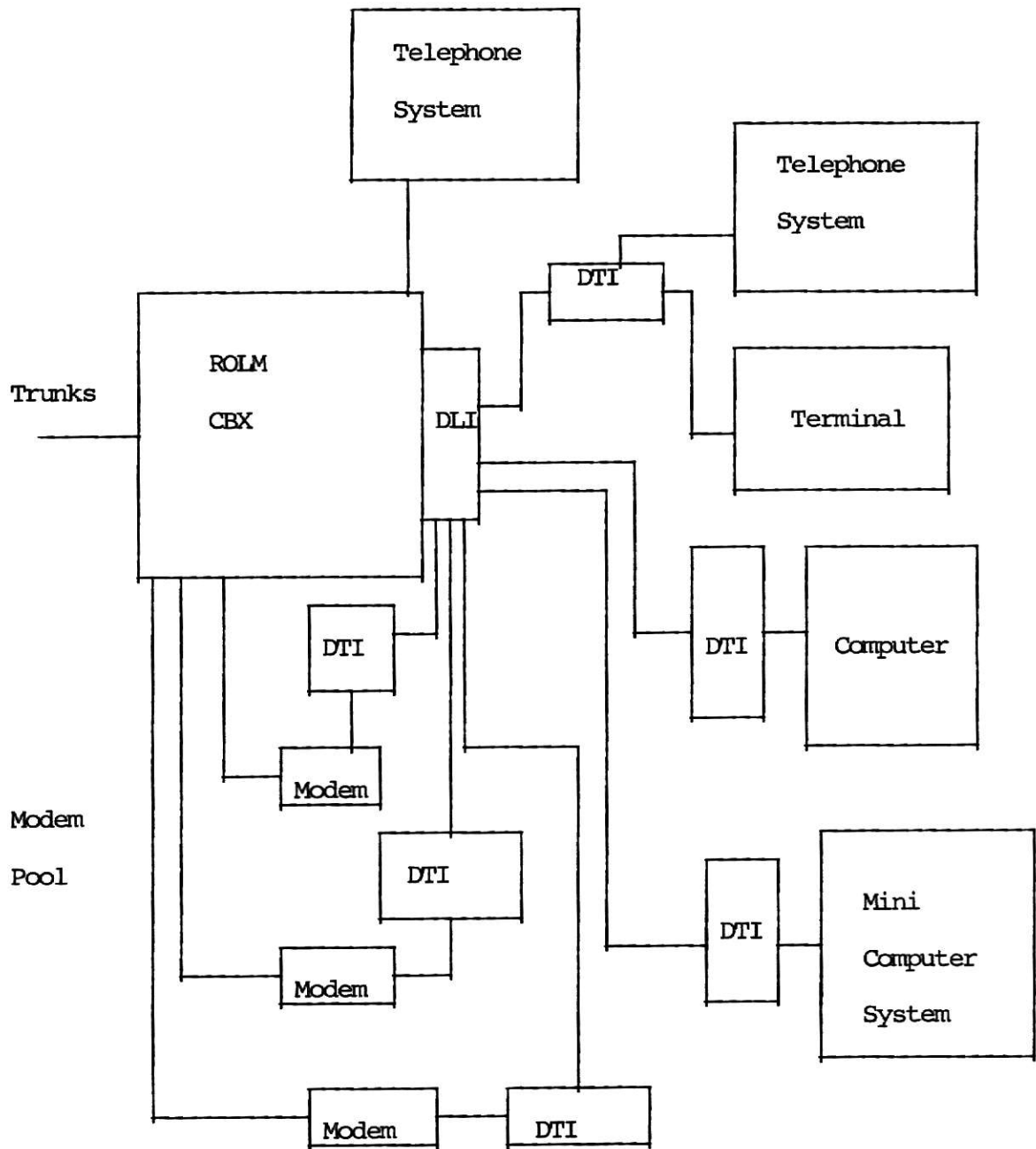


Figure 3.15 CBX Integrated Voice and Data Communications System

3.16 ROLM ELECTRONIC MESSAGE SYSTEM (REMS)

ROLM Telecommunications, Manufacturer

The Rolm Electronic Message System allows users to create, send, and receive messages via a terminal connected to the CBX. An existing CBX installation can be transformed into a REMS by installing a Message System Processor within the CBX switching equipment cabinet.

Rolm states that the REMS system has the following benefits important to business productivity:

- (1) saves time attempting to reach someone by phone
- (2) eliminates time wasted by phone call interruption
- (3) allows users to accept and send messages at convenient times
- (4) eliminates "small talk" associated with phone calls
- (5) reduces paper handling and associated costs
- (6) messages are delivered instantly
- (7) physically separated group members can be kept informed simultaneously.

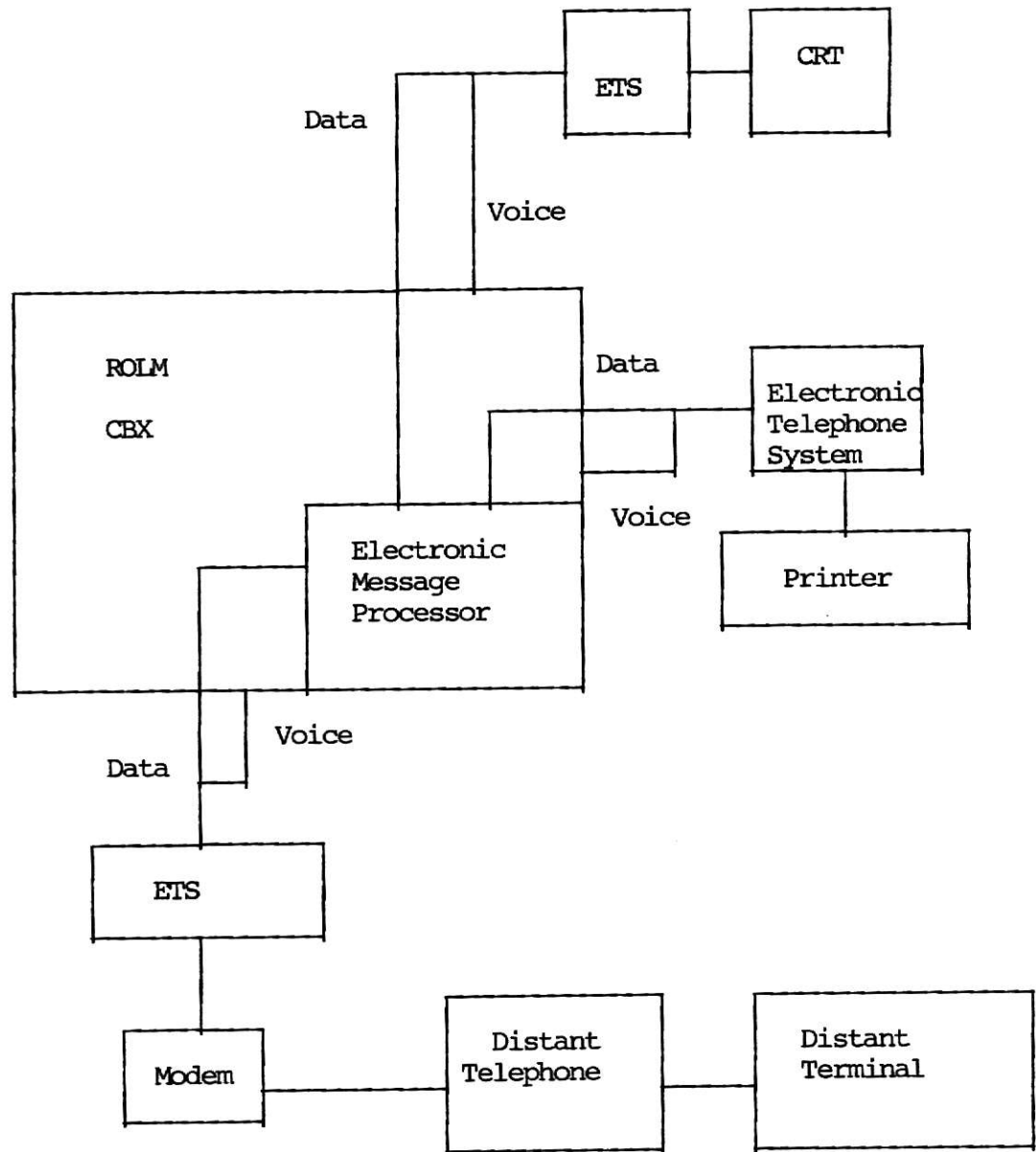


Figure 3.16-1 ROLM Electronic Message System

3.17 NET/ONE BASEBAND AND NET/ONE BROADBAND

Ungermann/Bass, Manufacturer

Net/One is a packet switching network which can deliver data at 4 megabits per second. The minimal Net/One set up consists of:

- (1) coax cable (standard RG-8A/U 50 ohm), 4000 foot maximum
- (2) passive transceivers
- (3) several Network Interface Units handling four peripheral devices each
- (4) repeaters

Connection to the cable is made through nondestructive taps with an integral, passive, baseband transceiver. Up to 200 taps, separated by a minimum of 10 feet may be placed on a single cable segment. The network can be added to without disrupting service, and inactive or malfunctioning nodes do not affect the rest of the network.

The transceiver drives data onto and receives data from the cable using a modified Manchester encoding technique. The NIU's transceiver interface has the job of address recognition, error detection, packet retransmission, and packet framing. When an address packet is recognized it is received into a 4000 byte random-access memory buffer and organized into a FIFO receive queue. When the complete packet is received, a cycle redundancy check (CRC) is performed to validate packet contents. Invalid packets are automatically removed from the buffer area.

Packet transmission works is reverse. Packet headers are built by the NIU network processor and are submitted to the 2000 byte FIFO transmit buffer. Before transmission, the receiver examines the state of the network to determine if the line is quiet. If the receiver detects invalid encoding it signals the transmitter that a collision has occurred. The transmitter then sends a signal on the network to notify the other nodes that collision has occurred. Each transmitting NIU then computes a random interval to wait before retransmitting. This is basically a CSMA/CD algorithm.

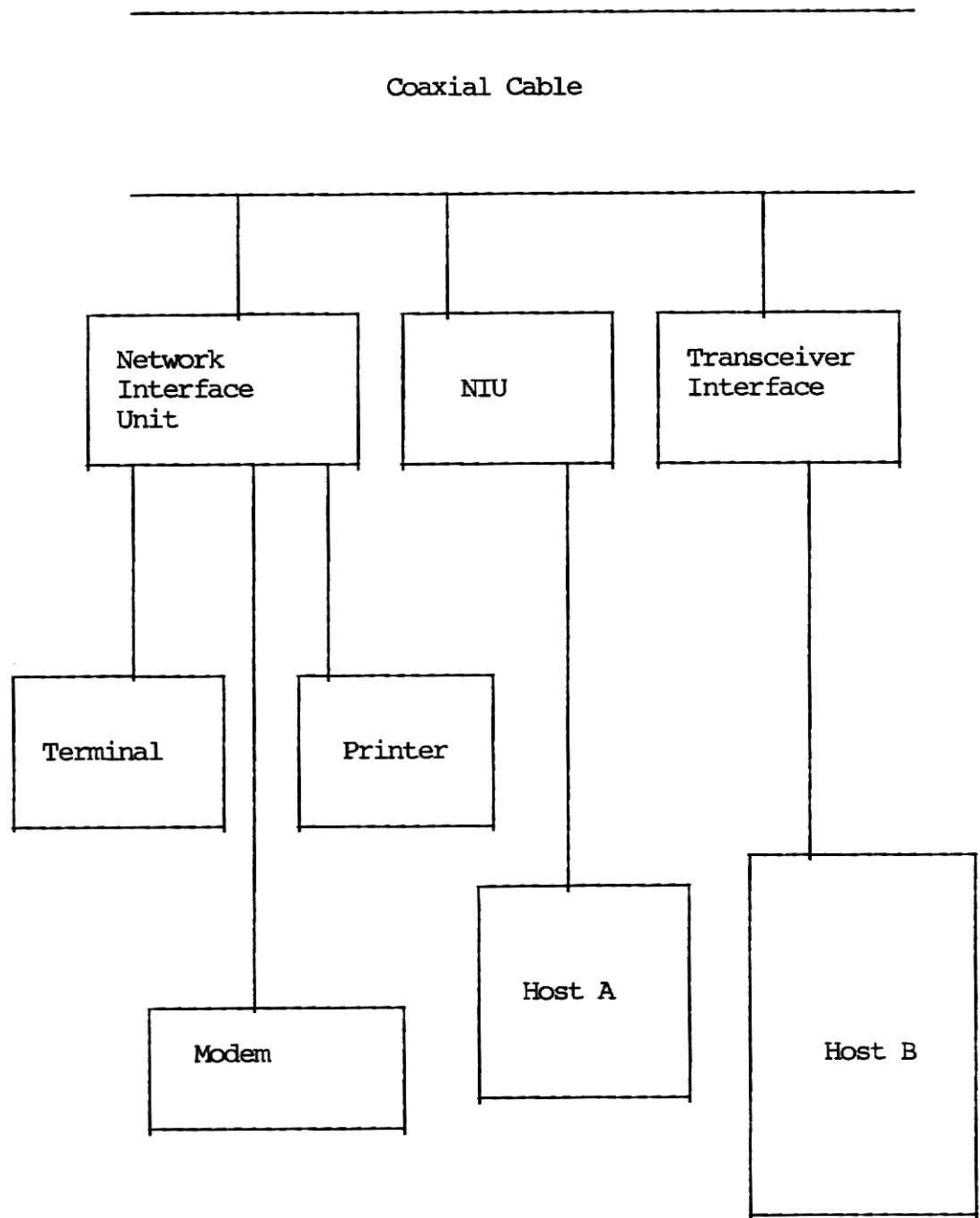


Figure 3.17-1 Net/One System

3.18 VALTEC COMMUNICATION FIBEROPTICS

Valtec, Manufacturer

Valtec has developed two components for use in a local area network. The first component is a fiberoptic computer cable that is designed for both moderate distances and for intra-building process control communications. The cable can be laid in trays or ceiling space, pulled through conduit, installed under carpet, or attached to walls. The cables are designed with a loose buffer tube to allow for expansion and contraction due to changes in temperature.

The second component is a LDM-9500 16-port Lightwave Data Multiplexer that accepts up to 16 inputs and multiplexes them for transmission over a single optical fiber. When a pair of optical fibers are used, full-duplex transmission is possible. Data can be transmitted up to two kilometers. Either synchronous or asynchronous mode can be used. Data rates in both asynchronous and synchronous modes are up to 64 thousand bits per second. The multiplexer accommodates any data character format, has standard diagnostic and visual indicators allowing for easy monitoring of channel and system status, and is protected by a redundant standby transmission system which automatically continues data flow in the event of a system failure. It is powered from a wall outlet.

3.19 ETHERNET

Digital Equipment Corporation,
Intel Corporation,
Xerox Corporation, Manufacturers

In May, 1980 DEC, Intel, and Xerox announced their determination to design and build electrical, logical, and protocol specifications for a local area network which they intended to use for future product development.

Ethernet has no switching logic and is not controlled by a central computer. The network consists of a passive segmented coaxial cable which simply accepts and carries transmissions. Each cable segment can be up to 500 meters long. Each individual device is tied to the network by its own communications transceiver. No two hosts can be more than 2500 meters apart. A unique 48-bit address for each system element allows data to be sent in packets to the unit that is to receive it. The packets can contain about 1,024 characters of information. A "listen before talk" procedure allows for checking the line before transmission. If collision occurs the message is re-transmitted at a later time period. The collision fragment will be discarded by the receiving nodes as it will always be shorter than a valid frame.

Ethernet uses a baseband transmission bandwidth which allows for data transfer of 10 million bits per second. It can handle 100 devices per segment with a maximum of 1024 stations. Ethernet topology is a branched non-rooted tree as depicted in Figure 3.19-1.

The goals of the Ethernet design are:

- (1) Simplicity
- (2) Low cost
- (3) Compatibility (avoidance of optional features)
- (4) Addressing flexibility (have the ability to send messages to a single node, group of nodes, or all network nodes)
- (5) Fairness (equal access to the network)
- (6) Progress (no node should prevent the progress of other nodes)
- (7) High speed
- (8) Low delay
- (9) Stability (under all load conditions)
- (10) Maintainability
- (11) Layered architecture

The Ethernet local area network has given rise to several network products designed to connect to it. Some are:

- (1) Xerox 8000 Network System

This system includes a 10,000 page information file, a laser printer, and communications units that link office equipment into an integrated network. Data can be sent between locations at the rate of about one million characters per second.

- (2) Xerox 8010 Star Information System

This system was announced in April of 1981 and is part of the 8000 network system. It is being offered to support business professionals and provide a personal information system for computing, text editing, graphics creation and communications. Technical skills are not needed to use the system. Most functions

in the system are available by moving a pointer and pressing a key. There are few commands to remember or type in. The system includes a display unit with keyboard, a small processor, and a control device.

(3) Intellec Development System

This system was developed by Intel to allow the user to develop and test communication software and applications for an Ethernet communication subsystem.

(4) iSBC 550 Ethernet Communications Controller

This system supports the functions of the Ethernet data link and physical layers. It supports office automation, distributed data processing, factory data collection, research data collection, intelligent terminals, and other products.

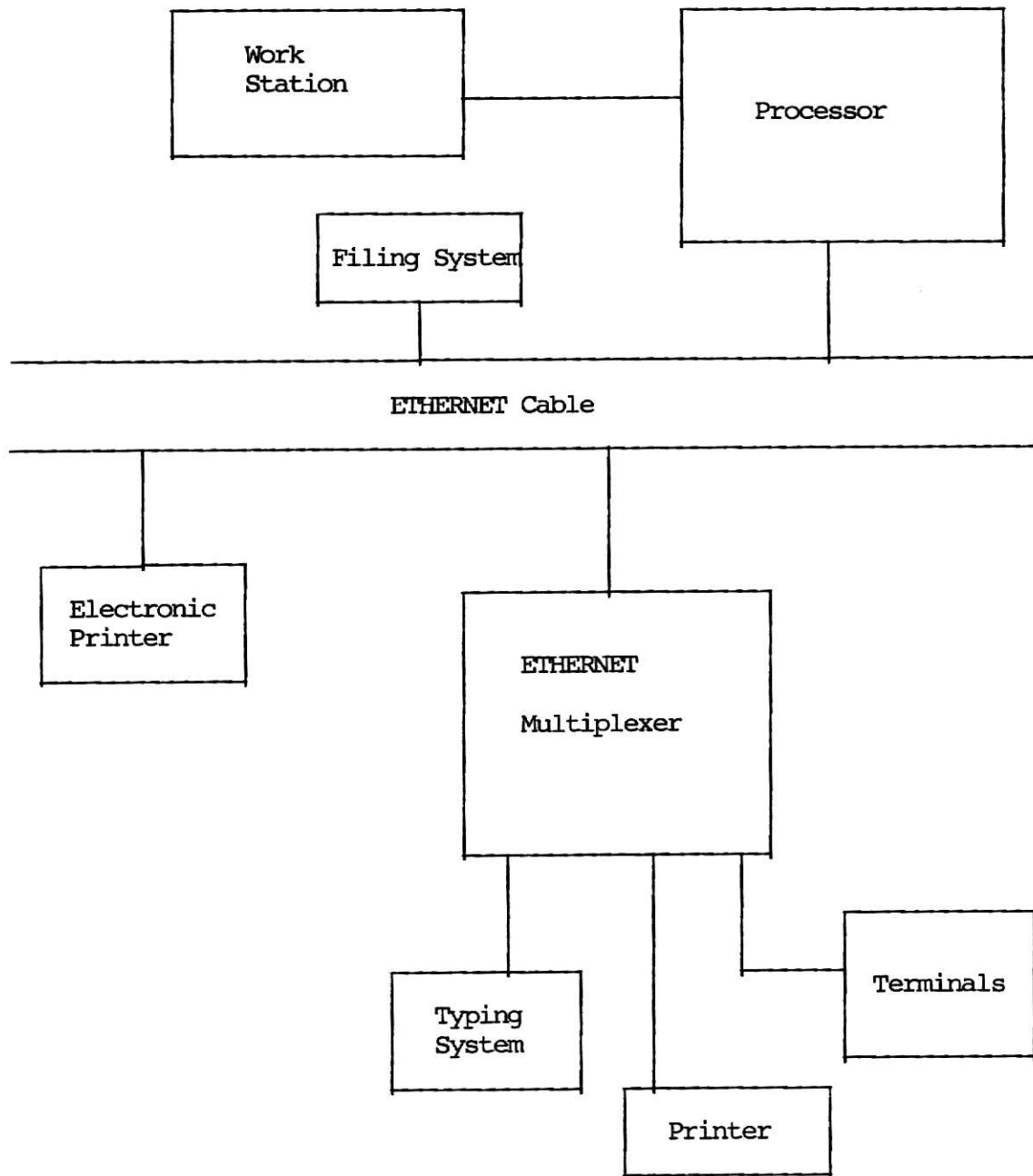


Figure 3.19-1 Ethernet System

3.20 Z-NET

Zilog, Manufacturer

Zilog's Z-NET local area network consists of a complete set of hardware, system software, and some applications software. It uses a common bus topology where all nodes are fully-connected. However, messages do not travel from node to node, but are broadcast over the entire network simultaneously. A central controller is not necessary in this configuration.

Z-NET uses dedicated lines. All nodes share equal access to the network on a first-come, first-serve basis. Up to 255 stations can be connected to the bus. The maximum cable length is approximately 7000 feet. This is standard coaxial cable. The network uses a bit-oriented, packet switching protocol which reaches data transmission speeds of up to 800,000 bits per second.

The basic Z-NET system components offered by Zilog include an MCZ-2 Microcomputer (the node), the MCZ operating system, floppy disk support, serial interface support, terminals, printers, SDS 2/01 Shared Data Station (a preprogrammed network node which includes the MCZ-2 Microcomputer and a hard disk controller), NST 2/01 Network Station Transceiver (which connects the digital node processor interface with the coaxial cable and is responsible for collision detection, clocking, and encoding/decoding data from the cable), tapes, cables, and terminators.

Z-NET system software is layered and consists of two basic elements:

- (1) the Kernel - an element of the system which performs the jobs of creating and deleting tasks, scheduling tasks, and providing for communication between tasks.
- (2) the Z-NET Network Protocol Software - which runs as a task under the Kernel. Z-NET NPS provides protocols through ISO's SESSION layer. When used in conjunction with Zilog's three protocols above the data link level, a powerful base is available on which to build.

Z-NET is a contention based system which resolves collisions by two methods:

- (1) a "carrier sense" function in which each node senses if the line is being used and if so waits to begin (listen before talk)
- (2) when two or more nodes begin to transmit at the same time, collision can be detected almost immediately because they can receive and transmit at the same time. If there is a collision they all back-off for a short, random time period before attempting to send again.

Z-NET can connect with "foreign" systems and as a node processor can be programmed to allow non-Zilog devices to be assembled together.

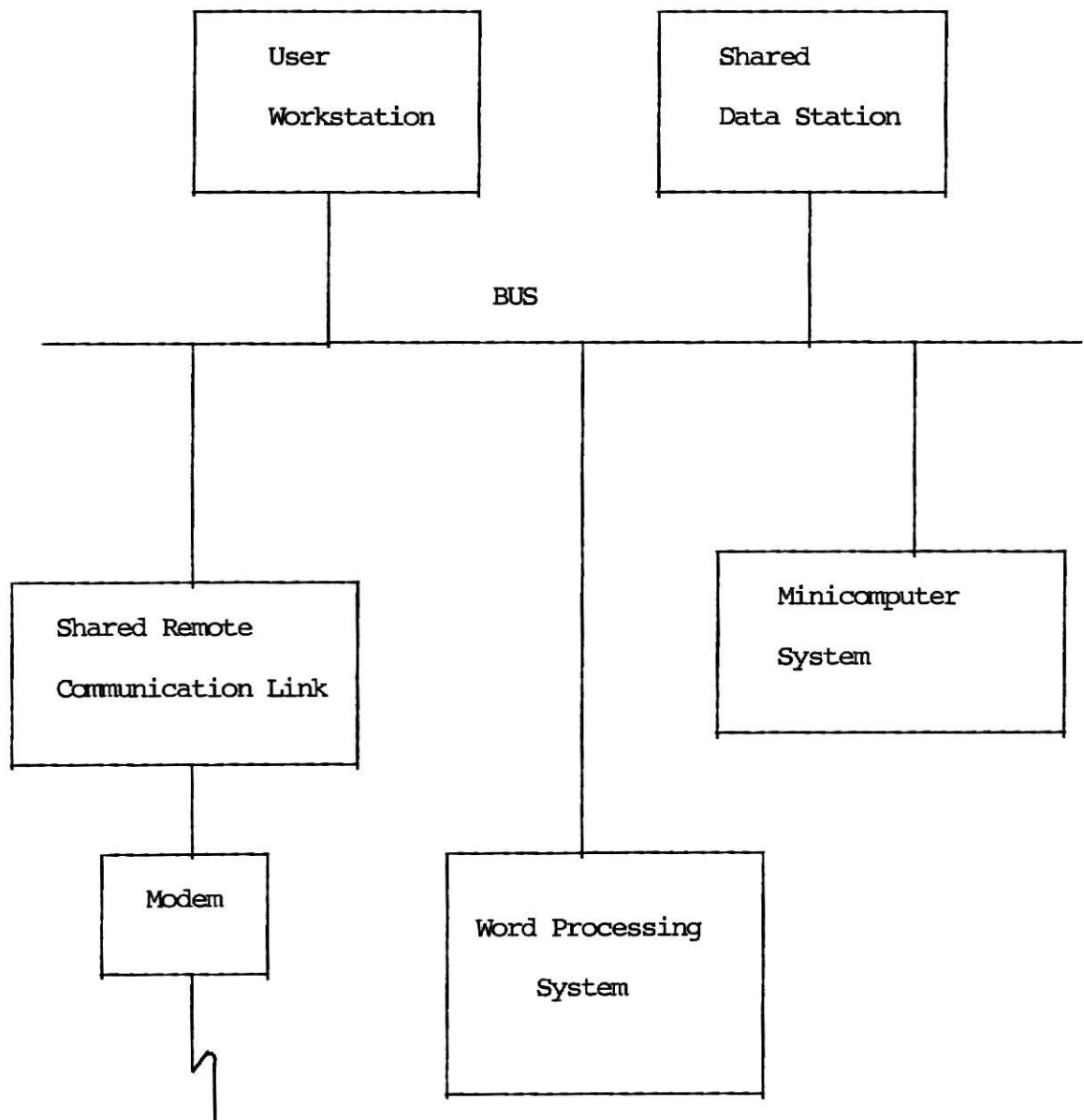


Figure 3.20-1 Z-NET System

CHAPTER 4 CONCLUSION

4.0 LOCAL AREA NETWORKS AND THE FUTURE

John Naisbitt in his article "Megamorphosis" discusses the shifts that are taking place and will be taking place in our country, the business world, and our daily lives. A number of these shifts could be influenced heavily by local area networks. They are (NAIS83):

<u>FROM</u>	<u>TO</u>
industrialized society	information society
centralized society	decentralized society
either/or	multiple-option
printing	telecommunications
material productivity	knowledge productivity

Let's take a look at how local area networks may affect these shifts. Since 1950 when 65 percent of the United States workforce was engaged in industrial occupations and 17 percent was involved in creating, processing, and distributing information, the job market mix has changed to reflect a 27 percent industrial workforce and a 60 percent information workforce. An 80 percent information society is expected by the year 2000.

Naisbitt predicts that the large organizations necessary to reap profits in industry through large scale operations which lower the per unit cost will not be necessary in the information society.

Small organizations with data processing capability should be able to take advantage of the decentralized data storage and retrieval methods now offered by local area network systems so that each decision maker within an organization has access to the latest, up-to-date, information possible. Knowledge will be the foremost resource while capital falls in prominence. Already consultants have been taking advantage of this thirst for knowledge that businesses have found themselves in dire need of. Selling what a person knows can be quite profitable these days for predicting the future has become more and more difficult.

Naisbitt predicts that the country is in the process of decentralizing - that, in fact, the life of certain cities is at an end, and that smaller decentralized elements will be formed because large centralized governments are not capable of addressing the problems of large populations.

Local area networks will be useful in small government operations where expenses will need to be compared constantly with revenues so that adjustments can be made. LANs with capabilities of hooking up with larger networks will be necessary for law enforcement activities, and other shared data processes.

Time changes current data into historical data quickly. Decisions based on old data will not be tolerated. Actions will be the result of analyzing current data and making appropriate decisions. Modeling will become more important as a decision making tool and local area networks will support the data input necessary from all parts of the organization.

Office automation will be at full force within a few years. Workers will be responsible for gathering facts, entering them into computer systems, determining report formats, manipulating the data, and printing out relevant information. The computer professional will dwindle in prominence from the applications programming area as more and more professional occupations will require direct user involvement with the computer. User friendly languages are already making a significant contribution to user involvement by making it easier and easier for non-data processing people to use the system.

Sperry UNIVAC's MAPPER (Maintaining, Preparing, Processing Executive Reports) software is having a tremendous impact on non-data processing personnel. This system is designed to require only a few days training in commands to manipulate fields within the database for users. They can then input into the database, change data, delete data, perform calculations on the data, format reports, print them out, and send messages to specific persons on other terminals without the need for interaction with computer professionals. Surely this is the way of the future.

4.1 SUMMARY

Business communications is changing dramatically. The need for more timely information continues to grow. Competition between businesses is fierce in our depressed economy. Decision making continues to gain importance as many industries teeter on the brink of insolvency. Decision models are being relied upon more and more so that consequences of possible decisions can be weighed before an actual course is decided. In order to stay even, or possibly get an edge on the competition, the latest communication and data processing facilities are necessary. And that is where the local area network will serve the business community — tying together computer data processing and data communications capabilities. Fast, powerful, integrated systems can be at the fingertips of corporate executives and analysts. The advantages of working with current, accurate data will convince companies to upgrade technology.

New local area network products are being announced on a regular basis. Manufacturers are continuing to upgrade products already on the market. Business personnel are becoming more aware of what network systems can do for them and, consequently, are demanding fast, efficient, and accurate data systems which require less interaction with the traditional centralized computer center. Micro-computers are cost feasible for almost any business, regardless of size, and their proliferation into our homes will generate requests for the same capabilities at the office. And the local area network will tie them all together so we can benefit from each other's creativity and productivity.

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LOCAL AREA NETWORKS:
SELECTION CRITERIA AND PRODUCT DESCRIPTIONS

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AN ABSTRACT OF A MASTER'S REPORT
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The increasing number of network products has made it extremely difficult for businesses to determine which systems or components would best fit their needs. This paper attempts to address the ten major local area network characteristics of importance to consider when researching such products.

The selection criteria include:

- (1) Topology
- (2) Line Types
- (3) Line Sharing Techniques and Trunk Access Methods
- (4) Physical Limitations
- (5) Transmission Media
- (6) Transmission Mode
- (7) Data Rate/Bandwidth
- (8) Length of Signal
- (9) Protocol
- (10) Layered Architecture

Twenty current offerings in the local area network market are described with special emphasis placed on the ten characteristics referred to above.

Finally, a look is made into the future and how local area networks may influence it.