THE STATE OF THE ART OF OFFICE AUTOMATION

Charilaos Fakiris

A Major Report

in

The Department

of

Computer Science

Presented in Partial Fulfillment of the Requirements
for the degree of Master in Computer Science at
Concordia University
Montreal, Quebec, Canada

August 1983

ABSTRACT

THE STATE OF THE ART OF OFFICE AUTOMATION

Charilaos Pakiris

This report presents the state of the art of office automation with respect to several different areas, such as, user's requirements, user's acceptance, as well as commercial office products and local office communication networks. These areas suit a variety of needs and improve the flow of information in an office environment. In addition, the architecture of office information systems is presented and the changes that will take place in office automation over the next few years are described.

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to Dr. B.C. Desai, my supervisor, for his advice and guidance throughout the course of preparation of this report. I am also thankful to Dr. P. Goyal for his suggestions to improve this report.

Finally, I would like to thank my parents who have patiently encouraged me throughout this work, and my friends for their assistance during the writing of this report.

CONTENTS

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION.

The technological revolution of hardware [NES-75b] that began with the introduction of the microprocessor at a low price, is now beginning to have an impact on areas of everyday life, such as the office environment. There are many factors, both technical and economical , that point to the need for office automation and office information systems. From a technical standpoint, the reduction in the cost of computer processing is a very strong driving force for office automation. Economically, it makes sense to invest more in a cheap resource in order to better utilize an expensive resource. Today, the cost of employing people is steadily increasing and the cost of computerized office equipment is falling. In addition, the information handling capabilities of the equipment is becoming more sophisticated. It thus makes sense to invest a little more in the equipment in an attempt to better utilize the available people. The problem of office automation is not only a problem of data processing or communications or the right equipment.Office information systems require the combination of all of these individual aspects of the information handling problems of the office in an integrated solution. Therefore, one can set up the following definition of an Office Information System (OIS) : An OIS is a system that uses technology,particularly computer and communications technology, to increase office productivity

and the effectiveness of the managerial, professional and clerical staff. OIS functions include the electronic capture , storage, processing, retrieval and distribution of business data and information through interactive workstations interconnected by an office network.

This report presents the state of art in office automation. First, it examines the required level of user skills to function in such an environment. Second, a general overview of the current situation on office automation is given. This includes the commercial OIS equipment, the local office communications networks, prototype OIS and an architecture of OIS. Third, there is a discussion on the acceptability of the systems by the people who will use them. The report then presents the future perspectives on office automation and finally, an annotated bibliography on office automation .

2. USER REQUIREMENTS.

The organization of most offices evolves over a long period of time. Changes to office procedures or organization are usually introduced gradually.This is because it is fairly difficult, costly, and traumatic to reorganize offices continually. If new people are hired, they have to be trained in the current procedures of the office. If new procedures are introduced, then people have to be retrained. If new equipment is acquired, office workers have to be trained in its use. Meanwhile, activity in the office should continue as usual without major disruptions to the company's business activities.

The proliferation of the automated office [TSI-80a] will probably be paced by users' acceptance. In order to minimize user resistance, it is important to provide an environment which is satisfactory to the users. The requirements of users in the office will have to be captured in an appropriately descriptive office model and expressed as capabilities of the office information system. Human factors engineering will play a very important part in translating user requirements into appropriate facilities in the automated office.

The concepts, methods and technologies in a conventional office have evolved as the need for them dictated. The users have had a long time to get used to

them and to master them. In the past, most of the technology and processing methods were relatively simple to master by most users. Users did not require a great deal of sophistication. Office automation introduces more concepts and technologies.These changes have to be introduced and provided in a way that the users can cope with them.

The user must feel that the system is merely a tool to be used in the performance of his/her job and is not coercive in any way. The tools must not only be easy to use, but must be the right tools required by the user. Many diverse capabilities are needed. As much as possible, however, the different capabilities should be provided in a uniform way so that the user is not required to learn many different conventions. An office information system will have to provide a facility for querying the data base to retrieve data or perform some office procedure. This facility can be in the form of a dialog language, form filling [TSI-79 c], or a simple command language. A good deal of work has been done on the design and human factors aspects of database query languages. Most of this research, however, has been oriented towards fairly sophisticated users.

Similar studies need to be done for query languages for OIS. It seems that some office information systems will be implemented using minicomputers in a distributed environment. In this case, local network communications

will have to be provided to send data from user to user. The facilities for this electronic mail capability will have to hide the network aspects of the communications from the user. Sending electronic mail in a network should not be any more difficult than addressing and mailing a letter or sending a memo, and should probably be a great deal simpler. Pictorial communication, e.g., graphics and pictures, and speech communication, e.g., recorded messages and telephone calls, also need to be available in the office information system interface. People have many ways to communicate ideas and messages. Office information systems cannot limit them to just one,e.g., printed text. They should be able to talk, point, relate images, etc. This implies that such things as speech equipment (telephones), visual displays (TV screens), facsimile and character text on paper, have to be available and integrated in the user interface.

It is important to determine the best way for office workers to interact with the system. It can be by menu selection, command buttons, pointing, speaking, joysticks, some combination of these , or other ways. Within any interface, a hierarchy of facilities needs to be provided so that first-time users can be guided by the system while more experienced users are not unduly annoyed by the system interaction. Facilities for interaction should be provided in a uniform way within levels as well as between levels. This implies that appropriate software

engineering techniques have been applied to permit a layered approach to interface design. It also implies that hardware design and software design proceed hand-in-hand so that they can be properly integrated. In order to test different interface designs, appropriate tools have to be developed that will allow a design to be put together quickly and the behavior simulated without necessitating a complete implementation. In this way, many different designs can be more easily evaluated and the probability of coming up with a good design can be greatly enhanced.

To be succesful, office information systems first and foremost have to meet the user's requirements. The users of office information systems will not be very sophisticated in terms of computer hardware and software technology. They will not want to have to master a lot of different approaches and technologies. They will not want to have to understand the intricacies of speech encoding, data communications and text management. However, they will want to use word processing, electronic mail, filing and other capabilities in a common, simple to use interface. Human factors, software and hardware engineering have to be applied to obtain a satisfactory solution, which will not be of much use if the users are unwilling to accept it.

3. CURRENT SITUATION IN OFFICE AUTOMATION.

At the present time, the office automation marketplace is a rather diverse one. Vendors have entered from many different angles and points of view :

1. Word Processing Systems - many vendors have equated office automation with word processing. There are two segments of the strictly word processing market which have a very large growth potential. These are the electronic typewriter, of which the IBM Model 75, the Olivetti ET221, and the Qyx units are all examples. They combine the microprocessor based power of larger, display oriented word processors, with the keyboard, print mechanisms, and packaging of a normal typewriter. The shared logic systems also have growth potential. Except in very small offices, there are groups of clerical or secreterial personnel who can be aided by word processing. The shared logic units operate much as the time-sharing data processing systems. Several users share a controller, printer, and usually disk storage devices. Since these units have CRT displays and the ability to connect more units, they are more easily upgraded with additional functions than the electronic typewriters.

The stand alone word processor is also growing, but is seen as a device which must be able to connect, via local high speed networks, or through lower speed communication

devices, to other units. Many vendors have recently added shared file systems. These permit several stand alone systems to access a single large disk of up to 200 megabytes of storage.

Whatever the type of word processing equipment, its vendors today are designing the product in order to increase the basic editing functionality, provide additional personal computing power, and allow far more communications with other devices in their path to the office of the future.

2. Minicomputer based systems - some manufacturers have approached office automation by adding features, such as word processing, to their existing minicomputer systems. Prime, Four-Phase, and DEC have all produced systems in this way. These generally are shared-logic , in that several simultaneous users are supported by the system with shared-resource, in terms of the file storage and the processor. The amount of applications software for managerial functions is increasing. For example, the Prime Systems perform scheduling, electronic mail, and reminding, as well as the basic word processing. They even have a set of dictionaries to translate among five languages.

3. Mainframe computers - some manufacturers, notably IBM(Data Processing Division) and Burroughs, have sought to put all the office automation functions on a large mainframe computer. Burroughs has installed a successful pilot

project at the Michigan Bell Telephone Company, where the president and more than 10 of his subordinates have terminals connected to a B6800 computer. They can send and receive messages, access company files, and perform text editing. IBM's SCRIPT (Document Control Facility and Document Library Facility) packages, along with STAIRS, give users the ability to create text, format it, and to retrieve it based on any information which exists in the text. This capability is not yet available on smaller systems.

4. Distributed computing - others approach office automation product development as merely another, albeit major, application for distributed processing. The IBM 8100 series has software announced for local word and data processing. These communicate to each other , and to large mainframes that provide the STAIRS type of information retrieval, and electronic document distribution. The XEROX Palo Alto Research Center's ALTO systems incorporated a powerful minicomputer at each workstation. The workstations were tied together on a high bandwidth local network (the ETHERNET) which also has a maxi-computer when larger power was needed.

The major software components in the office automation systems are :

1. Text Editor - this is the most visible interface to the user. It must be made simple enough to require minimum training, yet powerful enough to meet the features which most users now demand of an editor.

2. File System - average users do not wish to be concerned with the level of detail which most data processing system programmers need to know about file storage. Blocks, records, and other terms are foreign to the secretary who thinks in terms of forms. So a file system that supports these concepts must be supplied. Often, the files reside on floppy disks or other removable media, and special care must be taken to ensure that the proper file is mounted.

3. Text Formatter and Printer Control - the work of these programs is to output the text with headers, footers, neat title, pages properly numbered, and so on.

4. Communications - major users are almost all purchasing systems that can communicate. Not only must the system be able to converse with like systems, it may also have to act as a computer terminal to various host computers. The user interface must be simple enough so that it is easily handled by a secretary or non-technical manager.

5. Data Processing features - these range from simple mathematics packages to deal with columns of numbers, through simple business accounting, to the general ability to program the machine.

On the hardware side,there is much ongoing development in displays and printers. On the printer side, a low-cost, high quality non-impact printing system is desired. The high-cost versions (XEROX 9700) have been quite successful. These offer the extremely low noise level that cannot be achieved by impact printers. If they can be made cost-competitive, they will be widely used.

As for displays, larger formats (full page, and even two page with the Vydec 4000), and color (the IBM 3279) offer new possibilities which will aid in office automation.

Thus, the users are moving up from word processing, through to communications among their processors, to electronic mail, and then adding the personal computing and other functions that create a full effective office automation system.

3.1. Commercial Office Information Systems.

3.1.1. WANG - Systems.

3.1.1.1. WANG's Office Information Systems.

WANG offers a comprehensive series of Office Information Systems (OIS) which share important characteristics, such as, they are powerful (microprocessors in every OIS component allow many system functions to be performed locally, by workstations and other devices with very high speed and power), they are versatile, easy to learn and use, upgradeable and cost effective. These Office Information Systems (OIS) are :

- The OIS/105, ideal for a small cluster or work group.It provides large-system capabilities at an affordable price. With only one or two workstations, and with a WANG-printer,one can virtually automate the small office or work group at a very low cost.

On-line system storage of 2.5 MB means instant access to 1000 pages of text, to meet the demands typical of the small environment.

- The OIS/115, available in two models, eases the transition from small to medium-size office. Systems OIS/115 support up to eight devices including workstations, printers, and other peripherals.

OIS/115-1 provides a 4.2 MB sealed disk drive, while OIS/115-2 is equipped to accommodate 8.2 MB of storage.

- The OIS/125 A provides the added flexibility often required by an operation which is medium-sized and still growing. A combination of up to 16 devices , including workstations with 64 K of memory , round out the system in a busy office.The 5 MB disk on the 125 A permits quick and easy access to up to 2000 pages of text. An optional 5 MB disk, with 2.5 MB of removable media, increases off-line storage and provides extra protection for your documents.

- The OIS/130 A retains approximately 4000 pages of text on its 10 MB disk. If one adds an optional second 10 MB disk , one can store up to 8000 pages, back-up the system master, and acquire still more archiving capacity. The same variety of up to 16 devices available on the 125 A is also available on the OIS/130 A.

- The OIS/140 is available in three models. Every model of the OIS/140 supports up to 32 devices, for a truly versatile system. Each offers successively larger storage capacity, so one just selects the capacity which suits him.

Model I has a 26.8 MB disk to store approximately 10700 pages,

Model II, with a 53.6 MB disk, stores 21400 pages,

Model III stores 32100 pages on a 80.4 MB disk.

One or two optional 10 MB disks promote quick, easy archive filing off each system. If still more archive capacity is needed, or if it is prefered to have more back-up for the system, an additional disk (with 13.4 MB of removable media), equivalent in size to the master disk, can be

attached.

- The OIS/145 handles even the largest-volume office tasks efficiently. In addition to 32 devices - including 24 workstations - the OIS/145 can support up to 334000 pages of text. Providing enormous storage on a 275 MB drive, the 145 means immediate access to 110000 pages.A standard 10 MB drive with 5 MB of removable media allows even greater storage, large volume archiving, and document and file interchange among Office Information Systems.
Additional storage and back-up for 220000 pages is available on two optional 275 MB removable disks.

To extend the flexibility of an OIS in any environment, one can select the following peripheral devices:

- Workstations with 32 K, 48 K or 64 K of memory, for extended functionality.
- Archiving Workstations, to file and retrieve documents at remote locations.
- Ideographic Word Processors, to process and print text in conventional Chinese, simplified Chinese, and Japanese.
- Communicating Workstations, to perform telecommunications activities from individual work areas.
- Telecommunications Controllers, in bisynchronous protocol, to turn an OIS into on-line interactive system.
- WANG Intelligent IMAGE PRINTER, for typewriter-quality documents at the rate of 18 pages per minute, in landscape

or portrait-style and in a variety of typestyles.

- Daisy Printers, to provide typewriter-quality output at high speeds.
- Draft-quality Matrix or Chain Printers, which operate unattended at a rate of up to 425 lines per minute.
- Typesetter 48Z, to generate camera-ready material in eight on-line type fonts chosen from a library of over 300.
- Envelope Feeder, to feed three sizes of envelopes into the daisy printer automatically.
- Twin Sheet Feeder, to feed both letter and legal paper into the Daisy printer automatically.
- Magnetic Card Reader, to convert cards created on IBM Mag Card II's or their equivalent into WANG word processing documents.

WANG also offers an assortment of remarkable options to maximize system resources and streamline all office procedures. The system's capabilities are extended when the following are acquired :

- MAILWAY. The WANG electronic mail and message system, MAILWAY routes, distributes and tracks messages to other WANG systems anywhere.MAILWAY can even provide certain administrative services, for example, log information flow and confirm mail delivery.

Text and data move to their destinations from a MAILWAY workstation - quickly, easily and very economically.

- OFFICE - BASIC. With OFFICE - BASIC, the powerful

programming language option, the OIS virtually becomes two systems in one. Because OFFICE - BASIC allows data processing activities from any OIS workstation, the staff accomplishes a range of data and word processing tasks from the same simple keyboard.

- WISE. WISE is the WANG Inter-System Exchange, links all the Office Information Systems within the user's facility. The connection allows an operation to share unique peripherals, such as the IMAGE PRINTER. Each OIS capitalizes on the resources of the others through WISE, making every system more cost-effective.

3.1.1.2. WANG's Business Computing Systems.

WANG offers two powerful business computer lines the WANG 2200 series and the WANG VS. WANG 2200 Systems work in all types of businesses. Small and large businesses use WANG 2200 systems to process accounting, inventory, sales, manufacturing, distribution, and management planning information. Scientists and engineers use the WANG 2200 systems to perform modeling, complex mathematical calculations, and instrumentation monitoring. Administrators in hospitals, schools, and government use WANG 2200 systems to maintain thousands of records on patients, students, and constituents. The WANG 2200 series is :

- The WANG 2200 PCS-III, is the first in the WANG 2200 series of computing systems. The WANG 2200 PCS-III desk-top system offers a large, easy-to-read executive display screen, typewriter-like keyboard and numeric keypad, and up to two minidiskette drives for convenient information storage. Like all WANG 2200 systems, the WANG 2200 PCS-III is programmed in an enhanced version of BASIC, the easy-to-use computer language.
- The WANG 2200 SVP single-user, desk-top system can handle a multitude of information processing needs , such as accounting, inventory, and sales analysis.

The WANG 2200 SVP system specifications are :

User Memory : 32000 characters (standard)
64000 characters (optional)

Diskette Drive : Over 500000 characters (standard)
Over 1 million characters (optional)
Single-sided, double-density

Fixed Disk Drive : 2 million characters (optional)
4 million characters (optional)

Printers : Supports all WANG 2200 series printers featuring high print quality and high speed.

Telecommunications : Asynchronous : 2741, teletype
Bisynchronous: 3275, 2780, 3780, 3741, HASP.

- The WANG 2200 VP has the capability of supporting several peripherals (disk drives, printers) to handle expanding office automation requirements, and it can be upgraded to a larger, multi-workstation WANG 2200 MVP. Like all WANG 2200 systems , the WANG 2200 VP is supported by application programs and programming aids.
- The WANG 2200 LVP can be used as either a single- or multi- workstation computer system, providing solutions for all the office automation needs.

The WANG 2200 LVP can be used for order processing, inventory control, production scheduling, and accounting, or management functions such as sales forecasting and financial analysis. WANG's 2200 LVP system specifications are :

* User Memory : 32K to 128K bytes,
* Terminals : 1 to 4,
* Diskette storage : 1 megabyte, dual-sided, double density,
* Disk storage : 2, 4, or 8 megabytes, fixed disk technology,
* Printer speeds : from 30 characters per second to 600 lines per min.

- The WANG 2200 MVP is at the top of the WANG 2000 line of computing systems , and it can handle several processing jobs at the same time. The WANG 2200 MVP system supports up to twelve workstations , with large optional disk storage capacity and expandable memory designed to match the application.

The WANG 2200 MVP can expand to 12 terminals, 256K user memory, and over 300 megabytes of disk storage. For larger companies with distributed processing requirements, the WANG 2200 MVP can support a full line of asynchronous and bisynchronous telecommunications in a variety of industry-standard protocols.

The WANG's family of VS systems is user-oriented, it can be easily operated by office personnel and programmers alike, and it can handle many users, many jobs, all simultaneously.

In its smallest configuration, the system includes 128K bytes of memory, one workstation, one 10-megabyte disk drive, one diskette drive and a printer.

In its largest configuration, the system can include up to 128 workstations, up to sixteen 288-megabyte disk drives, optional 7- and 9- track magnetic tape drives, and printers of various speeds.

3.1.2. XEROX - Systems.

XEROX offers the following office products to automate the information processing that takes place in an office :

- The XEROX 860 Information Processing System (IPS). The XEROX 860 IPS offers multiple disk drive options to increase the storage capacity of systems that handle long documents and extensive records files. To improve the functionality of the XEROX 860 IPS, these accessories are available : Shared Printer Interface and Automatic Paper Feeder.

The XEROX 860 IPS Communications Accessory provides the capability of connecting the XEROX 860 IPS with suitably configured 860's, computers, Ethernet devices, or with the XEROX 850 Display Typing System, and some other word processors. The Communications Accessory transmits and receives information over telephone and other voice grade networks at speeds up to 4800 bits per second. The communications accessory is highly useful for gathering or distributing time vital information, and for developing multifunctional requirements as the office needs grow. The XEROX 860 IPS, designed for exceptional flexibility, can handle a multitude of word processing and data processing functions, and can be easily expanded as needs and applications grow.

- The XEROX 850 Page Display System. Ideal for offices with volume typing and heavy revision requirements, the XEROX 850 Page Display System encompasses the latest advances in word

processing equipment. The basic components of the four-part system are the Keyboard, Display Screen, Controller and Printer. The modular design offers the user the advantage of arranging the system for maximum office convenience. In addition, a wide range of auxiliary equipment, such as communications, Automatic Paper Feeder and Media Conversion Accessories, allows the user to enhance the capabilities of his system to suit the specific requirements of his office.

- The XEROX 820 Information Processor (IP). The XEROX 820 IP functions as both a Word Processor and a Desktop computer. As an inexpensive Word Processor, the XEROX 820 IP allows the user to upgrade existing office typewriters and non-display text editors. A user can have WP capabilities without paying for equipment with more features than he really needs. As a Desktop computer, the 820 XEROX IP gives the user a cost-effective way to automate his daily work routine through a wide range of software options.

- The XEROX 800 Electronic Typing System (ETS). The XEROX 800 ETS is available in two magnetic card configurations : a single card unit , and a dual card unit. Both models offer the user the advantages of more productivity, greater versatility and advanced electronic design.

- The XEROX 850 Automatic Paper Feeder (APF). When used in conjunction with XEROX 850 Page Display System, the XEROX 850 Automatic Paper Feeder provides an extra measure of speed and efficiency which will increase productivity and decrease turnaround time in the office.

- The XEROX 850 Communications Accessory. The XEROX 850 Communications Accessory transmits and receives information over telephone or other compatible voice-grade communications networks. The speed of transmission ranges from 10 to 300 characters per second.

3.1.3. AES DATA - Systems.

AES DATA offers the following products to automate the information processing that takes place in an office :

- AES PLUS combines speed and accuracy with effortless electronic typing Using a conventional alphanumeric keyboard, the system offers dramatic savings in time and energy :

* Automatically justifies right-hand margin.
* Provides automatic centering for titles or whole pages.
* Bold print can be called up for headings instantly.
* French or English or other language texts can be recorded and repoduced side-by-side with paragraphs aligned.
* Blocks of text, paragraphs, sentences, and characters can be selected and inserted anywhere in a document.
* The system can store up to 35 pages which can be recalled at any time in the future for correction and reprinting.
* Print production is carried out at a speed of 540 words per minute.
* Accepts everyday language commands.
* Automatically adds, subtracts, totals and calculates percentages while producing financial statements.
* Simplifies record keeping through automatic indexing on diskettes.

AES offers a series of diskettes, programmed to instruct the AES PLUS to handle special tasks.This unique software is

available in many individual formats : Financial Proofreading, Records Organization, Building Blocks, Search and Replace, Line Drawing, Select-a-Text, Proportional Printing, ESP (Extract, Sort Print), etc.

AES PLUS can communicate with any other AES system or with computers ,information banks and teletype stations anywhere in the world. The AES PLUS high speed point-to-point communications capability can minimize time lag for branch office communications and reduce costs of special courier services and excessive long distance telephone calls.

When equipped with the Asynchronous Communications option, the AES PLUS Word processor is capable of interfacing with most CPU sites supporting asynchronous terminals and other devices (PTR, PTP, OCRs, etc.) equipped with compatible communications procedures. The AES PLUS Asynchronous Communications option emulates an ASR-33 Terminal.

The 2780 Emulation program allows the AES PLUS word processor to communicate with most CPU sites supporting IBM 2780 ports.

- AES System - C20, known as MULTIPLUS. The 2780/3780/2770 Emulation package allows any AES SYSTEM C20 to communicate synchronously with other devices supporting compatible 2780/3780/2770 ports. Devices such as card readers, card punches, printers, etc., may be emulated.

The System C20 provides the user with a dynamic data display

on/off facility which allows operation in both foreground and background modes. When equipped with the Asynchronous Communications program, the AES SYSTEM - C 20 Word Processor is capable of interfacing with most CPUs supporting start-stop terminals and other devices with compatible communications procedures.

In a clustered C20 environment, only one local terminal may be in the communications mode at any one time.

- AES PLUS Extended Disk is designed to increase diskette storage capacity and the speed with which the AES PLUS handles even the toughest office jobs. The AES PLUS Extended Disk increases office efficiency while decreasing office costs. The 3780 Emulation program allows the AES PLUS word processor with Extended Disk to communicate with most CPUs equipped with compatible 3780 ports. Upon transmission, the AES PLUS Extended Disk emulates a card reader device and upon reception, both a card punch and printer device. Data is received on the video screen and then memorized in compatible AES page formats.

- AES SUPERPLUS IV which accepts double side diskettes.

- AES ALPHAPLUS APS10-1 is a self-contained typing system (incorporating video screen, keyboard, printer, media storage) that is extremely simple to learn and use. Some time saving features along with many others on the AES ALPHAPLUS APS10-1 are :

* Automatic centering
* Hyphenate assist

* Automatic justifying
* Automatic underlining
* Headers / footnotes / footers
* Insert / Delete
* Numeric alignment
* Paragraph alignment
* Reformat
* Strikeover correction
* Tab-to-block
* Text movement
* Word wraparound

- AES ALPHAPLUS APS12-1 is a self-contained typing system (incorporating video screen, keyboard, printer, media storage) that is extremely simple to learn and use. The AES ALPHAPLUS APS12-1 technology produces finished letters and helps to prepare envelopes in minutes. Also, in addition to the basic text editing capabilities of the AES ALPHAPLUS APS10-1, the AES ALPHAPLUS APS12-1 provides the list and repaginate features.

- AES ALPHAPLUS APS12-2 is a self-contained typing system (incorporating video screen, keyboard, printer, media storage) that is extremely simple to learn and use. The AES ALPHAPLUS APS12-2 combines the simplicity and cost-effectiveness of basic AES ALPHAPLUS APS10-1 text editing software with the added functions of the AES ALPHAPLUS APS12-1, and four powerful new skills :

* Glossary
* Line Drawing
* Proportional printing
* Search and replace (with the touch of a few keys, the AES ALPHAPLUS APS12-2 can find a string of characters and replace it).

3.1.4. MICOM - Systems.

- MICOM 2001 is a modular, high performance, standalone word processing system. Individual components may be arranged as the operator chooses, thereby ensuring maximum comfort and ease of operation. All parts are cable-connected. Maximum cable length is 10 feet.MICOM diskettes are pre-formatted, single sided. Each diskette stores up to 300,000 characters or 127 pages of text. MICOM 2001 is fully compatible with all MICOM software programs, including :

Math Pak II, Sort, Record Processing, OCR, Keystroke Memory, Proportional Spacing, BASIC, Asynchronous, 2780 and 3780 Bisynchronous and MICONET communications. MICOM 2001 is fully compatible with all MICOM hardware accessories, including :

Sheet Feeder, Continuous Forms Tractors, Wide Track and Dual Head Printers, OCR equipment and the Shared File System.

- MICOM 2001E is an advanced word processing system. MICOM 2001E has memory of 128K which allows the integration of many MICOM programs on a diskette.

- MICOM 2002. The MICOM 2002 basic configuration, consisting of a terminal, a printer, and the processing unit which houses the disk drives, can be extended to form the 2002 TWIN, with two printers and two terminals, or the 2002 CLUSTER formation, with up to four workstations.

Some of the main features of MICOM 2002 TWIN are :

* Easy to learn and use

* Automatic insertion
* Preparation of texts
* Search and Replacement in the whole text
* Graphics
* Statistics

etc.

- MATH PAK II is a MICOM software program which prepares financial statements, annual reports, and statistical documents, regardless of length or complexity, using all the speed, accuracy, efficiency, and simplicity of word processing.
- MICONET communications software program is used throughout the company to send or receive letters, important memos and reports.

MICONET lets a user exchange information between his MICOM system and another MICOM station anywhere in the world. MICONET is the quickest, most efficient way of sending a written document from one MICOM to another, transmitting messages at a speed of 4800 baud.

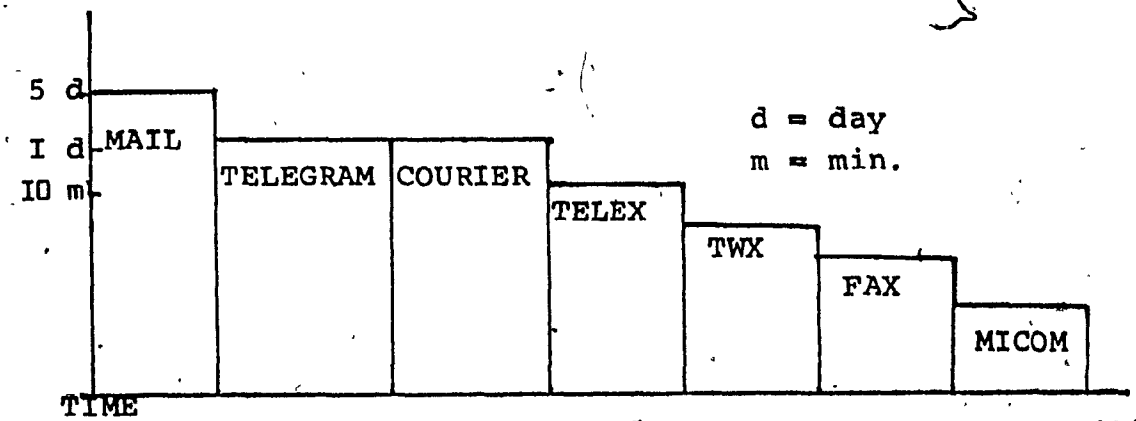

Fig. 3.I Comparison between MICOM and other commun. facilities

3.1.5. IBM _ Systems.

IBM offers a wide range of office products to suit a variety of needs and to improve the flow of information in an office environment. These office products are:

- IBM Displaywriter System. The IBM Displaywriter System is a software-based family of equipment and functions. It is designed to be cost efficient for today's needs, and modular, to grow as needs grow. The IBM Displaywriter System is based on IBM Licensed Program Diskettes. The IBM Display station consists of display, keyboard and electronic modules.

Two types of diskette drives are available for the Displaywriter- single and high density. These drives allow four variations for the system. They give from about 284,000 to approximately 2,000,000 bytes of customer-usable characters and controls. The basic units give maximum economy, the others make increased storage, less diskette handling and higher productivity possible.

There is also a choice of three impact printers with rated burst speeds of 15.5, 40 and 60 characters per second. Optional-automatic sheet-feed or tractor feed paper handlers can be attached to either a 40 or a 60 cps (characters per second) IBM Print-wheel Printer. The Printwheel Printers can work with as many as three work stations, reducing the cost per work station.

As an added information source, there is an optional Display-writer Mag Card Unit, which provides compatibility with existing IBM Mag Card products. IBM Displaywriter System-Text Processing capabilities include :

* aids to learning and everyday use displayed on screen
* standard and personalized formatting aids
* editing capabilities that encourage typing at rough draft speeds
* displays of text for review or revision
* storage of previously typed text for recall, editing and reduced document retyping
* automatic underscoring, centering, and indexing
* easy movement of material from one part of a page to another, or to an entirely different page
* automatic placement of material at the top or bottom of every page
* printing one part of a document while another segment is still being typed
* automatic line and page ending adjustments when revisions make text longer or shorter.

- The IBM Professional Office System(PROFS). PROFS provides the key office functions required by professionals, such as, electronic mail, messages and in-basket, document filing and retrieving, and time management through the use of calendars and reminders.Also, it provides secretaries with powerful text processing and file searching capabilities.

In addition, a user can select from a number of highly specialized and effective programs:

* Interactive Extension Facilities(IXF) which provides easy-to -use tutorials, helps and menus for the following:

* A Department Reporting System(ADRS), an easy-to-use interactive facility for producing customized reports.

* APL Data Interface(DI), a tool for answering one-time requests for information quickly, using logical expressions such as 'and', 'or', 'less than' or 'equal to'.

* The Document Composition Facility(DCF), can provide complete text formatting capability, including page numbering, automatic page headings, tables of contents, footnotes, boxes around blocks of text, spell checking, and many more.

* The Storage Information Retrieval System(STAIRS) provides a fully contextual search for direct access to, and fast scanning of, large numbers of documents.

- The IBM 6670 Information Distributor. The IBM Information Distributor capabilities include:

* On-line or off-line processing

* Automatic job recovery

* Operator-free transmission to the 6670

* Automatic paper selection, from either of the two paper drawers

* Up to 11 stored formats

* Internal storage diskette

* Up to 36 copies per minute with two-sided printing

* Two communications choices : Binary Synchronous Communications (BSC) and Synchronous Data Link Control (SDLC).

The IBM 6670 is especially effective when tied to the Professional Office System, the 8100 Distributed Office System and the 5520 Administrative System, for fast, high quality turnaround of letters, reports and presentations.

- The IBM Audio Distribution System. With the IBM Audio Distribution System, information can be recorded, stored, distributed and classified in his/her own voice. If he/she is out of the office, the system, when called, can quickly scan for messages, the allow him/her to select and listen to the specific ones he/she choose. In an office environment, the IBM Audio Distribution System can help to :

* Schedule and distribute messages by a specific date and time

* Lower long distance telephone costs by transmitting messages during lower rate hours.

* Record a variety of information, in addition to messages, such as progress reports or travel schedules, which can be accessed quickly by secretaries and updated easily by other users.

* Maintain high quality voice reproduction, including a speaker's expressions and inflections.

* Eliminate pauses throughout messages, thus providing a

continuous natural flow of words.

* Secure confidential information using passwords. For example, your self-created password lets you listen to complete messages, while a secretary's password might be used to ascertain who has sent messages, and a guest password can be given to vendors, family members and others for leaving messages.

* Eliminate the need for people to call back, and for secretaries to transcribe messages by hand.

- The IBM 5520 Administration System. The IBM 5520 Administration System is a modular, shared logic system which can be customized to fit someone's needs. It has a capacity of up to 130 megabytes of disk storage, and can support up to 18 display stations and 12 text-quality printers.

Operators of the 5520 are assisted in entering or editing text by :

* Menus and messages which simplify interaction.

* Automatic formatting capabilities, including page numbering, underscoring, column manipulation, insertion of headers and footers, and the merging of text and files.

Electronic document distribution, an important 5520 function, is supported in several ways :

* Documents sent to individual screens and printers on the same 5520 system or forwarded to another 5520.

* Documents sent to or received from a System/370 through

the use of 3270 emulation.

* Documents sent to other IBM Office Products, such as the IBM 6670 Information Distributor, using communication lines.

- The IBM 8100 Distributed Office System. Its basic building blocks are the IBM 8100 Information System and the Distributed Processing Controlled Executive Operating System (DPCX).

To these can be added the following components :

* The IBM Distributed Office Support Facility 8100 (DOSF/8100) Program Product. This provides easy-to-use basic text functions, local document storage on disk, and the ability to handle forms and pattern letters, standard paragraph insertions, wide documents and mass-mailing documents. The facility can\also be connected to host systems for both text and data processing applications.

* Text Display Stations, designed especially for the secretarial user

* Text Printers, including the 6670 Information Distributor, for producing high-quality correspondence.

* The System also provides a 'library' capability to allow shareable document files to be created and maintained at a host computer, which distributes messages and documents, and handles interaction between multiple 8100 users.

- The IBM System/23. The IBM System/23 marks an advancement in the merging of word processing and data processing trough a single system. The System/23 has been designed for small

businesses that need both data processing through a single system and text handling at a low price. It offers greater freedom from the office paperwork that sometimes strangles smaller organizations.

Highlights include :

* A menu-driven program written for fast operation and easy use, with default warnings for the more commonly-used procedures and standards.

* A display scale line showing margins, tabs, paper edges, centre point and a shadow cursor.

* Vertical scrolling and horizontal segmenting to review all parts of a stored page.

* Functions to create,revise,delete,duplicate,print,store, retrieve and change the profile of documents.

* Text manipulation made easier by stored formats, an automatic carrier return, block movement of texts, as well as functions for pagination.

* The interactive keying of variable information to stored letters or documents.

* Completed documents can be assembled directly from letter descriptions and data processing file data.

* The 5242 Model 2 Printer also provides a high quality printout, and the optional Document Insertion Device allows out forms to be inserted, if it is necessary.

- The IBM Personal Computer. It is very flexible and easy to use, so that it can handle a vast array of commercial,

educational, professional needs. This can be done because of its capabilities :

* The small, powerful processor, which holds over 40,960 characters in permanent memory and up to 262,144 characters in user memory.

* The 83-key keyboard, which includes a 10-key calculator pad for basic data entry and 10 function keys for activating commonly repeated tasks.

* The Colour/Graphics Monitor Adapter which provides input to a colour TV set or colour monitor.

* The monochrome display unit that lets a user view up to 25 lines of 80 characters each. A user can adjust brightness, contrast, and highlight with underlining, blinking, reverse images and high intensity.

* The versatile matrix printer which prints in both directions at up to 80 characters per second. It prints in 12 different typefaces at up to 132 characters per line and can handle multipart forms.

The IBM Personal Computer includes :

* A built-in speaker to assist in diagnostic capability and the generation of music, plus the ability to add one or two diskette drives, using 5 1/4'' diskettes and a series of self-tests and parity checks for increased reliability.

* Other optional features include a game control adapter to allow users to attach 'joysticks' to the system, plus an asynchronous communications adapter for communicating with data bases, other compilers, and laboratory instruments.

* A range of programming packages for budget planning, sales analysis, cash flow, word processing, accounts receivable, accounts payable, general ledger accounting, as well as action-packed video games.

3.1.6. Comparisons among OIS.

1. WANG - Systems.

WANG products are :

-versatile, applicable for small, medium and large-size office.

-upgradeable, it is possible to extend the flexibility of any OIS in any environment with the following peripheral devices :

* workstations with 32K, 48K or 64K of memory
* archiving workstations, to file and retrieve documents
* communicating workstations, to perform telecommunications activities
* ideographic word processors
* telecommunications controllers, to turn an OIS into on-line interactive system
* IMAGE printer, for typewriter-quality documents at the rate of 18 pages/min.
* DAISY printers, to provide typewriter-quality output at high speeds
* chain printers, which operate at a rate of up to 425 lines/min
* typesetter 48Z, to generate camera-ready material in eight on-line type fonts chosen from a library of over 300
* envelope feeder
* twin sheet feeder
* magnetic card reader

2. XEROX - Systems.

XEROX products :

- offer multiple disk drive options to increase storage capacity
- to improve their functionality, these accessories are available:

* shared printer interface
* automatic paper feeder (increase productivity and decrease turnaround time in the office)
* communications accessory (transmits and receives information over telephone and other voice grade networks at speed up to 4800 bits/sec., or from 10 to 300 characters/sec.)

3. AES DATA - Systems.

AES DATA products :

- can be provided with a series of diskettes, programmed to instruct AES DATA products to handle special tasks.
- provide the user with a dynamic data display on/off facility which allows operation in both foreground and background modes, e.g., System C20.
- can accept double size diskettes, e.g., AES SUPERPLUS IV.
- can communicate with any other AES-System or with computers, information banks and teletype stations anywhere in the world in high speed, e.g., AES PLUS.
- offer an optimum efficiency in text processing, e.g., AES

System C20.

4. MICOM - Systems.

MICOM products :

- are fully compatible with MICOM software programs, such as the following :

* MATH PACK II, a software program which prepares financial statements, annual reports, statistical documents
* Sort
* Record Processing
* OCR
* Keystroke Memory
* MICONET communications, a software program which lets a user exchange information between his MICOM system and another MICOM station anywhere in the world. Transmits messages at a speed of 4800 baud.

- are fully compatible with MICOM hardware accessories, such as : Sheet Feeder, Continuous Forms Tractors, Wide Track and Dual Head Printers, OCR equipment and the Shared File System.

- MICOM 2001E is provided with a 128K memory which allows the integration of many programs on a diskette.

5. IBM -Systems.

IBM products :

- offer two types of diskette drives, single and high density. These drives give from about 284,000 to

approximately 2,000,000 bytes of customer-usable characters and controls, e.g., IBM Displaywriter.

- offer advanced text processing aids for a productive information handling.

- to improve their functionality there is a choice of three impact printers with rated burst speeds of 15.5, 40 and 60 characters/sec.

3.2. Local Office Communication Networks.

One can characterize distributed computing as a spectrum of activities varying in their degree of decentralization, from one extreme of remote computer networking, to the other extreme of multiprocessing.

Remote Computer networking is the loose interconnection of previously isolated, widely separated, and rather large computing systems.

Multiprocessing is the construction of previously monolithic and serial computing systems from increasingly numerous and smaller pieces computing in parallel.

Local Computer networking is the interconnection of computers to gain the resource sharing of computer networking and the parallelism of multiprocessing.

The separation between computers and the associated bit rate of their communication can be used to divide the distributed computing spectrum into broad activities.

Activity	Separation	Bit rate
Remote networks	Greater than 10 Km	Less than .1 Mbps
Local networks	10 - .1 Km	.1 - 10 MBPS
Multiprocessors	Less than .1 Km	Greater 10 Mbps

Characteristics of a Local Computer Network.

The network must be inexpensive to install and as robust as possible. Being robust simply means it resists inadvertant attempts to bring it down, whether these attempts are caused by hardware failure, software bugs at any level, or any unpredicted sequence of events.
The network must allow the connection of a sufficient number of devices and provide for the connectivity (communication between arbitrary devices) required by the application.
The raw data transmission rate must be balanced between the economic and total system throughput requirements of the application with a favorable cost/performance ratio.

Kinds of Local Computer Networks.

The requirements of a practical local network system in terms of robustness, ease of installation, flexibility, throughput and connectivity suggest several viable architectures, all of which have been thoroughly researched and analyzed.

* Star Architecture : Can offer low delay, relies on fast control switch, vulnerable to failure.
* Ring Architecture : Offers delay proportional to number of nodes and is sharing of single channel among all nodes.
* Single Channel Cable (Common Bus) Architecture. : As Ring architecture.

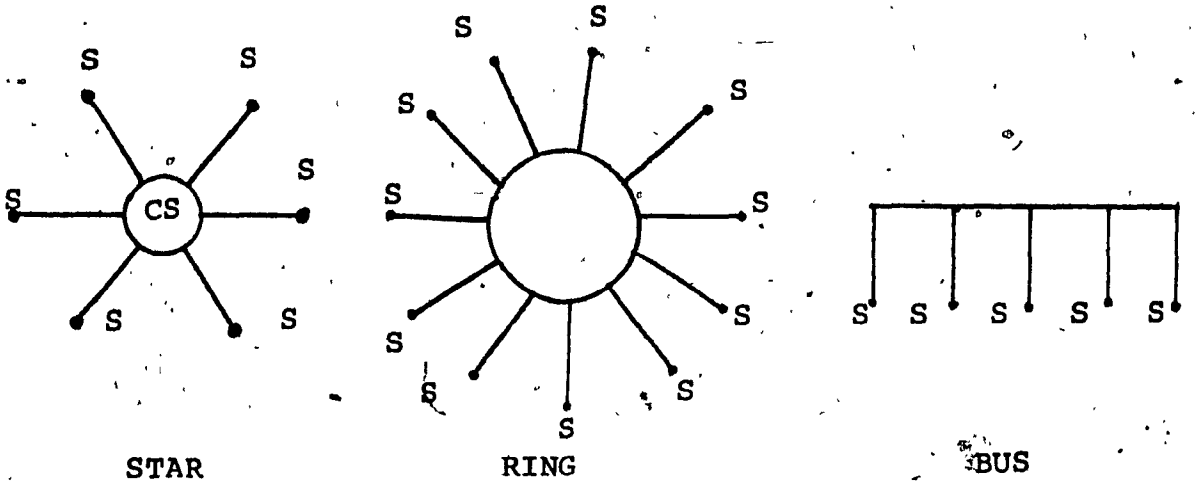

Fig. 3.2 Different Local Computer Networks

The communications technology established by the global communications networks - segmenting a stream of information to be transmitted into ''packets'' and transporting them through a complex routing from source to destination - has been borrowed for all of these local network architectures. Thus, all of the above architectures are simply different topologies, or arrangements of nodes, each having inherent strengths and weaknesses.

An example of a LOOP mode is IBM's SDLC loop used on the 8100. It suffers from the disadvantage of having a centralized loop control, which limits robustness. It also has poor connectivity and rather low throughput.

Examples of RING structures are found in several experimental systems and is the basis of Prime Computer's

Prime-net. In these architectures each node is inserted in a ring-shaped communications path as an active element. RING structures do have one advantage. By virtue of having active elements dispersed along the path, each segment between nodes is a single point-to-point channel. Thus, due to ease of signal transmission across each dedicated link between nodes, higher data rates can be achieved.

What follows is a list of companies and their local networking products as verified in mid-January [WOH-80] by Architecture Technology Corp., Minneapolis, Minn. Although they don't qualify as fullfledged networks, CBXS have been included because they can handle some of the essential requirements of a local net.

The list divides the products by technology and speed :

- low speed, defined as less than 1 megabit per second,
- medium speed, up to 20 Mbps,
- high speed, more than 20 Mbps.

NETWORK PRODUCT SUPPLIERS

AMD
Ethernet components (VLSI, MOS-VLSI)
Sunnyvale, Calif.

Aph Technological Consulting
Ethernet Interface for the DEC LSI-11
Pasadena, Calif.

Bridge Communications
High-level communications services
Ethernet board
Sunnyvale, Calif.

Canoga Data Systems
Fiber optics systems
Canoga Park, Calif.

Codex
Network support products
Mansfield, Mass.

Computer Energy (CEI)
3270 Local network wiring products
Coleman, Wash.

Computrol
Megalink, modems, Comptrol Systems
Ridgefield, Conn.

Concord Data Systems
CCITT switching telephone network products, IEEE 802 token passing products
Lexington, Mass.

Datastream Communications
Network access systems (T7 IBM gateway)
Santa Clara, Calif.

Envax Corp.
Envax 500 (intelligent box to interface an LCN to Telex/TWX/others)
Irving, Texas

Harris
A single chip military standard serial interface
Melbourne, Fla.

Hewlett-Packard
HP 12050A fiber optic, HP-IB link
Cupertino, Calif.

ITT
Optic fiber digital modules
Roanoke, Va.

Intel
Ethernet 432 based systems, Multibus boards, development systems
Santa Clara, Calif.

Interlan, Inc.
LCN controller boards and software
Chelmsford, Mass.

Lee Data
Coax Eliminator (for 3270-based products)
Eden Prairie, Minn.

Masstor Systems
Shared VSS (virtual storage system)
Sunnyvale, Calif.

Mostek
Ethernet components (VLSI, MOS-VLSI)
Carrollton, Texas

MuSYS
NET/82 S-100 Z80A single board computer to provide networking
Tustin, Calif.

National Semiconductor
LC-8545 intelligent communications controller board
Sunnyvale, Calif.

TCL
Plug-compatible Ethernet (PCE) transceiver
Santa Clara, Calif.

3COM
Plug-compatible Ethernet (PCE) transceiver
Mountain View, Calif.

Valtec Corp.
Fiber optic data transmission links
West Boylston, Mass.

Western Digital
1 MBps token passing LSI chip and chops supporting the X.25 standard
Irvine, Calif.

Table 3.I Network product suppliers

BASEBAND: LOW SPEED

A.B. Dick
Magna III
Minneapolis, Minn.

Corvus Systems
Omninet
San Jose, Calif.

Digital Microsystems
HiNet
Oakland, Calif.

General Electric
Energy Management local network
Warwick, R.I.

Nestar Systems
Cluster/One Model A
Palo Alto, Calif.

Ohio Scientific
Level 3 Net
Aurora, Ohio

Pragmatronics
Comnet
Boulder, Colo.

Personal Micro Computers
Downloader
Mountain View, Calif.

Protex Industries
Starnet II
Denver, Colo.

Software Dynamics
SDNET
Anaheim, Calif.

BASEBAND: MEDIUM SPEED

Apollo Computer
Domain system
N. Billerica, Mass.

Datapoint
Arcnet
San Antonio, Texas

Gould-Modicon
Modway
Troy, Mich.

Hasler A.G. Ltd.
Silk
Croyton Surrey, England

IBM DAta Products Div.
Series/1
White Plains, N.Y.

Logica VTS Ltd.
Logica VTS Polynet
London, England

Network Systems
Hyperbus
Brooklyn Park, Minn.

Proteon Assoc.
Pronet
Waltham, Mass.

Prime Computer
Primenet
Wellesley Hills, Mass.

Prolink Corp.
Prolink systems (on Proloop)
Boulder, Colo.

Sperry Univac
Shinpads (shipboard inegrated dp systems)
St. Paul. Minn.

Ungermann-Bass
Net/One
Santa Clara, Calif.

Xerox
Ethernet
Dallas, Texas

Zilog
Z-net
Cupertino, Calif.

BASEBAND: HIGH SPEED

Control Data
Loosely Coupled Network
Minneapolis, Minn.

Litton Amecon--
UBITS (Universal Bus Information Sransfer System)
College Park, Md.

NEC
N6770 (32 mbps fiber optic data link)
Lexington, Mass.

Network Systems
Hyperchannel, S720 Satellite Link
(in conjunction with SBS)
Brooklyn Park, Minn.

Table 3.2 Baseband local networks

BRAODBAND: LOW SPEED	BROADBAND: MEDIUM SPEED	CBX LOCAL NETWORKS: LOW SPEED
ICC The Intelligent Cable (TIC) Bethesda, Md.	Amdax CableNet (7 or 14 MBps) Bohemia, N.Y.	Anderson Jacobson 10X-1000 San Jose, Calif.
Interactive Systems/3m Videodata TDM Products Ann Arbor, Mich.	Interactive Systems/3M Videodata Token Passing Net (Unnamed as of January)	Gandalf Data PACX IV Wheeling, Ill.
Printer Terminal Comminications Ann Arbor, Mich.	Sytek LocalNet 40 Synnyvale, Calif.	Infotron Systems TL 460 (Intelligent Data PBX) Cherry Hill, N.Y.
Printer Terminal Communications LADD (LOcal Area Data Distribution) Ramona, Calif.	Wang Laboratories Wangnet Lowell, Mass.	InteCom IBX (Integrated Business Exchange) Dallas, Texas
Sytek LocalNet 20 Sunnyvale, Calif.		Mitel SX 200 (digital PBX), Superswitch Dulles Intl., Washington, D.C.
		Northern Telecom SL-1 (integrated data/voice system) Richardson, Texas
		Rolm Release 7 local network, REMS Santa Clara, Calif.
		Selscor Panda II (voice/data PBX) Tulsa, Okla.
		Ztel AXIS (advanced Exchange info System), PBX-type local network switch Andover, Mass.

Table 3.3 Broadband and CBX local networks

3.2.1. ETHERNET.

ETHERNET is a system [MET-76] for local communication among computing stations. ETHERNET is named for the historical luminiferous Ether through which electromagnetic radiations were once alleged to propagate. An Ethernet transmitter broadcasts completely-addressed transmitter-synchronous bit sequences called packets onto the Ether and hopes that they are heard by the intended receivers. The Ether is a logically passive medium for the propagation of digital signals and can be constructed using any number of media, including coaxial cables, twisted pairs, and optical fibers. ETHERNET uses tapped coaxial cables to carry variable length digital data packets among personal minicomputers, printing facilities, large file storage devices, magnetic tape backup stations, larger central computers, and longer-haul communication equipment. The shared communication facility, a branching Ether, is passive. A station ETHERNET interface connects bit-serially through an interface cable to a tranceiver, which in turn taps into the passing Ether. A packet is broadcast onto the Ether, is heard by all the stations, and is copied from the Ether by destinations which select it according to the packet's leading address bits. This is broadcast packet switching and should be distinguished from store-and-forward packet switching, in which routing is performed by

intermediate processing elements.

To handle the demands of growth, an ETHERNET can be extended using packet repeaters for signal regeneration, packet filters for traffic localization, and packet gateways for internetwork address extension. Control is completely distributed among stations, with packet transmissions coordinated through statistical arbitration. Transmissions initiated by a station defer to any which may already be in progress. Once started, if interference with other packets is detected, a transmission is aborted and rescheduled by its source station. After a certain period of interference-free transmission, a packet is heared by all stations and will run to completion without interference. ETHERNET controllers in colliding stations each generate random retransmission intervals to avoid repeated collisions.

Even when transmitted without source-detected interference, a packet may still not reach its destination without error, thus, packets are delivered only with high probability.

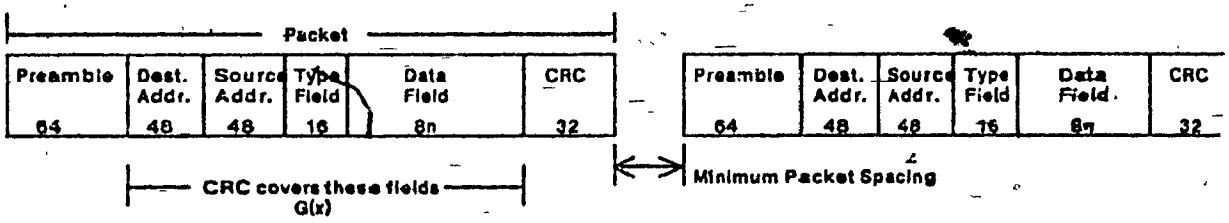

Fig. 3.3 Ethernet's packet format

Stations [SHO-82 c] must be able to transmit and receive packets on the common coaxial cable with the indicated packet format and spacing. Each packet should be viewed as a sequence of 8-bit bytes, the least significant bit of each byte (starting with the preamble) is transmitted first.

* Maximum Packet Size : 1526 bytes (8 byte preamble + 14 byte header + 1500 data bytes + 4 byte CRC)

* Minimum Packet Size : 72 bytes (8 byte preamble + 14 byte header + 46 data bytes + 4 byte CRC)

* Preamble : This 64-bit synchronization pattern contains alternating 1's and 0's, ending with two consecutive 1's. The preamble is : 10101010101010101010101010101010101010101010101010101011.

* Destination Address : The 48-bit field specifies the station(s) to which the packet is being transmitted. Each station examines this field to determine whether it should accept the packet. The first bit transmitted indicates the type of address. If it is a 0, the field contains the unique address of the one destination station. If it is a 1, the field specifies a logical group of recipients.

* Source Address : This 48-bit field contains the unique address of the station that is transmitting the packet.

* Type field : This 16-bit field is used to identify the higher-level protocol type associated with the packet. It determines how the data field is interpreted.

* Data Field : This field contains an integral number of bytes ranging from 46 to 1500 (the minimum ensures that valid packets will be distinguishable from collision fragments).

* Packet Check Sequence : This 32-bit field contains a redundancy check (CRC) code, defined by the generating polynomial :

$$G(X) = X^{32} + X^{26} + X^{23} + X^{22} + X^{16} + X^{12} + X^{11} + X^{10} + X^{8} + X^{7} + X^{5} + X^{4} + X^{2} + X + 1$$

The CRC covers the address(destination / source),type, and data fields. The first transmitted bit of the destination field is the high-order term of the message polynomial to be divided by G(x) producing remainder R(x). The high-order term of R(x) is the first transmitted bit of the Packet Check Sequence field. The algorithm uses a linear feedback register which is initially preset to all 1's. After the last data bit is transmitted, the contents of this register (the remainder) are inverted and transmitted as the CRC field. After receiving a good packet, the receiver's shift register contains :

11000111 00000100 11011101 01111011 $(X^{31},\ldots,X^{0})$.

* Minimum Packet Spacing : This spacing is 9.6 usec, the minimum time that must elapse after one transmission before another transmission may begin.

* Round-trip Delay : The maximum end-to-end, round-trip delay for a bit is 51.2 usec.

* Collision Filtering : Any received bit sequence smaller

than the minimum valid packet(with minimum data field) is discarded as a collision fragment.

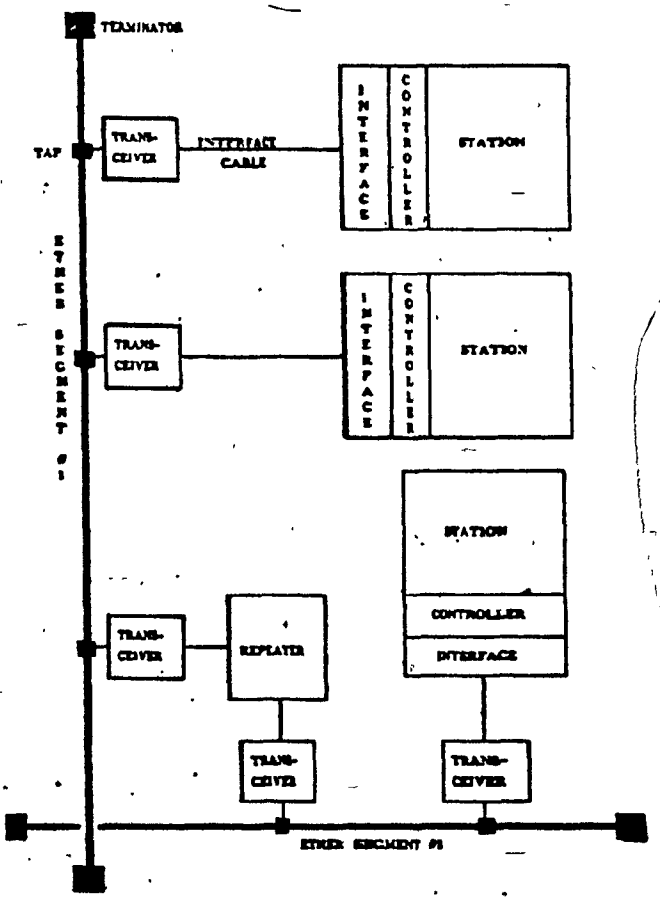

Fig. 3.4 Design principles of Ethernet [MET-76]

Topology. The topology of the Ethernet [MET-76] is that of an unrooted tree.

It is a tree such that the Ether can branch at the entrance to a building's corridor, yet avoid multipath interference. There must be only one path through the Ether, between any source and destination. If more than one path were to exist, a transmission would interfere with itself, repeatedly arriving at its intended destination after having travelled by paths of different lengths. The Ether is unrooted because it can be extended from any of its points in any direction. Any station wishing to join an Ethernet taps into the Ether at the nearest convenient point.

Looking at the relationship of interconnection and control, one can see that Ethernet is the dual of a star network. Rather than distributed interconnection through many separate links and central control in a switching node, as in a star network, the Ethernet has interconnection through the Ether and distributed control among its stations.

Control. Sharing of the Ether is controlled in such a way that it is probable two or more stations will attempt to transmit a packet at roughly the same time. Packets with overlap in time on the Ether are said to collide. They interfere so as to be unrecognizable by a receiver. A station recovers from a detected collision by abandoning the attempt and retransmitting the packet after some dynamically chosen random time period. Arbitration of conflicting transmission demands is both distributed and statistical.

When the Ether is largely unused, a station transmits its packets at will, the packets are received without error, and all is well. As more stations begin to transmit, the rate of packet interference increases. Ethernet controllers in each station are built to adjust the mean retransmission interval in proportion to the frequency of collisions, sharing of the Ether among competing station-station transmissions is thereby kept near the optimum.

A degree of cooperation among the stations is required to share the Ether equitably. In demanding applications, certain stations might usefully take transmission priority through some systematic violation of equity rules. A station could usurp the Ether by not adjusting its retransmission interval with increasing traffic or by sending very large packets. Both practices are now prohibited by low-level software in each station.

Addressing. Each packet has a source and destination, both of which are identified in the packet's header. A packet placed on the Ether eventually propagates to all stations. Any station can copy a packet from the Ether into its local memory, but normally only an active destination station matching its address in the packet's header will do so as the packet passes. By convention, a zero destination address is a wildcard and matches all addresses. A packet with a destination of zero is called a 'broadcast packet'.

Reliability. An Ethernet is probabilistic. Packets may be lost due to interference with other packets, impulse noise

On the Ether, an inactive receiver at a packet's inteded destination, or purposeful discard. Protocols used to communicate through an Ethernet must assume that packets will be received correctly at intended destinations with high probability only. An Ethernet gives the best efforts to transmit packets successfully, but it is the responsibility of processes in the source and destination stations to take the precautions necessary to assure reliable communication of the quality they themselves desire.

Control Procedure. The control procedure defines how and when a station transmits packets into the common cable. The key purpose is fair resolution of occasional contention among transmitting stations.

- Defer : A station must not transmit into the coaxial cable when carrier is present or within the minimum packet spacing time after carrier has ended.
- Transmit : A station may transmit if it is not deferring. It may continue to transmit until either the end of the packet is reached or a collision is detected.
- Abort : If a collision is detected, transmission of the packet must terminate, and a jam (4 - 6 bytes of arbitrary data) is transmitted to ensure that all other participants in the collision also recognize its occurence.

- Retransmit : After a station has detected a collision and aborted, it must wait for a random retransmission delay, defer as usual, and then attempt to retransmit the packet. The random time interval is computed using the backoff algorithm. After 16 transmission attempts, a higher level (e.g. Software) decision is made to determine whether to continue or abandon the effort.

- Backoff : Retransmission delays are computed using the Truncated Binary Exponential Backoff algorithm [SHO-80b]; [SHO-82c] with the aim of fairly resolving contention among up to 1024 stations. The delay (the number of time units) before the n-th attempt is a uniformly distributed random number from [0 to 2 -1] for 0 n =10 (n=0 is the original attempt). For attempts 11-15, the interval is truncated and remains at [0 to 1023]. The unit of time for the retransmission delay is 512 bit times (51.2 usec).

3.2.2. WANGNET.

WANGNET local networking system [WANGa] is a 340 MHz broadband, local-area cable-bus network. Many office communications applications such as distributed data processing and word processing, electronic mail, and video may be supported concurrently on a single WANGNET cable-bus. Frequency allocations and assignments within the 340 MHz bandwidth allow WANGNET systems to offer :

* A shared-access frequency band for communications between WANG 2200 series computers, WANG Office Information Systems (OIS), and WANG VS computers. The data rate for this band is fixed at 12 million bits per second.
* 16 dedicated frequency channels (emulating 16 leased lines) for multipoint or point-to-point communications between WANG and non-WANG RS-449-compatible devices with matched communications protocols. Data rates up to 64,000 bits per second are possible.
* 32 dedicated frequency channels (emulating 32 leased lines) for multipoint or point-to-point communications between WANG and non-WANG RS-232-C-compatible devices with matched communications protocols Data rates up to 9600 bits per second are possible.
* 256 switched channels (emulating a switched network) for point-to-point communications between 512 WANG and non-WANG RS-232-C-compatible devices with matched communications protocols. Data rates up to 9600 bits per second are

possible.

* 7 dedicated frequency channels for standard CATV-type video communications

The capabilities listed above utilize approximately 35 percent of the total available 340-MHz system bandwidth. The remaining 65 percent will be used for the addition of new capabilities.

The WANGNET local networking system has gateways for communication over leased-line or switched-line networks, satellite links, and microwave links to other WANGNET local networks, WANG computers, and non-WANG computers. Data rates, communication modes, and gateway-to-gateway link integrity depend on bandwith and other critical parameters of the external transmission media. WANGNET system offers various options for local network control, multiplexing, contention, and gateway implementation.

Design Principles of WANGNET.

Cable Distribution. The WANGNET cable-bus topology is treelike. A transmit -receive crossover point (loop) located at the midpoint of the main coaxial trunk devides the cable into a transmit half and a receive half, and the two halves are folded together. One cable tree is for transmission only, and the other is for reception only. Data on the transmit line propagates towards the network

loop. At the loop, data passes to the receive line and propagates back to all network user outlets. On the receive line, addressed physical or logical destinations capture information.

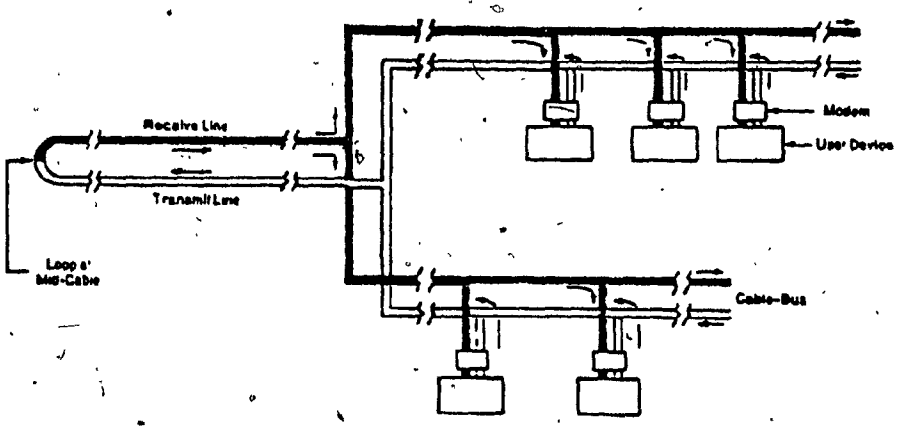

Fig. 3.5 WangNet Cable Bus [WANGa]

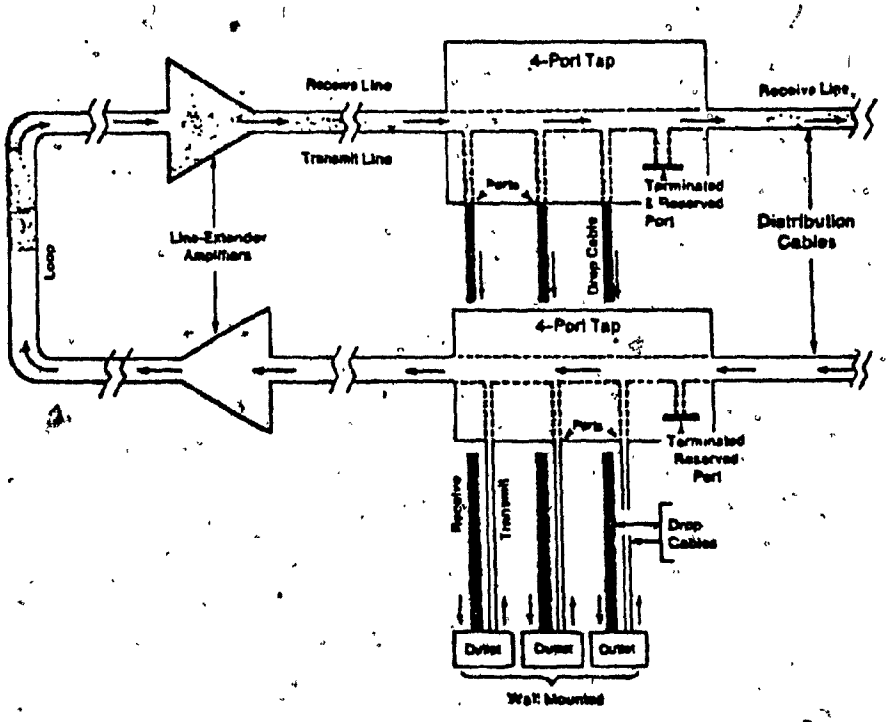

Fig. 3.6 WangNet Cable Distribution [WANGa]

Backbone Hardware. WANGNET local area networking systems use dependable commercial-type CATV hardware. The main trunk and branches of the network distribution cable use sheathed coaxial cabling, directional couplers, signal splitters, and undirectional CATV-type line-extender amplifiers. Cable runs may be routed through causeways, false ceilings, floor trench ducts, etc.

Four-port tap devices connect sheathed distribution cabling to flexible coaxial cable drops, which in turn terminate at network outlets. At least one of the four ports in each tap is terminated and reserved for the addition of one drop cable. Furthermore, any four-port tap can be interchanged with one having six or eight ports.

All line-extender amplifiers used with the cable are AC powered through the center conductor and shield (ground) of the broadband coaxial cable itself. Automatic switchover to emergency power can be provided through the use of a standby battery/inverter system, or customers may elect to use their own backup power system.

Frequency Allocations. The broadband cable system design provides a 340-MHz frequency spectrum, with certain constraints, as directed by FCC Docket # 21006. A Wang Band, a Utility Band, and an Interconnect Band are presently allocated. Currently unallocated frequencies allow for future expansion of Wangnet services.

Wang Band. The Wang Band is reserved for communications between Wang VS, OIS, and 2200LVP/MVP/SVP systems. Wang Band data is packet formatted for transmission on the cable, and a Carrier-Sense Multiple-Access with Collision-Detection contention mechanism enables Wang systems to communicate at 12 million bits per second (Mbps) over virtual circuits. Within the Wang Band, a user can accomplish the following :

* Use the MAILWAY electronic mail system to distribute documents or messages to other VS,OIS, or 2200 systems.
* Perform VS data processing tasks from any Wang workstation suitably equipped for data processing operations.
* Edit a document resident on an OIS or VS system from any Wang OIS workstation, or from any Wang VS workstation suitably equipped for word processing operations.
* Initiate document or file transfers to another system.
* Request document or file tranfers to another system.

For Wang Band communications, the appropriate physical interface to the cable-bus is the Wang Cable Interface Unit (CIU), which is installed between a network outlet and an appropriate communications controller.

Each CIU is microprocessor based and is powered by standard 115-volts, 60-Hz AC lines. The CIU manages packet assembly/disassembly, flow control between the network and the CIU, flow control between the CIU and the WANG system, and listening for the Wang Band carrier. CIUs are independent devices, which means that the failure of any one CIU would only affect communications to or from the WANG

system attached to that CIU, and no other CIU or WANG system would be affected.

Interconnect Band. The Interconnect Band has three channel groups, each group offering different communications capabilities between WANG and/or non-WANG systems :

* 16 dedicated frequency channels (emulating 16 leased lines) for multi- point or point-to-point communications between RS-449-compatible devices at data rates up to 64 Kbps.
* 32 dedicated frequency channels (emulating 32 leased lines) for multi- point or point-to-point communications between RS-232-C-compatible devices, at data rates up to 9600bps.
* 256 switched frequency channels (emulating a switched network) for point-to-point communications between 512 RS-232-C-compatible devices at data rates up to 9600 bps.

Interconnect channels permit use of any communications protocol that is common to both sending and receiving entities.

64-Kbps and 9600-bps Dedicated Channels. Within the Interconnect Band, sixteen 64-Kbps channels are available, primarily for dedicated point-to-point or multipoint communications between a host computer and one or more WANG or non-WANG systems. Thirty-two 9600-bps channels allocated within the Interconnect Band are for slower-speed, dedicated, point-to-point communications and for multipoint communications applications such as the WANG Remote Cluster

Facility.

The appropriate physical interface to the WANGNET cable-bus for communications over the 64-Kbps and 9600-bps dedicated channels of the Interconnect Band is the WANG crystal-controlled, Fixed-Frequency Modem. The 64-Kbps, dedicated-channel version of the Fixed-Frequency Modem has one RS-449-compatible connector for attachment of the user device. Modems for the 9600-bps dedicated channels have one RS-232-C- compatible connector for the user device. Both Fixed-Frequency Modem versions have provisions for dual-coaxial interconnection to a user outlet.

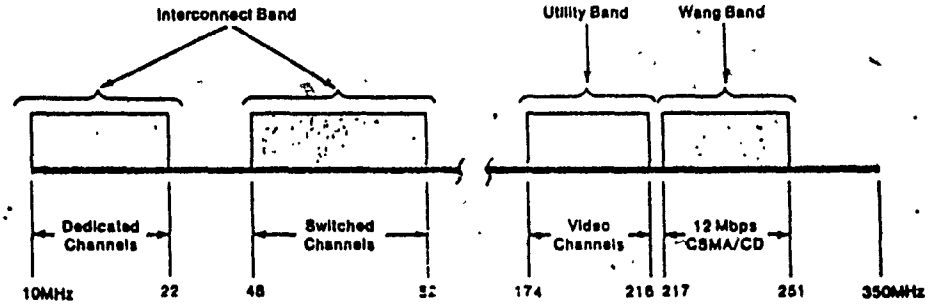

Fig. 3.7 WangNet Frequency allocations [WANGa]

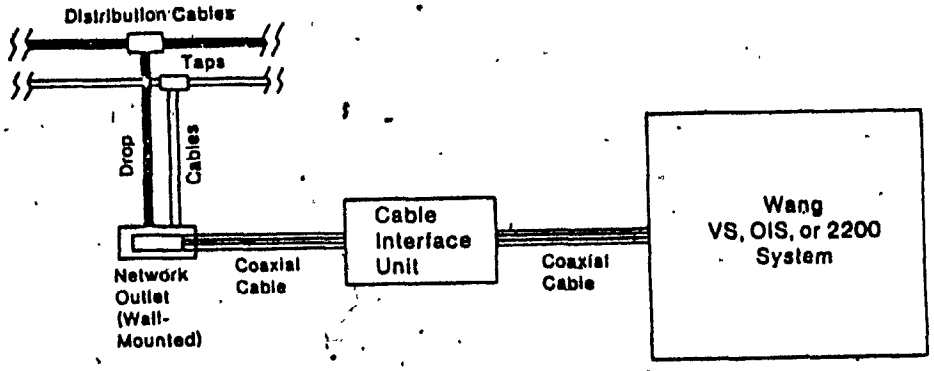

Fig. 3.8 Wang Cable Interface Unit [WANGa]

9600-bps Switched Channels. This sub-band emulates operation of a switched network, with 256 frequency channels - rather than physical communications lines - dynamically allocated to 512 user systems. The appropriate physical interface to the WANGNET cable-bus for communications over the 9600-bps switched channels of the Interconnect Band is the Wang Frequency Agile Modem. These modems are microprocessor based, and are powered by 115-volt, 60-Hz AC lines. Their external features include an RS-232-C-compatible connector to accommodate a Wang or non-Wang communications interface, an RS-366 connector for autodial capability, a dial-up key pad for call procedures, and LED call-status lights.

Management and allocation of 9600-bps switched channels are performed by the Wang Dataswitch.Each Frequency Agile Modem has a unique address assignment, and the Wang Dataswitch polls all such addresses, seeking call/connection requests. If a called modem is not busy, the Dataswitch issues a channel-selection command to the calling and called modems, allowing connect/communicate/disconnect activity over the selected channel. Each channel provides a transparent, temporary, full-duplex path for data communication.

Frequency Agile Modems are connected to user outlets, such that the distance along the transmit line from the Dataswitch through the network loop, and along the receive line to any outlet, does not exceed 2 cable-miles.

Utility Band. Seven 6-MHz video channel allocations allow communications between standard CATV-type transmit/receive video devices, such as cameras and monitors. Each Utility Band channel is capable of supporting one composite color-video-and-audio signal.

Expansion Potential. Unlike star-topology networks, WANGNET permits the addition of new network outlets without requiring installation of new cable runs that extend from the control center of the network to the location of each new outlet. Instead, existing distribution cabling can be branched through the use of directional couplers, signal splitters, and multiple-port taps, to add new distribution and/or drop cabling. This approach makes creation of new network outlets or larger Wang-designed network expansions easier and more convenient than the addition of lengthy cables or twisted-pair wire runs.

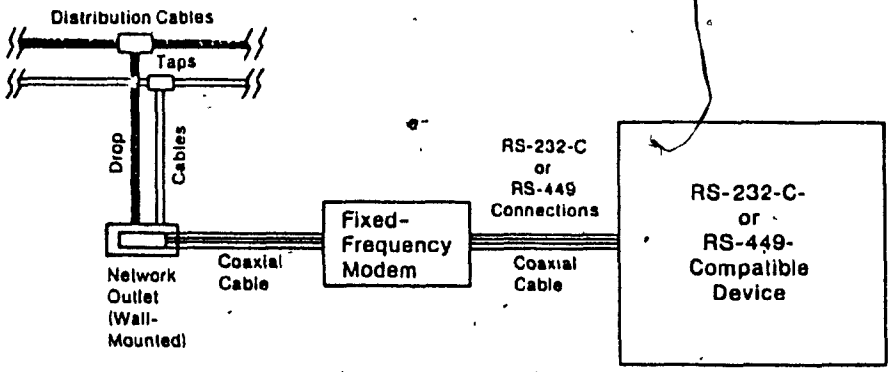

Fig. 3.9 Wang Fixed-frequency modem [WANGa]

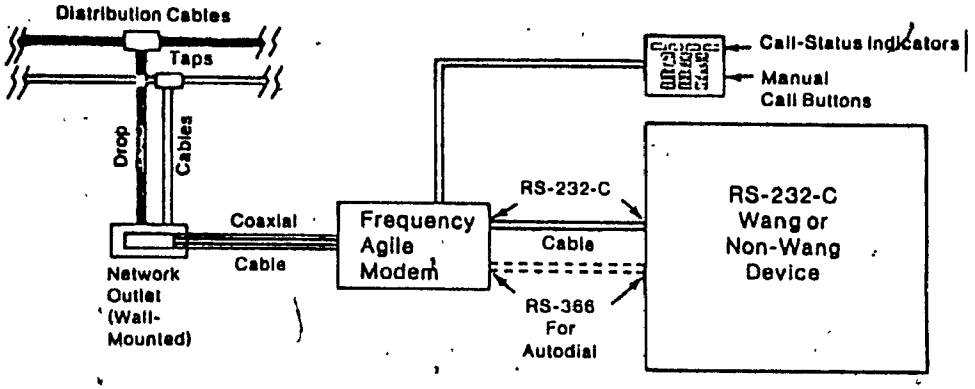

Fig. 3.I0 Wang frequency-agile modem [WANGa]

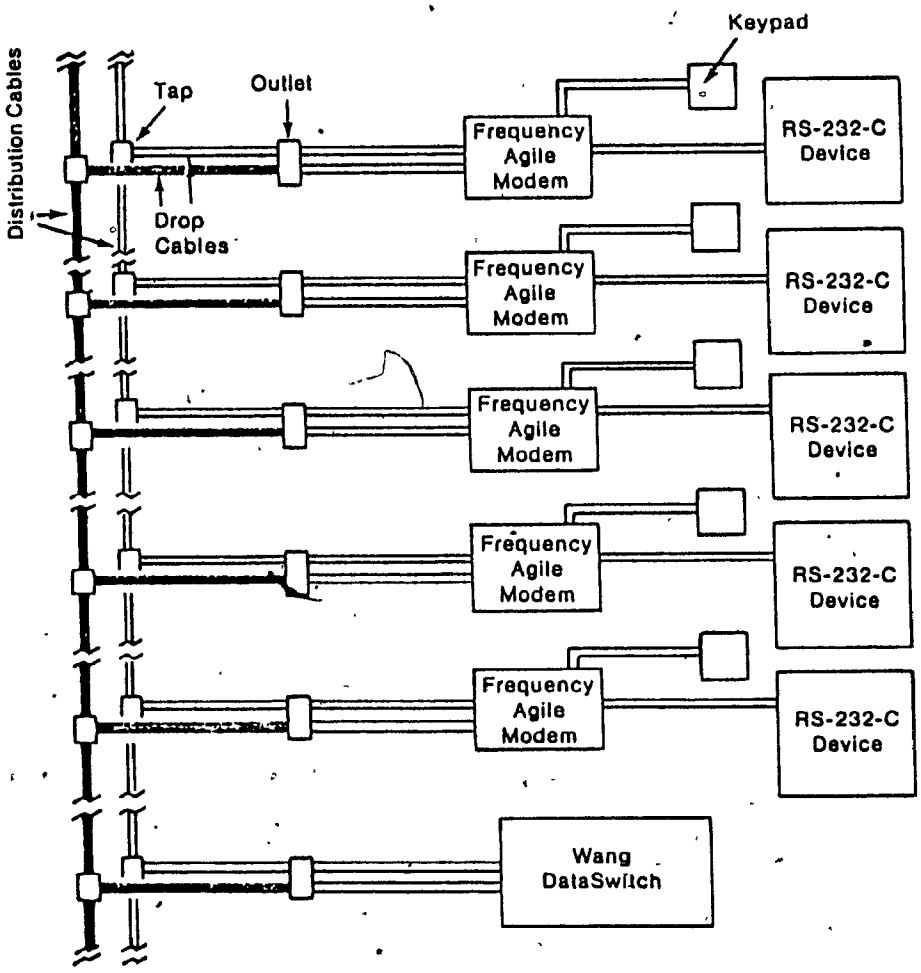

Fig. 3.II Wang Dataswitch [WANGa]

3.2.3. Z-NET.

Z-NET architecture [ZILOG] provides a Single Channel (common bus), packet switched, multiple access network with fully distributed control. Each node "hears" any packet transmitted by any node and if it "hears" its own address, it accepts the packet. When a node desires access to the channel, it takes it, unless another node is already transmitting. In this way, communications control is distributed and not controlled by a single 'master' whose failure could bring down the whole network.

In addition, connection to the cable is through a passive, high impedence tap. Nodes are easy to install, move or remove.

The common single-channel architecture provides excellent connectivity and robustness. The packet switching and distributed control provides efficiency and high utilization of the communications medium.

Zilog was among the first computer systems companies to introduce such a local computer network Z-NET..

Design Principles of Z-NET.

Components of a Z-NET system. The nodes, or stations of a Z-NET system consist of two types, the processing or controller stations and the shared data stations. The processing or controller station is any MCZ-2 system

configured as a stand-alone business computer or as a powerful multiple controller. The shared data station is the SDS 2/01 Shared Data Station. The SDS 2/01, consisting of a ten megabyte cartridge disk with its own dedicated processor mounted in a desk-high, office-oriented rack, provides a sophisticated Shared Data Manager Software package. The cable which connects the stations is of the common cable-TV type. Between the station and the cable is the NST 2/01 Network Station Tranceiver. This small, wall-mountable unit functions somewhat like a combination 'modem' and 'radio transmitter/receiver'. Between the Transceiver and the cable is a common BNC 'T' tap connecter.

The transmission facilities permit up to 255 stations to be connected. The actual number that can be connected and operated simultaneously depends on the type and communication requirements of the specific application. The stations can be connected to the coaxial cable across a total length of two kilometers. If there is no 'T' tap installed in the desired location, network transmission will not be acknowledged while the tap is installed. After the tap is installed, communications can pick up where they left off with no restart required. Throughout this time, the systems connected to the network are still fully functional. CRT's, or any other device that interfaces, via a standard RS-232C serial interface up to 19.2K baud , can be attached to the network through any MCZ-2 computer station. Each

computer can support up to five such lines.

There are two types of storage used by the Z-NET local computer network system : local and shared.Local storage is restricted to the particular MCZ-2 computer station in which it is incorporated. Up to four megabytes of double-sided, double-density floppy disk storage can be added to any computer station. Data stored there can be accessed by other stations on the network only if the station is programmed at the application level to accept such requests. Shared storage is that which is available in the Shared Data Station. With a base of ten megabytes, each Shared Data Station can expand to forty megabytes in increments of ten. One may add as many Shared Data Stations as necessary and practical up to the 255 station limit. The network sees no difference between an MCZ-2 computer station and a Shared Station.

Specifics of the Z-NET System Software.

The essential core of the Z-NET system is the software contained within each MCZ-2 and SDS 2/01 station connected to the network. The RIO/CP operating system contains a layered set of modules where each layer-to-layer interface is specifically defined. Thus, each layer is a separate module that can be exchanged with a modified or new one, provided that the interface specification is adhered to. The RIO/CP operating system has been designed and

implemented from the very beginning to facilitate the local network in the most efficient manner possible. The layered design provides the benefits of lower development cost, maximum flexibility and maximum ability to modify the system for enhancing or expanding capability. Within the RIO/CP system is the multitasking Kernel, along with device control, resource management and end-user tasks.

Among the resource management tasks are the File Management tasks and the layered protocols that drive the Z-NET local computer network. The layers of protocol are :

* Applications layer
* Operating System layer (Identity file request)
* Network Control layer (Pass packets for transport the lower layers)
* Data link layer (Identity File system as destination-direct packets)
* Physical link layer (Interface to physical transmission hardware)

The direct benefit of the multitasking Kernel, layered operating system and communications protocols is the ability of the application layer to ignore where a task is located in the network, with which any arbitrary task must communicate. Thus, file management tasks, remote global communications tasks and applications tasks may be run on any station connected to the net, and the applications programs using these programs do not care where they are physically located. The task-to-task communications is

managed by the multitasking Kernel and implemented by the layered protocol system.

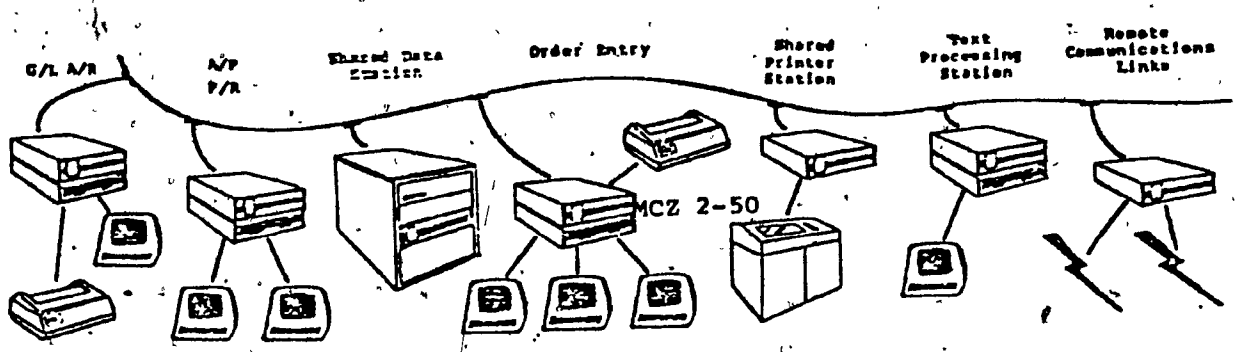

Fig. 3.I2 Z-NET Local Computer Network [ZILOG]

3.2.4. HiNET Local Computer Network

The capabilities of the HiNET Local Computer Network are :

-With NiNET, [HIN-82] each desk-top work station interconnects with a master station's abundant central file storage, as well as with all other work stations.

-With HiNET, a user gets maximum computing use from his own station, as well as information to - or from - the Master Station - or any other station on the network.

-HiNET provides a user with instant response from all over the building.

-With HiNET, a user can start as small as two work stations and add up to 250 stations anywhere he/she wants within the building. Since each low-cost station is a complete computer - not just a terminal - additional stations don't tax the system. They add to its capability.

-HiNET uses standard interfaces so a user can 'talk' on the network and use almost any printer or other peripheral.

-HiNET provides all the hardware-and software-someone needs for a complete, proven local computer network. Advanced systems' utilities provide the utmost in both data security and system integrity.

-HiNET utilizes 16 bit processors in single board or Multibus configurations, advanced memory management and data storage, high speed local network data and telecommunications, real time processing redundancy and

back-up capabilities, multi-level data security provisions, end-to-end diagnostics and automatic error correction routines.

3.2.5.IBM's SNA

IBM's System Network Architecture (SNA) [GRA-75] has significant capabilities not available with previous offerings from IBM. In terms of increased capabilities, SNA:

- allows any network terminal to access any applications program in any host,
- frees the user of many communications management responsibilities,
- provides for network reconfiguration during network use,
- provides for automatic link switchover in the event of link failure,
- frees the host of some communications responsibility,
- centralizes network control,
- allows several hosts to be serviced by a single communications processor,
- provides full-duplex line operation (SDLC),
- permits remote modem diagnostics.

To realize the full measure of SNA, a number of new hardware and software products are necessary :

- a host-resident access method (ACF/TCAM/MSNF or ACF/VTAM/MSNF),
- the 3705-II communications processor,
- the synchronous data link control protocol (SDLC),

- special communications processor software (ACF/NCP/VS),
- a dedicated host for network control (CMC),
- special software for network monitoring and control,
- special SNA terminals,
- new microprocessor-based diagnostic modems,
- SNA-compatible operating systems.

Central to SNA is host control of communications. Associated with the host-resident access method is a system service control point. The SSCP controls a domain of resources, including communications processors.

Hardware. One of two IBM communications controllers (3705-I or 3705-II) must be present in each domain of an SNA network. However, certain network configurations and capabilities are dependent on hardware options available only with the 3705-II communications controller. Being IBM's most powerful controller to date, the 3705-II is to be compared with two other top-of-the-line controllers : NCR - Comten's 3690 and the Computer Communications Inc. CC-85. Both are plug-compatible replacements for the 3705-II.

Software. Brief descriptions of software employed for implementing SNA are given below :

- SNA telecommunications access methods.

Two IBM communications access methods support SNA. These are the telecommunications access method (TCAM) and

the virtual telecommunications access method (VTAM). The communications access method is the key to achieving SNA and is a major component of the host operating system. The access method handles the interaction between the host application program and the local communications controller. Within a SNA system, VTAM or a version of TCAM that is compatible with SNA is required.

- The advanced communications function (ACF).

An advanced communications function (ACF) was introduced by IBM in 1976, with a separate program product enhancement for both TCAM and VTAM. The most significant capability of ACF was the added ability to interconnect different operating systems and different hosts, whether in the same or geographically different locations.
Any access method that drives an SNA network contains a system service control point (SSCP). The SSCP is actually the 'switchboard' logic for the system, and contains a matrix of defined communications parameters for each of the addressable elements in the network.

- Multisystem networking.

The network elements defined to the SSCP comprise the system's 'domain'. An addressable unit may belong to only one domain, even if more than one access method is resident in the same host. The multisystem networking facility

(MSNF), however, provides the means for cross-domain communications.

The multisystem capability provides any supported terminal within the network with full access to any application program in any connected host. The access method, in conjunction with the communications processor, provides network transparency to both the application and the terminal involved. The terminal operator need not even know which host controls the application.

- Advanced communications function for network control program / virtual storage (ACF/NCP/VS).

This element is a software module resident in the 3705-II. It manages the details of line control and the routing of data through the network. The access method sends control parameters to the NCP. The control parameters in turn direct the NCP to perform specific operations. The access method directs the NCP, which in turn controls the network operation and provides the access method with its required data and resulting status information.

- Network communications control facility (NCCF).

NCCF is a software module used to monitor and control an SNA network. It resides in a separate host dedicated to network control.

- Network problem determination application (NPDA).

NPDA assists users by determining communications network problems by collecting records of errors detected by the network.

Critics of SNA, while acknowledging its clear superiority over earlier IBM offerings, maintain that it :

* is expensive,
* is complex,
* lacks flexibility,
* lacks efficient network control,
* excludes non-IBM products.

Implementating SNA is expensive because it requires the most recent (and most expensive) hardware and software released by IBM. The complexity of SNA is accounted for in part by the involvement of host software (the access method) in controlling communications. Among other considerations, personnel training is adversely affected by SNA complexity. Lack of flexibility is evident in procedures required to make network changes - adding trunks, adding nodes, adding or removing terminals. For obvious reasons, compatibility with other vendors was not a design consideration for SNA. Network control is allocated to dedicated hosts with special software. This strategy is both expensive and risky.

ALTERNATIVES TO SNA

Two of the leading vendors specializing in plugcompatible replacements for IBM communications processors, which also provide extensive alternative architectures to SNA [AMA-82], are NCR-Comten and Computer Communication Inc. (CCI). CCI and Comten entered the IBM network by replacing the IBM 3705 communications controller with one of their own

- The IBM 3705-II is replaced with a Comten 3690 or CCI CC-85.
- IBM front-end software, AFC/NCP/VS, is replaced with Compten or CCI software modules.
- The Comten and CCI communications processors support peripherals (including magnetic tape units, card readers,line printers, disc units and consoles).

From an architectural perspective, CCI and NCR-Comten are noteworthy, not because of IBM compatibility, but because of the manner in which their approaches to data communications differ from IBM. Both NCR-Comten and CCI transfer the control of data communications from hosts to communications processors. Furthermore, they do so without modifying host software.

The strategies employed by the two independents for obtaining SNA capabilities have three central elements in common :

- IBM communications processors (front-ends, remote

concentrators) are replaced by their own.

- Proprietary software modules transfer network control to the data communications network, thereby providing the network with capabilities equal to or exceeding SNA.
- The access method is fooled into thinking that it retains control of the network.

Hardware and software descriptions on these two alternative architectures to SNA (NCR - Comten and CCI) are provided by [AMA-82].

3.2.6. Comparisons among Local Office Communication Networks.

The microcomputer is now poised to make even greater inroads into areas of computing that have previously been dominated by minicomputers and mainframes. Local area networking is the latest development in the evolution of multiuser microcomputer systems, systems designed to share expensive resources like printers, hard disc drives and plotters, while making maximum use of cheap processors and memories.

Most conventional local networks consist of a central controller with wires connected to each terminal device. The new local network technologies often avoid the central controller and reduce the number of wires by connecting all the terminals to the same wire.

The problems in contemplating a local network system are standardization, compatibility and cost. The IEEE have defined the local network [MID-82] thus : "A local area network is distinguished from other types of data networks in that communication is usually confined to a moderate geographic area such as a single office building, a warehouse or a campus, and can depend on a physical communications channel of moderate-to-high datarate which has a consistently low error rate."

The IEEE, in attempting to be definite about network architecture, continue :

"Although the exact parametric values for the area length,number of stations and topology has been debated at great length, suffice it to say that the committee is basically concerned with a cable up to several kilometers in length, supporting several hundred stations in a variety of topologies at speeds of,tentatively,1,5,10 and 20 Mbits/sec."

Though this is not a rigorous definition, it does contain some useful points. The high datarate and low error rate reflect two important characteristics : the speed of communication is fast enough to accommodate a large number of terminals. The low error rate achievable in a local network means that error-checking equipment can be simple and therefore cheap.

Network topology. The topology of a local network can be of several types,such as star, hierarchical, ring or bus. Each has its merits and demerits. Historically, the star configuration was first, with a central host computer surrounded by terminals. The trend then moved towards remote job-entry satellites which are themselves star networks. The drawbacks with these are cabling,for large sites, and potentially critical elements such as the central controller. The present trend is towards ring,bus and tree architectures, where the individual terminals are connected together rather than each connected individually to the central controller. The most notable of these are the bus

network, Alohanet (USA) and the Cambridge Ring network (UK).

Alohanet was devised by the University of Hawaii [MID-82]. The need to link the university terminals spread over the islands gave rise to a radio-based system. It was refined to overcome inefficiencies caused by transmitting without listening for other transmitters. This development became known as carrier sense multiple access (CSMA). XEROX took up this idea and applied it to coaxial cable. They refined it further by listening during transmission as well as before. This allowed for collision detection when two nodes attempted simultaneous access. An exponential back-off mechanism, which has been proved at levels in excess of 150 per cent of full capacity, was imposed on the network. This system is known as Ethernet.

The Cambridge Ring consists of a number of repeater nodes spaced at up to 100 m apart and a central controller which provides timing, power for eight nodes and the ability to monitor traffic. The mechanism chosen for transporting data is an empty slot in a package. It is comparable to a train with lots of carriages moving arround a circle. When a station sees a carriage is empty, it can fill up that carriage. The problem with this system is that if more than one of the carriages is empty, the station can still only fill one. There is a sort of Super Cambridge Ring being developed that will allow loading of two carriages from one station, as well as providing bidirectional transmission,

which will allow much easier break detection [WIL-80b].
How the Ring actually works is that when a package arrives, the station checks that it is showing an empty slot, puts two characters into the slot with a further two characters defining source and destination addresses,sets the flag bits to indicate a full slot and passes the packet to the next node. The packet is passed from node to node until it reaches the destination address where the two data characters are removed and flag bits set to indicate receipt [WIL-75a].

There are other institutionally developed networks : the Australian Csironet and the UK Strathnet.
Strathnet is based on the Ethernet system. Csironet is a packet- switching system operating in a virtual circuit mode. The heart of the system is the main computer complex,situated in Canberra, where each host computer is linked by means of a fast data highway, known as the "hyperchannel", consisting of a single coaxial cable link operating using a multidrop principle at a speed of 50 Mbits/sec. The hyperchannel network processor adaptor contains a microprocessor, channel interface, data buffer and trunk control logic. Figure 3.13 illustrates four basic network topologies : the Star, the Bus and the Ring. Various hybrid topologies are also available.

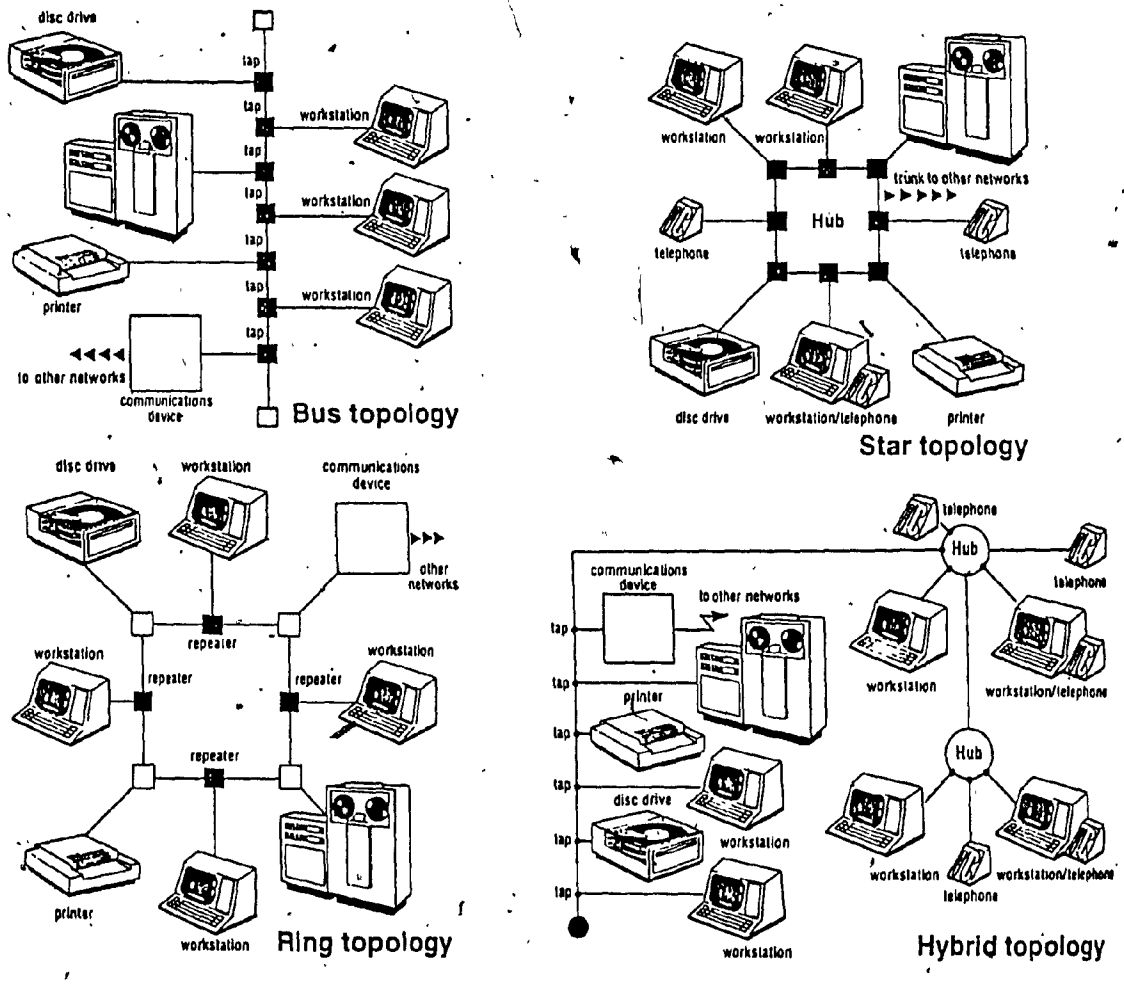

Fig. 3.13 Network topologies. [TEN-83]

Cable types and transmission methods. There are several different types of cable used for local networks :

- coaxial, e.g. Ethernet
- twisted pair (or quad), e.g. Cambridge Ring
- multicore, e.g. ClusterOne
- fibre optics, there are several systems under development.

Most systems are based either on telephone cable or coaxial cable. Telephone cable is slightly cheaper and usually easier to bend. Coaxial cable has a higher bandwidth than telephone cable (about 300 MHz compared with about 5 MHz).Most transmission methods are variants of a few basic types.A key distributuion is between baseband and broadband systems :

- Baseband Systems have many different types of transmission depending on network topology. One important category for transmission is that of broadcast systems(like Ethernet). With this, each terminal in the network is free to broadcast its information over the network.This can, however, lead to two transmissions occurring at the same time,resulting in corrupted data. Access methods have therefore been developed to overcome this.

One technique uses carrier sense multiple access (CSMA), which was developed at the University of Hawaii for Alohanet.Each station in the network listens to see if any other is transmitting. If a channel is engaged, then the terminal defers its transmission until some time later.Since

signals take a short time to travel along the network, it is possible for two stations to transmit almost at the same time, causing collisions. Transmitting stations therefore listen to the first part of the transmission. A collision will be detected and both stations will stop transmission.The terminals then wait for a small random time interval and retransmit. Since the time interval is random, it is unlikely that the two transmissions occur at identical times again.This technique is called collision detection.

- Broadband systems transmit completely independent channels at different frequencies. They make use of the high bandwidth available with coaxial cable. It is similar to cable television distribution systems,but unlike cable television, broadband local networks require communication in two directions between terminals or devices connected. This is achieved either by using two separate cables linked at one end (the head end) by a repeater or by using a single cable where the head end equipment is used as a frequency counter. The Cambridge Ring system is an example of this sort of transmission.

3.2.7. Implementation of Local Area Networks.

A Local Area Network provides high speed data communication over a coaxial cable bus. Multiple data, voice or video channels can be multiplexed on the broadband cable. Each date terminal has a unique network address allowing a virtual circuit to be established from one terminal to another.

The network ensures virtually error-free data transmission through data integrity checking and automatically requests transmission of incorrect data packages. Date terminal equipment access the network using a token controlled multiple access technique. The intelligent terminal concentrator multiplexes several terminals on the same cable access. Serial line and direct memory access interfaces to different types of computers are provided through fontend communication networks.

A gateway processor provides calling into and out of the local Area Network via leased and public dial lines or public data networks using the X.25 protocol. RF data transmission is at 1 Mbit/sec over distances of up to 8 Km without repeaters. Asynchronous or synchronous terminal access is at speeds of 9600 baud in 4-16 port configuration. The X.25 gateway provides access to the networks

Telenet,Tymnet and internationally to other packet-switching networks.

* Net/One * Omninet * Perinet

*Polynet * Ultranet *Z-Net

A recent survey [MOO-82] by IDC Europa research organization revealed that only two per cent of European computer users currently use local network technology. A further 14% intend to move into the technology at some undefined time in the future. A sizeable 37% of the companies questioned said "they did not know enough" about local area networks. The survey was conducted among 400 computer users in Britain, West Germany and France.

What managers need to do is to look beyond the commercial promotion of local area networks to the real problems which they face. Derek Laval, a director of CASE [MOO-82], identifies three main problems which face many users of computers and other modern office technology. These are wiring, compatibility and connectivity. A company,says Laval, may have more than one mainframe, more than one minicomputer, together with a large batch of different terminals and personal computers, and these have to be connected up together by a number of wires. Two main issues result from this problem : connectivity and installation. With respect to the third issue - wiring problem - there is only a partial solution. These are two

propositions :

* The broadband local area network is a completely different proposition. The cabling used in a broadband network is very great in size and very difficult to handle. Installation of broadband cabling in many office buildings would involve significant structural alterations. The wiring for a broadband network is very expensive. So the broadband local area network gives a partial solution to the wiring problem.

* A baseband local area network will tend to be based on one cable or a multiwire cable as thick as a coaxial cable.That cable must run round the whole of the building so that all terminals and any future terminals can be connected to it.On top of that, a connection must be made between the terminals and the cable. This cabling approach will solve the problem of having a large number of devices connected to one another, but there is still a substantial wiring problem. So the baseband local area network is only a partial solution to the wiring problem, but it does better than a broadband local area network.

3.3 PROTOTYPE OFFICE INFORMATION SYSTEMS.

3.3.1. OFFICETALK-ZERO.

Officetalk-Zero is a prototype office information system [ELL-80], designed and implemented by the Office Research Group at XEROX Palo Alto Research Center (PARC). The Officetalk-Zero effort began in late 1976 as a study of languages for expressing office procedures, and subsequently evolved into an OIS emphasizing the interface between human users and automation.

The implementation of Officetalk-Zero took place in an environment of multiple minicomputers interconnected by a high-speed communication network (ETHERNET , Z-NET, etc.). Each minicomputer, a Xerox Alto, was a 128K 16-bit word minicomputer with a 2.5-megabyte disk and a sophisticated CRT display. Areas on the screen were pointed to by a cursor under the control of an x-y coordinate input device called a 'mouse'. The 'mouse' was operated by a button, which was depressed,then released. Software could determine the state of the button as well as the x-y coordinate addressed by the 'mouse'. Intercommunication was accomplished by electronically passing forms among the 'work stations'.

The user's model of the Officetalk-Zero system is merely an electronic aid for carrying out his/her normal

tasks. Therefore the primary difference between the user's Officetalk-Zero model and the user's pre-OIS model is the substitution of electronic forms for paper at the work station. Each work station provides a graphical window onto a worker's desk, allowing the worker to manipulate electronic forms by employing the pointing device and the keyboard.

Capabilities and Functions of Officetalk-Zero. The major part of the following section comes from the paper "Office Information Systems and Computer Science" by C.A. Ellis and G.J. Nutt [ELL-80].

Officetalk is a distributed program that executes on at least one minicomputer in conjunction with the communication network and a second minicomputer system for file storage (called a File Server). The File Server maintains a database describing all pending electronic transactions, such as electronic mail, information about each authenticated user of the system, or a set of tailored blank forms to be used in the particular application.

Officetalk is designed to save the major portion of the user's information state in the File Server and as little as possible in the local minicomputer. To implement a particular Officetalk application, a tailored set of blank forms must be designed and entered into the database. Officetalk provides a forms editor which allows one to specify the graphical design of a form and the style of each

field on the form. The forms editor requires that the newly designed forms satisfy certain conditions, such as no overlapping fields. It also permits certain fields to be designated as signature fields.

Upon starting Officetalk, the user is shown an image of a desktop containing parts of forms, similar to Figure 3.14 The user employs the mouse to maintain the forms on the desktop. Each form is displayed in a rectangular 'window' on the CRT device. The form may be larger than the window. Hence the user is allowed to enlarge or shrink the window, and to move the form within the window by pointing the cursor to appropriate parts of the window frame. The user can also move the window around on the display screen by using the cursor to 'pick up' the window and move it. Each window includes a menu of Officetalk commands which can be applied to the form that is visible in the window. The mouse is used to point at, and thereby invoke commands. An Officetalk desktop contains the following four forms, which are called 'file indexes' :

- The in-basket - an index on incomming mail,
- The out-basket - an index of mail to be sent and mail that has been recently sent,
- The forms index - forms that the user has saved,
- The blank stock index - the set of available forms.

Each 'file index' entry contains several fields : One field names the file, an 'action field' specifies a command which

can be applied to that file entry, while other fields list other information. A 'file index' form is special in the sense that it contains a field on the form itself which allows command invocation. Ordinary forms do not contain an action field.

A user who wishes to generate a document selects a blank form from the blank stock index by pointing at the action field of the appropriate entry. The form then is drawn in a new, fully visible window. The user may enter information into the form by pointing at the field and typing a character string. The editor restricts the data types to match the form's field definitions. Officetalk also allows the user to draw freehand on a form, the mouse is used as a 'brush' which can take on several different styles. Once prepared, a document can be filed in the user's personal file and thus be listed in the personal form index mentioned above. It can also be copied, the original field, and the copy placed in the out-basket for mailing. The contents of the out-basket are actually mailed (placed on the File Server) when the user points to a 'transmit' selection in the out-basket menu.

Officetalk is a prototype office information system that integrates a set of common facilities into a single system with a simple user interface.

continue...

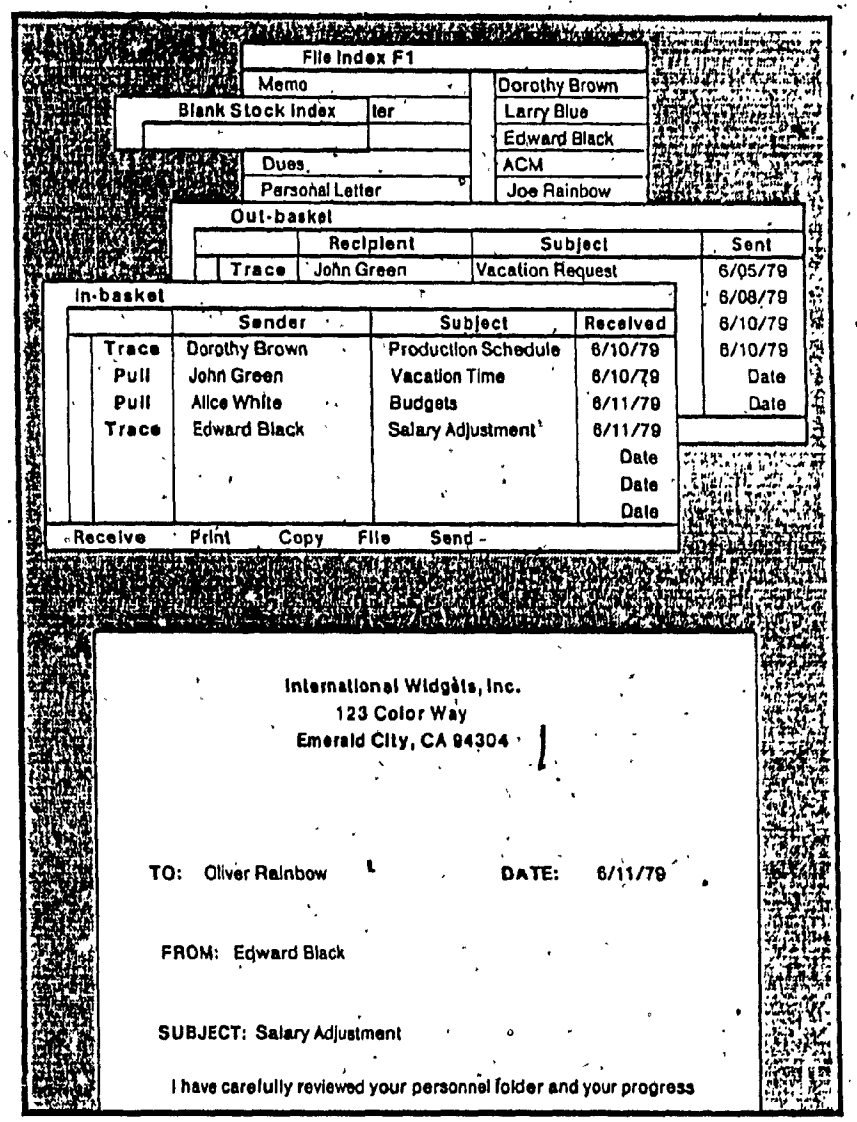

Fig. 3.I4 Officetalk-Zero OIS [ELL-80]

3.3.2. SCOOP : Another prototype OIS.

SCOOP (System for Computerization of Office Processing) is a prototype OIS which emphasizes the specification, representation, and automation of office procedures [ZIS-77a]. This OIS is based on Petri nets augmented by production rules for modeling offices as asynchronous concurrent processes. This model, called the Internal Representation, is a conceptualization of how the machine represents the problem to itself. In addition, an External Representation describes office procedures as activities and documents in a nonprocedural programming language for the office analyst.

Zisman, who has developed SCOOP, considers the order entry process in an office as an example of this model. The office that performs the order processing function consists of a 'receptionist' and an 'order administrator'. The receptionist records the arrival of each customer request for goods in a log book, types the required information onto an order form, and then sends the form to the order administrator. Upon receipt of the order form, the order administrator processes the order, using the customer file. He/she next uses information from the billing file to validate the fact that this customer is not delinquent in previous payments. Then a decision is made whether to ship the goods C.O.D. Or to bill the customer for later payment. In the case of C.O.D., a single form, f3, is completed. In

the bill-later case, two forms, f1 and f2, are filled out.This simplified fragment of an office procedure serves as an expository aid.

The SCOOP system accepts, as input, APN (Augmented Petri Net) descriptions of office procedures, interprets the descriptions, and then 'tracks' instances of these procedures, automatically executing portions of the procedure which can be performed by the computer.

One Petri net must be constructed for each agent, who is frequently, but not always, human. Thus the 'receptionist agent' is desired by the Petri net of Figure 3.15 (a) and the 'order administrator agent' is described by the Petri net of Figure 3.15 (b).

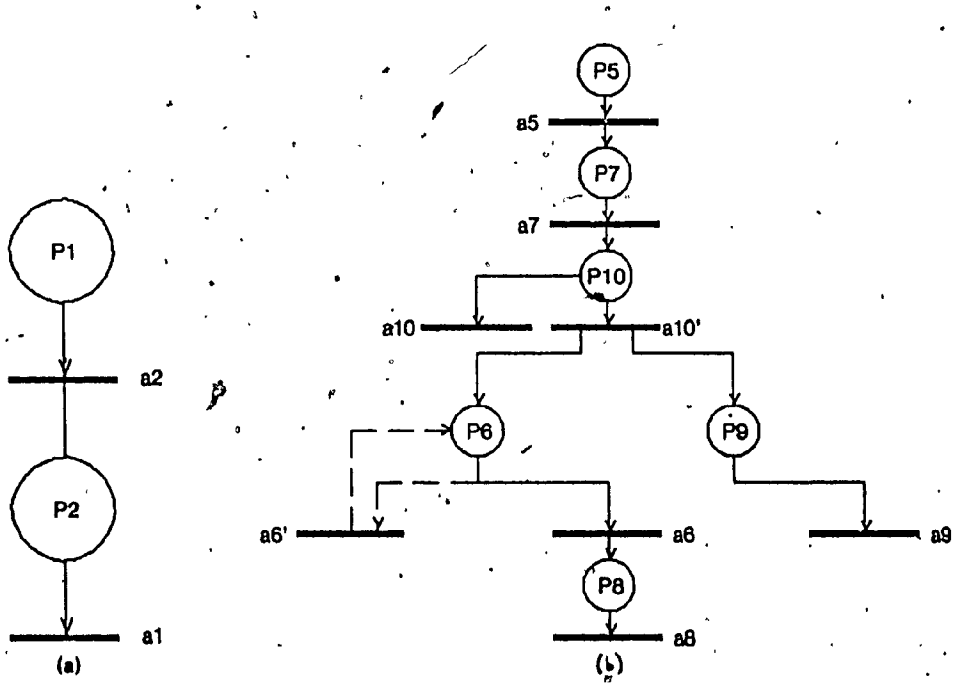

Fig. 3.I5 (a) Receptionist agent [ELL-80]

(b) Order administrator agent [ELL-80]

The semantics of the actions that occur at the nodes of the net are presented as sets of productions in the following Tables :

INITIAL MARKING: (P1)	
TRANSITION a1- Conditions: [exists log-book] Actions: [filem write log-entry this-order]	TRANSITION a2- Conditions: Actions: [filem write sys-scratch this-order] [instantiate order-administrator this-order]

Table 3.4 Productions for receptionist agent

INITIAL MARKING: (P5)	
TRANSITION a5- Conditions: [exists customer-file] Actions: [filem read customer-file this-order] [assign u activity-output]	TRANSITION a8- Conditions: Actions: [assign f1 v]
TRANSITION a6- Conditions: [exists billing-file] Actions: [filem read billing-file this-order] [assign v activity-output]	TRANSITION a9- Conditions: Actions: [assign f2 u]
TRANSITION a6'- Conditions: [enabledsince 6'5] Actions: [doc reminder order-administrator]	TRANSITION a10- Conditions: [compeq shipping-mode cod] Actions: [assign f3 u]
TRANSITION a7- Conditions: [exists customer-file] Actions: [assign shipping-mode cust-type]	TRANSITION a10'- Conditions: [compeq shipping-mode bill-later] Actions:

Table 3.5 Productions for order administrator agent

The major part of the following section which presents what happens within the model when a customer's request for a product arrives, comes from the paper "Office Information Systems and Computer Science" by C.A. Ellis and G.J. Nutt [ELL-80].

Customer request arrivals are modeled by a token arriving at the place P1 of the Petri net presented in Figure 3.15 (a). P1 is the initial place specified for this net. The token appearing at P1 enables transition a1. Some unspecified time after this enabling, the action specified by transition a1 will actually occur. That is, the transaction will 'fire'. Note that it is not known exactly when this activity will take place because the receptionist may be busy doing something else or may not even be working at the time of arrival. This nondeterministic timing notion is captured nicely within the Petri net formalism because Petri net transitions are defined to fire at some finite but indefinite time after the transition is enabled. One variation from the standard Petri net definition that occurs in this model is that transition firing is not instantaneous. This instantaneity could be accomplished by associating transitions with the termination of transactions, but there are advantages to associating times with transactions in order to separate execution time from wait time and to perform analysis. Because a Petri net is an uninterpreted model, someone must look at the associated productions in order to find out what is really happening

within any transition. Table 3.4 implies that transition a1 results in the writing of an entry into the log book. This action enables the next step in the Petri net (transition a2) : the keying of a customer request into the system. Transition a2 also has the side effect of enabling an instance of the order administrator agent to begin by placing a token on the initial place P5 of the Petri net in Figure 3.15 (b).

Methods for modeling decision making (location P10) and parallel processing (transition a10') are illustrated in Figure 3.15 (b). Note that a single token on place P10 can cause either transition a10 or transition a10' to fire, thus removing the token from place P10. However, both transitions cannot fire since removal of the token by one disables the other. Firing of a transition also depends on the production rates associated with the transition. If the condition portion of all associated productions is 'true', then the transition can fire. In this case, it depends on the value of the variable 'shipping mode' which was set by the previous transition a7. When transition a10' fires, it places tokens onto both P6 and P9 , thus enabling transitions a6 and a9. Again, these enabled transitions cannot fire until their associated production predicates are true. In this case, as in many cases of parallel asynchronous processing, productions associated with different independent transitions are in the active production rule set.

In the SCOOP system implementation, each production consists of a list of predicates followed by a list of actions to be performed if all predicates are true. In Table 3.5, after transition a7 has fired, if 'shipping mode' equals 'C.O.D.', then a10 can fire, if 'shipping mode' equals 'pay later', then a10' can fire. The dashed lines to and from the new transition a6' in Figure 3.15 (b) have been added to illustrate the mechanism for modeling time-outs on a transition, such as a6 in the example. If activity a6 is not completed within the time limit specified, then (and not before) transition a6' will fire and cause some reminder to be generated. The enabled a6' predicate performs this triggering function (Table 3.4).

The rule associated with transition a6' states that if this transition has been enabled for five or more days, then a document entitled 'reminder' should be sent to the order administrator. Then the timer is reset and transitions a6 and a6' are reenabled. One generation of the augmented Petri net formalism that is not visible in this example is the ability of one net to cause a variable number of initiations of another net. This notion of spawning a variable number of processes is useful for representing systems in which the number of concurrent activities is determined by dynamic conditions.

The system implementation contains an execution monitor that is driven by the internal representation of a

set of augmented Petri nets. As a transition T fires, the execution monitor removes the productions associated with T from the active production rule set and enters productions of any transitions which are enabled by the firing of T. The execution monitor starts some processes which can be implemented as automatic procedures and other processes which are interactive cooperative ventures between person and machine. At a lower level, special-purpose hardware and software systems exist to carry out various office tasks that receive messages from SCOOP. The special-purpose systems used by SCOOP are document generators, electronic mail senders and receivers, file services, and media schedulers. With SCOOP a single, unified systems interface is presented to the user instead of an array of office automation tools.

3.4 Architecture of Office Information Systems.

The objective for OIS architecture is to be able to put together system configurations that meet the needs of a wide spectrum of offices : Very small - Very large.

Primary goals for OIS architecture are : modularity, expandability, extensibility, interconnectability, and cost. The OIS tools which are available in order to present a possible OIS architecture are given below :

a) Integrated Workstation.

With respect to Hardware : display, keyboard, speaker, microphone, connection to the network (noise data), secondary storage facility (local and/or shared), hardcopy facilities (local/shared).

With respect to Software : powerful editor,powerful formatter, sophisticated form filling, information storage and retrieval, electronic mail, database querying (simple, high-level query language),calculator functions, record processing (e.g.,sorting).

b) Office network (local area network, cheap per station; reliable, high bandwidth).

c) Shared resources, such as intelligent copier/duplicator, OCR, photo composer, archive devices (tapes,microfilm,video disk), gateways to external networks (X.25, TTX), central

storage and databases ,facsimile scanners/printers, number cruncher (powerful processor).

A possible OIS architecture is as follows :

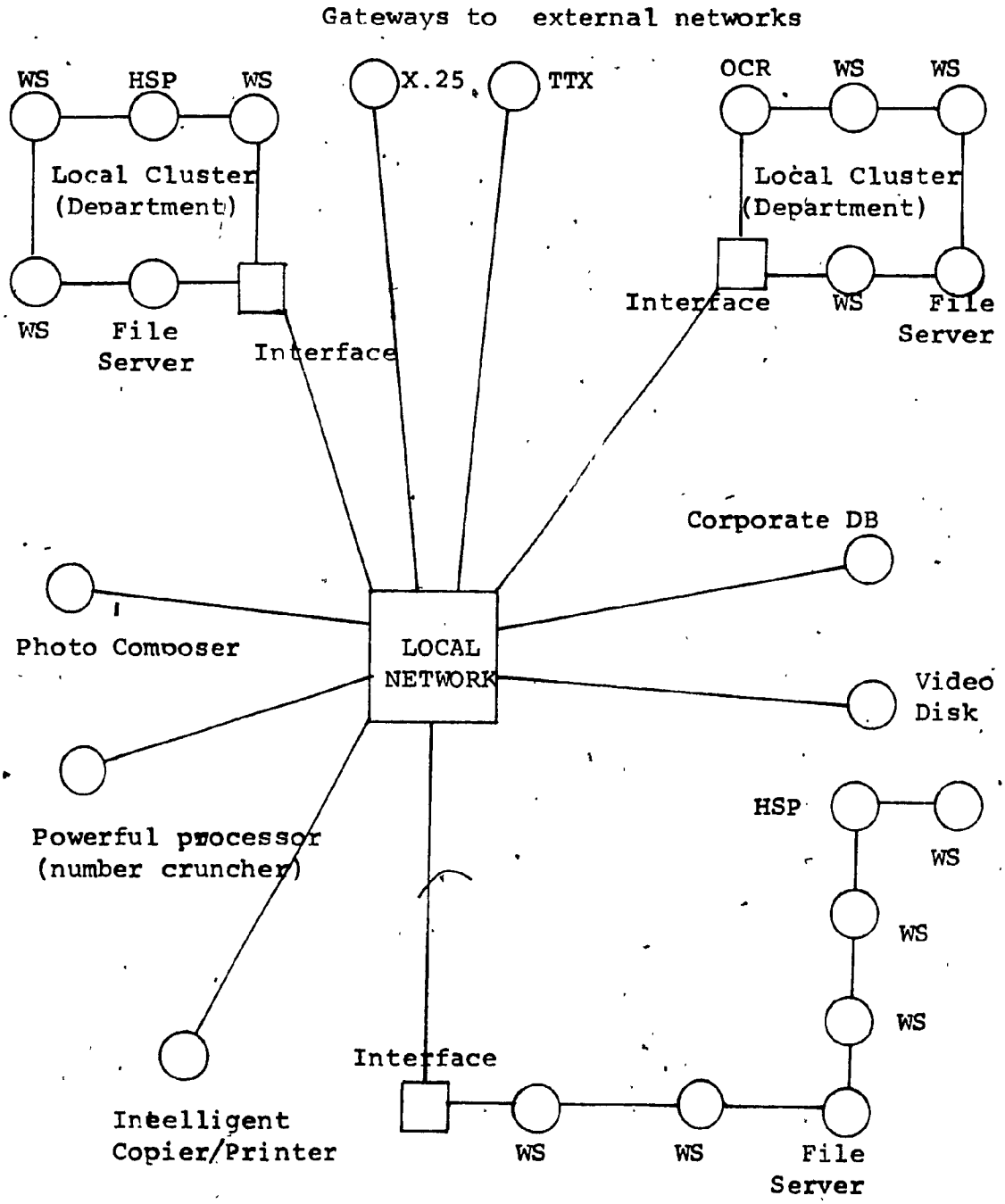

Fig. 3.16 OIS Architecture (where OCR : Optical Char Reader, HSP : High-speed Printer)

With this architecture there are three classes of systems : standalone, departmental, corporate.

Problems to be overcome in designing and implementing such a system are :

* Naming : different users, different storage devices.
* Consistency : of distributed filing system.
* Reliability : what happens if a node fails.
* Security : how to ensure only authorized users use the system.
* Access : controlling access to files (passwords, lists (access lists))
* Resource sharing and management : without a centralized operating system

In the OIS architecture, the main elements are : workstation (WS), Office network, shared resources.

WORKSTATION (WS)

The software architecture for an OIS workstation is :

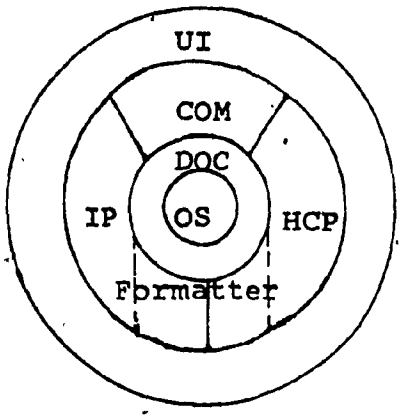

Fig. 3.17 Software architecture for an OIS WS

where :

a) OS Kernel is a real time O.S. With the following functions :

* multi-tasking,
* scheduling,
* synchronization,
* memory management (primary memory),
* interrupt handling,
* inter task communication.

b) DOC : Document subsystem (only on WSs with local secondary storage).

The functions of the DOC subsystem are :

* abstract objects : document
* transfer of documents to/from primary memory
* maintenance of documents in secondary memory
* document management : creating,deleting,copying
* document catalogue/directory : list of all documents
* document access control : password, access lists.

c) COM : Communications subsystem, with the following functions :

* transport documents in and out of the workstation
* must handle underlying communications protocols
* may have to do code conversion
* may have to do format conversion

d) IP : Interactive Processing

* Interactive tools : editor performs operations (acts on user input), display (presents) result (show output).
* editor and display S/W are grouped together for performance reasons.
* IP subsystem shares 'formatter' with HCP subsystem.

e) HCP : Hard Copy Presentation

* printer software
* different fonts : loadable fonts
* different quality depending on speed
* this subsystem shares 'formatter' with IP subsystem.

f) UI : User Interface, with the following functions :

* translates between user commands and system facilities
* translates user commands into a sequence of commands to the system software
* COM, HCP, IP, DOC provide most facilities for basic OIS tasks and the subsystem UI is the bridge between user and system software.

4.USER RECEPTIVENESS.

In any new systems effort, the acceptability of the systems to the people who will use them is an important factor. In the case of Office Automation, where a system must serve a wide variety of users, this is particularly true. Office automation will have a great impact on the life of office workers. Their working conditions will definitely change. Whether they will change for the 'better' or 'worse' depends on one's definition of 'better'. In economic terms [TSI-80a], the changes should be for the better as far as reduced costs and greater productivity go. Socially, in terms of job satisfaction and human interactions, there are many unaswered questions. Much will depend on whether the office worker sees office automation as a threat to his job and to his self worth. It already seems to be the case that very talented productive people benefit from office automation tools, since they can concentrate on the ideas and not their mundane representation and dissemination. However, less imaginative people, who had a comfortable feeling about participating in a meaningful way in an important activity, may feel displaced.

Any automation process raises the possibility of increased productivity. However, it is not always true that this will automatically imply improved quality.

Technological advances have allowed the production of more TV programs and commercial films. It is debatable whether this has resulted in an improved product. Thus there is a danger that in an automated office people will concentrate more on superficial quality, e.g., color printouts, sophisticated formatting, rather than the information content of the messages or the relevance of the office procedures.

The need for formal offices as it is known today may disappear when everyone has their own personal computer tied in to a communications network. There have always been prophesies of the office in the home. Perhaps office automation will be the realization of this scenario. If so, what will be the social implications of the demise of the formal office where many friendships and social contacts are made ?

The automated office has many implications for the structure of society, as it is known today. There are many questions that need to be answered before we plunge headlong toward the automated office. The technical problems, although many and challenging, are not insurmountable. If the automated office is not realized it will not be because it was not technically feasible. Rather, it will be because people did not want it.

The GAZETTE reported on April 7, 1982 a study of the health hazards associated with the use of Video Display Terminals (

VDTs). It was reported that there were seven abnormal pregnancies among women using VDTs in a federal government office, and the vice-president of the Public Service Alliance of Canada had demanded that pregnant VDT operators be transfered to other work, since no medical doctor or scientist can give any guarantee that no harm will come to an unborn child.

The physical characteristics of these terminals are already well known [COH-82], and the results of one investigation after another were all negative with respect to their harmless use, including those of a very thorough study by the U.S. Bureau of Radiological Health published in February, 1982.

The best answer was provided in the GAZETTE on April 10, 1982 by an article by Janet Bagnall [BAG-82], entitled 'Women's work : An endangered species.' In her interesting article she quoted a shop steward in the Bell Canada office as saying : 'I know a lot of women take tranquillizers every day. The stress is terrible. It's the monotony. It's not being able to move. And staring at the screen the whole time with the glare from the lights.'

This was said originally about computer-age telephone operators, but it applies equally to many users of word processors and other VDTs. It is well attested that sophisticated electronic office equipment tends to dominate the operator. A typewriter is a 'tool', but a VDT is a

master - a master, moreover, that may well reduce the employment opportunities in many tranditional occupations.

5. FUTURE PERSPECTIVES ON O.A.

There are a large number of interesting and exciting changes that will take place in office automation over the next few years. Some of these will be the result of advances in voice and optical character recognition, and of the development of extremely high density storage media such as optical videodisks.

The real heart of the future of office automation [MOR 76], however, lies in two areas. The first is that of computerization of office procedures by using particular systems. This puts the knowledge base for a company onto a computer system, and frees human beings to do the more intersting work of deciding among competing ideas. The second is that of communications. Research has shown that managers spend more than 50% of their time communicating. The aspect of communications that has been studied most intensively by the computer science community is computer communication networks. There has been a recent emphasis in the same area with respect to local computer networks. Much of the work has been directed toward improving the performance, reliability and flexibility of communication over a data network. In the process of investigating ways to accomplish these improvements, researchers have concentrated on network structures and network protocols. Researchers have considered structures ranging from fully interconnected nodes, as might be found in a multiprocessor

system, to central switching facilities, which rely on a switching center to pass information among the nodes.

In the area of transmission protocols, investigators have concentrated on mechanisms to increase reliability, communication unit sizes, and protocols offered to the end user of the communication facility.

6. BIBLIOGRAPHY.

[AMA-82]

Amand, J.V.St., "Alternatives to SNA", Computer Communications Vol. 5 No. 1,Feb. 1982.

[ARG-71]

Argyris, M., "Management Information Systems : The challenge to rationality and emotionality", Management Science 17/6, (1971), pp. 275-292 .

[BAG-82]

Bagnall,J., "Technological change affects positions mostly held by women", GAZETTE (Living), April 10, 1982, pp. D5.

[BAR-80]

Barron, J.L., Mylopoulos,J., "Dialogue organization and structure for interactive information systems", C.S.R.G., University of Toronto (1980).

[BAS-82]

Bass, C., "Comparison of Local Network Technologies", MICROPROCESSORS and MICROSYSTEMS, vol. 6, No. 8, Oct. 82.

[BAU-80]

Bauman, L., Coop, R.D., "Automated workflow control : A key to office productivity", National Computer Conference, 1980.

[BIR-80]

Birrel,A.D., Needham,R.M., "A universal file server", IEEE Transactions Software Engineering, SE-6/5, (1980), pp. 450-453.

[BOW-79]

Bown,H.G., Storey,J.R., "Development of the Canadian Videotex System : TELIDON", The Canadian Journal of Information Science, vol. 4, (1979), pp. 52-59.

[BRO-78]

Browner, C., Chibnik, M.,"Report on a summer Research Project : A behavioral view of office work", XEROX, Palo Alto Research Center, 1978.

[BUR-77]

Burns,J.C., "The Evolution of Office Information Systems", Datamation, April 1977, pp. 60-64.

[BUS-75]

Business Week, June 30, 1975, "The office of the future".

[CAR-80]

Card, S.K., Moran, T.P., Newell, A., "The keystroke-level model for user performance time with interactive systems", CACM 23/7, (1980), pp. 396-410.

[CAR-76]

Carlisle, J.H., 'Evaluating the impact of office automation on top management communication,' Proc. AFIPS 1976 National Computer Confrence, vol. 45, pp. 611-616.

[CAT-80]

Cattell, R.G., 'An Entity-Based Database Interface,' XEROX, Palo Alto Research Center, 1980.

[CHE-80]

Cheung, C.K., Kornatowski, J.Z., "The OFS user"s manual", C.S.R.G., University of Toronto (1980).

[COH-82]

Cohen, M., 'VDT's : Let's probe people and not just machines ', GAZETTE (Letters), April 22, 1982, pp B2.

[COM-76]

Computing Survey (1976), special issue on DBMS.

[COO-80]

Cook,C.L., "Streamlining office procedures - An analysis using the Information Control Net model", National Computer Conference, 1980.

[CUL-76]

Cullum, P.G., "The transmission subsystem in Systems Network Architecture", IBM Syst. J., vol. 15, No. 1 (1976).

[DEA-75]

DeAtley, E., 'Word Processing and the computerized office', Computers and People, Sept. 1975.

[DIO-80]

Dion,J., "The Cambridge File Server", Operating Systems Review 14/4, (1980), pp. 20-35.

[DOD-69]

Dodd, G.G., 'Elements of data base Management Systems,' Computing Surveys 1/2, June 1969, pp. 117-133.

[ELL-80]

Ellis, C.A., Nutt G.J. ,'Office Information Systems and Computer Science,' Computing Surveys, vol. 12, No. 1, March 1980.

[ENG-73]

Engelbert, D.C., Watson, R.W. , Norton, J.C., 'The augmented knowledge workshop,' Proc. AFIPS 1973, National Computer Conference, vol. 42, 1973.

[ENG-79]

Engel, G.H., et al. 'An Office Communications System,' IBM Systems Journal 18/3, (1979), pp. 402-431 .

[GIB-81]

Gibbs, S., "Output generation in office information systems", Technical Report CSRG-127, (March 1981), pp. 134.

[GIL-82]

Gilbert ,R., 'The General-Purpose Interface Bus,' IEEE MICRO, February 82.

[GOL-80]

Goldberg, A. , Ronson ,D., 'A metaphor for user interface design,' XEROX, Palo Alto Research Center, Learning Research Group, 1980.

[GRA-75]

Gray, J.P. , Blair, C.R., 'IBM's Systems Network Architecture,' Datamation (April 1975).

[HAM-77a]

Hammer, M, et al.,"A very high-level programming language for data processing applications", CACM 20/11, (1977), pp. 832-840.

[HAM-79b]

Hammer, M., Zisman, M., "Design and implementation of office information systems", Sloan School of Management (M.I.T.), 1979.

[HAM-80c]

Hammer, M., Sirbu, M., "What is office automation. ?", Laboratory for computer science (M.I.T.), January 1980.

[HAM-80d]

Hammer, M. , Kunin ,J.S., 'Design principles of an office specification language,' National Computer Conference , 1980.

[HAN-82]

Hanlon, P.D. , Weston ,R.H., ' Use of Local Area Networks within manufacturing systems', MICROPROCESSORS and MICROCOMPUTERS, vol. 6, No. 8, Oct. 82.

[HLN-82]

'HiNET Local Computer Network,' Digital Microsystems, MINI-MICRO SYSTEMS, March 1982, pp. 76.

[HOB-76]

Hobgood, W.S., 'The role of the Network Control Program in Systems Network Architecture,' IBM Syst. J. Vol. 15, No. 1 (1976).

[HOG-81]

Hogg,J., Nierstrasz,O.M., Tsichritzis, D.C., "Form procedures", Technical Report CSRG-127, March 1981, pp. 101.

[HUD-80a]

Hudyma,R., "The hardware design of distributed office workstations", C.S.R.G., University of Toronto (1980).

[HUD-81b]

Hudyma,R., "An incremental family of office workstations", Technical Report CSRG-127, March 1981, pp. 158.

[HUT-82]

Hutchison ,D., Corcoran Peter, "Building local area networks to Ethernet specification,' Computer Communications vol. 5, No. 1 (Feb. 1982).

[ING-78]

Ingalls,D.H., "The Smalltalk-76 programming system design and implementation", XEROX, Palo Alto Research Center, 1978.

[ISR-80]

Israel, J.E., Mitchell J.G., Strurgis H.E., 'Separating Data from function in a distributed file system,' XEROX, Palo Alto Research Center, 1980.

[KLE-82]

Klee, K. , Verity, J.W., 'Battle of the Networks,' Datamation, March 1982.

[KLI-80]

Kling, R., 'Social analysis of computing , Theoretical perspectives in recent empirical research,' Computing Surveys 12/1, (1980), pp. 61-110 .

[KOR-79]

Kornatowski, J.Z., "The MRS user"s manual", C.S.R.G., University of Toronto (1979).

[KRA-80]

Krasner,G., "The design of a Smalltalk music system", Systems Science Laboratory, XEROX, Palo Alto Research Centers, July 1980.

[LAD-80]

Ladd,I., Tsichritzis,D., "An office form flow model", National Computer Conference, 1980.

[LEF-78]

Lefkovits, H.C., 'A status report on the activities of the CODASYL end user facilities committee (EUFC),' SIGMOD Report 10/2 3 (1978).

[LOC-81]

Lochovsky, F.H., 'Human factors issues in office information systems,' Technical Report CSRG-127, March 1981, pp. 19.

[LOV-81]

Loverseed, B., 'ETHERNET : is it a standard solution ?', Computing, British Computer Society, Nov. 26 (1981).

[McC-82]

McCartney, J., "Who will be in control of future networks ?", Data Processing, Feb. 1982.

[McF-76]

McFadyen, J,H., "Systems Network Architecture : An overview", IBM Systems J., vol. 15, no. 1 (1976).

[MET-76]

Metcalfe, R.M. , Boggs, D.R., 'ETHERNET : Distributed packet switching for local computer networks,' Comm. ACM 19, 7 (July 1976), pp. 395-404.

[MICOM]

"MODERN OFFICE PROCEDURES", MICOM Co., Toronto, Canada.

[MID-82]

Middelboe ,S., 'Local Area Networks', MICROPROCESSORS and

MICROSYSTEMS, vol. 6, No. 1, Jan-Feb 82.

[MIL-77]

Miller, L.A. , Thomal, J.C., 'Behavioral issues in the use of interactive systems,'' Int. J. Man-Machine Studies (1977) 9, pp. 509-536.

[MOO-82]

Moores,B., "Implementation of Local Area Networks", MICROPROCESSORS and MICROSYSTEMS, vol. 6, no. 8, Oct. 82.

[MOR-76]

Morgan, H.L., "Office automation project - A research perspective", Proc. AFIPS 1976, National Computer Conference, vol. 45, pp.605-610.

[MOR-79]

Morgan, H.L. , Root, D.J., 'A concept of corporate memory,' NYU Symp. On Office Automation Systems, New York univ., Graduate School of Business, New York City, pp. 31-36 (1979).

[MYE-80]

Myers, W., "Computer Graphics : The human interface", COMPUTER 13/6, (1980), pp. 45-54.

[NES-75a]

Ness, D.N., 'Office Automation Project : Text Processing,' Working Paper 75-02-02, Department of Decision Sciences, The Wharton school, University of Pennsylvania, 1975.

[NES-75b]

Ness, D.N., 'Office Automation Project : Overview,' Working Paper 75-05-03, Department of Decision Sciences, The Wharton school, University of Pennsylvania, 1975.

[NES-76c]

Ness, D.N., 'Office Automation Project : Secreterial Interface,' Working Paper 76-06-06, Department of Decision Sciences, The Wharton school University of Pennsylvania, 1976.

[NES-77d]

Ness, D.N., 'Living Plan Project : Introduction to Living Plans,' Working Paper 77-08-02, Department of Decision Sciences, The Wharton school, University of Pennsylvania, 1977.

[NES-76e]

Ness, D.N., 'Office Automation Project : Managerial Overview.', Working Paper 76-07-04, Department of Decision Sciences, The Wharton school, University of Pennsylvania, 1976.

[NES-77f]

Ness, D.N., 'OAP : Responsive Mail.', Working Paper 77-01-07, Department of Decision sciences, The Wharton school, University of Pennsylvania, 1977.

[NES-77g]

Ness, D.N., 'OAP : File support programs.', Working Paper 77-01-08, Department of Decision sciences, The Wharton school, University of Pennsylvania, 1977.

[NES-77h]

Ness, D.N., 'OAP : Non-Deterministic Procedures in office processes,' Working Paper 77-02-02, Department of Decision sciences, The Wharton school, University of Pennsylvania, 1977.

[NES-77i]

Ness, D.N., 'OAP : Personal Scheduler,' Working Paper 77-02-05, Department of Decision sciences, The Wharton school, University of Pennsylvania, 1977.

[NES-77j]

Ness, D.N., 'OAP : The Mail System,' Working Paper 77-08-03, Department of Decision sciences, The Wharton school, University of Pennsylvania, 1977.

[NES-77k]

Ness, D.N., 'OAP : Folders, Drawers, and Cabinets.' Working Paper 77-08-06, Department of Decision sciences, The Wharton school, University of Pennsylvania, 1977.

[NES-761]

Ness, D.N., "OAP : User Support.' Working Paper 76-05-03, Department of Decision sciences, The Wharton school, University of Pennsylvania, 1976.

[OLS-79]

Olson, M.H. , Lucas,H.C., 'The impact of administrative support systems on the organization,' Proc. NYU Symp. On Office Automation systems, (1979), pp. 63-69 .

[PET-77]

Peterson, J.L., "Petri nets", ACM Comput. Surv., 9,3 (Sept. 1977), pp. 223-252.

[RAB-81]

Rabitti, F., 'Distributed query facilities for office information systems,' Technical Report CSRG-127, March 1981, pp. 201.

[RAW-78]

Rawson E. , Metcalfe R.M., 'Fibernet : Multimode optical fibers for local computer networks,' IEEE Trans. On Comm.,

26 7, July 1978, pp. 983-990.

[RIN-80]

"RINGNET : A packet switched local network with decentralized control", Computer Networks 3 (1980), pp. 373-379.

[ROV-79]

Roulifson, J.R., 'Office Automation - Matching user requirements with computer research,' Proc. NYU Symp. On office automation syst., 1979.

[RYA-81]

Ryan, R., Marchall ,G.D., Beach, R. , Kernam ,S.R., 'Intel Local Network Architecture,' Intel Corporation, IEEE MICRO, Nov. 1981, pp. 26-41.

[SAN-80]

Sandewall, E. , Hektor, G., 'Provisions for flexibility in the Linkoping office information system,' National Computer Conference, 1980.

[SEN-77]

Senko, M.E., "Data structures and data accessing in database systems past, present, future", IBM Systems J. 16/3, (1977), pp. 208-257.

[SHA-81]

Shackil,A.F., 'Design case history : WANG's word processor,' IEEE Spectrum, August 1981, pp. 29-33.

[SHE-78]

Shemer, J.E., Keddy, J.R., "Architecture of an experimental office system : The soft display word processor", COMPUTER, Dec. 1978, pp. 39-48.

[SHI-82]

Shipp,W., Webber,H., "Brown University Network - BRUNET", MICROPROCESSORS and MICROSYSTEMS, vol. 6, No. 8, Oct. 82.

[SHN-79]

Shneiderman, B., "Human factors experiments in designing interactive systems", COMPUTER, Dec. 1979, pp. 9-19.

[SHO-79a]

Shoch, J.F., 'An overview of the programming language Smalltalk-72', Learning Research Group, XEROX Palo Alto Research Center, Sigplan Notices, Vol. 14, No. 9, Sept. 1979, pp. 64-73.

[SHO-80b]

Shoch, J.F., 'An annotated bibliography on local computer networks', XEROX Palo Alto Research Center, April 1980.

[SHO-82c]

Shock, J., Dalal, Y., Redell, D., "Evolution of the Ethernet Local Computer Network", COMPUTER, Aug. 82.

[STE-78]

Steely, J.E., 'When management is automated', Datamation 1978.

[TAP-82]

Tapscott Don, 'Investigating the electronic office,' DATAMATION, March 1982.

[TEN-83]

Tennenhouse,D.L., "Unravelling the mystery of LAN", Canadian DATASYSTEMS, May 83, pp. 36-41.

[TSI-80a]

Tsichritzis, D.C., Lochovsky, F.H., 'Office Information Systems : Challenge for the 80's ,' Proc. Of IEEE, Vol. 68, No. 9, Sept. 1980, pp. 1054-1059.

[TSI-80b]

Tsichritzis, D.C., 'OFS : An integrated form management system,' Proc. VLDB conf. 1980.

[TSI-79c]

Tsichritzis, D.C., 'A form manipulation system,' C.S.R.G.,

University of Toronto (1979).

[TSI-79d]

Tsichritzis, D.C., 'Form flow models,' C.S.R.G., University of Toronto (1979).

[TSI-81e]

Tsichritzis, D.C., 'Form management,' Technical Report CSRG-127, March 1981, pp. 86.

[TSI-81f]

Tsichritzis, D.C., 'Data base versus message systems,' Technical Report CSRG-127, March 1981, pp. 185.

[TSI-81g]

Tsichritzis, D.C., 'The death of the computer center,' Technical Report CSRG-127, March 1981, pp. 235.

[WANG-a]

"WANGNET : Local networking system", WANG laboratories Inc., one industrial Avenue, Lowell, Mass. 01851.

[WANG-b]

"REMOTE WANGNET", WANG laboratories Inc., one industrial Avenue, Lowell, Mass. 01851.

[WHI-77]

White, R.B., 'A Prototype for the Automated Office ', DATAMATION, April 1977.

[WIL-75a]

Wilkes, M.V., 'Communication using a Digital Ring ', Proc. Of the Pacific Area Computer Communication Network System Symposium, Aug. 1975,pp. 47 - 56.

[WIL-80b]

Wilkes, M.V., Needham, R.M., ' The Cambridge Model Distributed System ', Computer Laboratory, University of Cambridge, (1980).

[WOH-80]

Wohl, A., ' A Review of Office Automation ', DATAMATION, Feb. 1980.

[YAS-75a]

Yasaki, E.K., ' Toward the Automated Office ', DATAMATION, Feb. 1975.

[YAS-78b]

Yasaki, E.K., ' IBM's Offering of SNA : Some find it a success ', Datamation, Feb. 1978, pp. 176 - 180.

[ZILOG]

' Z-NET : Local Computer Network System ', ZILOG Inc., Cuperino, California 95014.

[ZIS-77a]

Zisman, M.D., ' Representation, Specification and Automation of Office Procedures ', Ph. D. Dissertation, Wharton School, University of Pennsylvania, Philadelphia, Pa., 1977. (Working Paper 77-09-04)

[ZIS-78b]

Zisman, M.D., ' Office Automation : Revolution or Evolution ?', Sloan Management Review (M.I.T.), vol. 19, no. 3, Spring 1978.