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AN EVALUATION OF THE NEED FOR LOCAL AREA NETWORKS AT NAVAL AVIATION SQUADRONS AND WINGS

by

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In the 1990's the Navy faces a new host of challenges. With decreasing defense spending it must find a way to keep its ADP hardware modern. The technological advances in computer technology of the 1980's have left the Navy with a non-cohesive strategy for ADP procurement. The Navy spent millions of dollars buying thousands of new micro computers for the desktops of its ships and squadrons. The 1990's are a new decade, but the constant development of new computer technology hasn't changed. Should the Navy continue to spend millions of dollars on these new technologies or should it keep on upgrading the computer assets it currently has? This thesis evaluates the Navy's needs for one of those new technologies: Local Area Networks (LANs). Should the Navy upgrade its stand alone desktop micro computers to networked computers or are stand alone desktop computers good enough for the Navy's needs of today and tommorrow? Is there sufficient benefit alone to justify this move to networked computers at squadrons and wings?.

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AN EVALUATION OF THE NEED FOR LOCAL AREA NETWORKS AT NAVAL AVIATION SQUADRONS AND WINGS

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ABSTRACT:

In the 1990's the Navy faces a new host of challenges. With decreasing defense spending it must find a way to keep its ADP hardware modern. The technological advances in computer technology of the eighties have left the Navy with a non-cohesive strategy for ADP procurement. The Navy spent millions of dollars buying thousands of new micro-computers for the desktops of its ships and squadrons. The nineties are a new decade but the constant development of new computer technology hasn't changed. Should the Navy continue to spend millions of dollars on these new technologies or should it keep on upgrading the computer assets it currently has? This thesis evaluates the Navy's need for one of these new technologies: Local Area Networks (LANS) . Should the Navy upgrade its stand alone desktop micro-computers to networked computers or are stand alone desktop computers good enough for the Navy's needs of today and tomorrow? Is there sufficient benefit alone to justify this move to networked computers at squadrons and wings?

It was found that Naval aircraft squadrons and wings are the backbone of the Navy's ability to project power. The installation of LANs at these units and the aircraft carriers that they deploy to can provide them with a vital boost in administrative productivity. Selection of LAN technologies should be done on a unit by unit basis. The emphasis of the selection criteria used should be to provide maximum compatibility, upgradablility, security, and portability. Finally, There must be a central

control group that monitors overall progress with LAN selection and installation.

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I. INTRODUCTION

A. BACKGROUND

The United States Navy has gone from the cold war of the Reagan years to the Bush years of the peace dividend and fiscal cutbacks that continue today. The choices that the Navy made during the 1980's concerning the acquisition of microcomputers and related hardware and software were as varied as the vendors that exist in the marketplace. These choices were generally good and quality hardware and software was purchased, but the nature of the computer industry has left the Navy with some problems such as how to keep up with the latest technology when the generation lifetime for a given piece of hardware is often less than two years. For civilian industry this is less of a problem because they are profit oriented and can plan and budget for hardware obsolescence. The Navy is usually only able to update existing equipment every five to ten years. This means that it must get by with technology that is often outdated. This trend is only likely to worsen as the Navy is asked to further its scale-down in size and scope. It then becomes very obvious that it must be prudent when updating or upgrading its hardware and software or when its plans to make new equipment purchases. The Navy must ensure that whatever it is buying is the best value for

its given functionality, is the most mature technology or has the best value in terms of its comparability and upgradability.

Upgrading the Navy's existing microcomputers to Local Area Networks (LANs) will be the most important decision that the Navy makes in the nineties, with regards to Information Technology (IT). The reason for this is that networking the Navy's microcomputers will provide the Navy with a significant increase in productivity and connectivity throughout the various levels of command and increased flexibility with its computer resources at a minimal cost.

Operational units of the Navy are usually the last to receive modern office technology. The microcomputer is arguably the most important piece of hardware in the workplace today and it has only in been available to the Navy's operational units for about five years. Current Department of Defense (DOD) contracts provide access to a modest range of microcomputer models and related hardware. Maximizing the productivity of these computer assets during the 1990's will require very thorough planning and budgeting. Installing LAN's at the squadron level will provide each squadron with an increase in productivity and connectivity with its wing and related squadrons. The cost of installing a LAN at a squadron is low when compared to the benefits of doing so. Chapter VIII discusses Cost Benefit Analysis of installing LANs at the squadron level.

B. OBJECTIVES

This thesis examines the current status of computer technology at Naval aircraft squadrons and wings. The focus of the thesis is to examine the current technology and to illustrate how and why networking the existing computers would provide substantial productivity gains as well as increased functionality and security. LANs would allow for improved standards and policies concerning the use of computers, their related peripheral devices and software. In addressing this issue, the following questions will be considered:

1. Are LANs cost effective when compared to existing stand alone desk-top micro-computers? (see Chapter VIII)
2. What other benefits exist in a LAN-based versus a stand alone micro-computer system? (see Chapter III)
3. What Navy approved network topologies are the most cost effective for Navy aircraft squadrons and wings? (see Chapter V)
4. Is there a LAN topology that will meet Naval aircraft squadrons and wings need to be portable to aircraft carriers or forward deployment sites? (see Chapter VI)
5. Are there software cost savings when utilizing a LAN? (see Chapter VIII)
6. Who should be responsible for administrating and maintaining the squadron and wing LANs? (see Chapter IX)
7. What training will be required for users of the proposed LANs? (see Chapter IX)

II. TRENDS IN COMPUTER USE AT NAVY SQUADRONS AND WINGS

The Navy has provided its aircraft squadrons and wings with a limited group of computer systems for non-tactical use. These computers "have generally increased the productivity of the administrative personnel by allowing each man to produce more information of a higher quality than was previously possible in a manual mode."(McMican,1985) The systems purchased were limited by computer standards of the 1980's and provided a limited advance into word processing. The computers, such as the Zenith Data System's 100 series of computers were slow and cumbersome and their software choices were limited. Data were stored on low capacity 8.5 inch floppy disks. Eventually as microcomputers began to rise in popularity in the workplace, the Government Services Administration (GSA) established a microcomputer contract with Zenith Data Systems. "DESKTOP I" provided the government buyer with the Zenith 248, a 80286 based micro-computer with 640,000 bytes of Random Access Memory (RAM), upgradeable to 1 Megabyte of RAM (one megabyte is one million bytes), one 5-1/4 inch floppy drive and either a monochrome, or color video monitor. An internal hard-drive and a tape backup were also made available. This was a step up to the computer technology of the 1980's, but soon after the first of the systems was shipped, Intel was displaying its 32-bit 80386 processors with

speeds that at least doubled that of the 80286 chip. The Navy was buying yesterday's technology before most of the DESKTOP I systems were delivered to their customers. This is a serious dilemma for the military as a whole and the Navy in particular.

A. CURRENT TRENDS IN ADP ACQUISITION AT WINGS AND SQUADRONS

The Navy has tried to keep pace with the computer industry in its continuing quest for faster and more capable computers, but the bureaucracy involved in purchasing computer equipment is so involved that negotiating a single contract for Automatic Data Processing (ADP) equipment can take eighteen months or even up to two years. In that time frame the computer industry has often delivered one and announced a second generation of hardware beyond the equipment being contracted for. This has led to problems of compatibility with and upgradability to future systems before the system has even been installed and turned on. The current trends in ADP acquisition at wings and squadrons reflects this problem. The issue moves from what ADP equipment should be bought to will the equipment bought be functional until it can be upgraded or replaced?

1. A REVIEW OF HARDWARE

The current state of ADP equipment at Naval wings and squadrons is as follows:

- eight to ten Zenith 248 micro-computers per squadron

- one letter quality wide carriage printer per computer
- most video monitors are monochrome with some having color capability
- most computers have one 5-1/4" drive and a 20 megabyte hard-drive
- 640,000 RAM memory is standard with many upgraded to 1 megabyte of RAM
- two to four laptop computers per squadron

2. A REVIEW OF SOFTWARE

The software available for these computers was initially whatever the user wanted to install on the hard-drive. This became a security risk, because anyone could copy files to or from the hard drive of these computers and could then remove sensitive or even classified data from the computer. Navy policies concerning microcomputers were changed so that only government procured software could be placed on government computers and sensitive data was to be kept only on floppy disks. This decreased the security risk, but it hampered the productivity and creativity of the government computer users. The following list of software is not all inclusive rather is meant to show that there were few choices to be made by the users of these computers.

- Wordstar Professional
- Enable 1.15
- Dbase III +
- Lotus 1.1

3. A REVIEW OF PLANNED UPGRADES

The Navy does have plans to provide upgrades or improved models of both hardware and software. (Olsen,1991); (Morgan,1991) An example of this effort is the DOD Companion contract, from Government Technology Services Inc. (GTSI). This contract provides an impressive list of possible upgrades for the basic Desktop I computer. Upgrade choices include:

- 3-1/2 inch floppy drives
- Compact Disk-Read Only Memory (CD-ROM) drives
- Removable hard disk drives
- Memory expansion cards
- Modems
- Laser printers/plotters
- Printer sharing devices
- Uninterruptible power sources
- Facsimile boards and scanners
- Video Graphics Array (VGA) monitors and video cards
- Math co-processors
- 80386 CPU microcomputer upgrade board

In addition to the listed hardware upgrades a much larger list of software became available to the user as well. Software upgrades include:

- Quicksilver Professional
- Wordperfect 5.1

- R:BASE 3.1
- Harvard Graphics 3.0
- HyperAccess 3.32
- Security Guardian 3.51
- PC Tools 7.0
- TAMGen 1.0
- DOS Aid
- Several Unix/Xenix products
- Microsoft Windows 3.0
- Word for Windows 1.1
- PageMaker for Windows 4.0
- Ventura Publisher 3.0
- PerFORM PRO Designer & Filler 2.1

As these lists illustrate there have been strides made in providing more choices for the user. The Zenith 248 computer can be upgraded by an 80386-25MHz CPU board with 4 Megabytes of RAM. VGA monitors and CD-ROM drives can be added to give the Zenith 248 a needed shot in the arm. Software upgrades allow the user to pick software that meets his or her needs best, Microsoft Windows is supported with a reasonable list of software and there is video and memory upgrades to support these software products. It is still not clear whether Microsoft Windows and or other Graphical User Interfaces (GUIs) will be the future of computing or just another path that can be taken to the future of computing.

B. LAN'S IN THE NAVY

Networked computers can be used to communicate in ways that are not available by more traditional means such as the telephone or by memo. By using Electronic mail (E-mail) it is possible to compose one's own thoughts while they are fresh and then send them to another person or group of people who will receive them as soon as they are available. This means that the author of a note or memo can contact a group of people when it is convenient to him and then get back to his other business. Lost time waiting on a phone or just waiting for a person to be free can be eliminated or at least reduced by a large extent by the use of E-mail.

In the 1980's the Navy saw that the desk-top computer could greatly increase the administrative productivity of most organizations and they set out to procure computers that would satisfy this end. Today the Navy is seeing that there is a trend toward networking desk-top computers to provide better control of the hardware, better security of the data stored within the computers and to provide further productivity gains.

1. A REVIEW OF WHAT IS IN USE TODAY

Currently the Navy has several types of networks running aboard ships and at larger ashore commands, but networks at the squadron or wing level are only in the planning stages. Many of the networks the Navy has installed

in the past are mini-computer based. Examples of these systems aboard ships are the PERQ first installed aboard the USS CARL VINSON in 1981, the WANG VS-80 also installed aboard the USS CARL VINSON in 1982, and the Shipboard Non-tactical Automated data Processing (SNAP) program first installed in 1974. The SNAP system alone would cost the Navy about a billion dollars.(McMican,1985)

2. A REVIEW OF WHAT IS PLANNED FOR THE FUTURE

Across the Navy there are networks planned for units of every size. The aircraft carrier GEORGE WASHINGTON, will have a fiber optic backbone for its ship wide LAN installed while still under construction. Most of the Navy's ships have a network of some type, but the GEORGE WASHINGTON is the first ship to have a LAN built into the ship from the keel up. COMNAVAIRPAC has plans to provide funding for LANs at the squadron and wing level in the coming years. In fact it appears that all across the Navy there are plans to network micro-computers. (NOS Study,1991); (Green,1991) One such example of a project, that will use LAN technology, is the Naval Aviation Logistics Command Management Information System (NALCOMIS). Its purpose is stated in the quote below.

> "The Naval Aviation Logistics Command Management Information System (NALCOMIS) manages, tracks and reports on aircraft maintenance and material management requirements aboard aircraft carriers, amphibious aviation helicopter support ships, Marine aviation logistics squadrons and Naval air stations... The principal

objective of NALCOMIS is to automate the Naval Aviation Maintenance Program (NAMP) business functions throughout the Navy and Marine Corps aviation maintenance activities, and to implement a standardized management system that will have a measurable, positive impact on aircraft weapons system readiness." (OTA,1991)

This project is just one of many that the Navy is pursuing in the name of automation, standardization, and increased productivity. It will eventually be made available to aviation squadrons at Naval Air Stations and aboard aircraft carriers. Although the main product of the NALCOMIS system is a software product, it is the use of networked computers that will allow it to achieve its stated purpose. When complete it will link virtually every aviation and aviation related unit in the Navy and Marine Corps with a central database and management system that will provide every user with a significantly richer database of information on aviation components, and their management throughout the logistical system of the Navy and Marine Corps.

3. A DISCUSSION OF THE NOS STUDY

The Network Operating System (NOS) study conducted by COMNAVAIRPAC was intended to explore the operating characteristics of the three most popular, (in terms of market share), LAN operating systems in an attempt to evaluate how each system meets the requirements of the Navy.

" The rapid dissemination of microcomputer equipment throughout the force has resulted in increased productivity at all levels. To ensure the continuation

> of this trend, interoperability between these diverse pieces of hardware and software becomes a major issue. Due to the ready availability of a multiplicity of bridges, routers, protocol converters, and other hardware based items that provide essentially transparent interfaces between different cabling mediums, and even networking protocols, the key ingredient in the formula is utilization of a common Network Operating System." (NOS study,1991)

This study evaluates the three operating systems: Banyan Vines Virtual Network operating system, Novell Netware 386, and 3COM 3+. It compares how each performs an exhaustive list of attributes; the following is a list of major areas covered:

- Data integrity
- Access security
- Redundancy
- On-line storage
- Shared print service
- Uninterruptable power supply
- Network management
- Configuration management
- Operating system support
- Application support
- Communications hardware and protocol support
- Memory requirements
- Network interface cards
- Telecommunication standards compliance
- Mail handling system

- Correspondence addressing

The conclusion of the NOS study was that all three of these NOS products satisfied the requirements of COMNAVAIRPAC's ship and squadrons. Each system had certain strengths and weaknesses, but all met all of the requirements set forth in the study. Banyan Vines is UNIX based while NetWare 386 runs on DOS, OS/2 and Macintosh operating systems. 3COM 3+ runs on a proprietary emulation of DOS.

III. MAKING A CASE FOR OFFICE AUTOMATION

LANs are the latest phase in the continuing trend of office automation. What is Office Automation? One definition is given by the Office of Technical Assistance (OTA): "the application of microelectronic information technology to office work. It includes "mainframe" computers, smaller minicomputers, personal or microcomputers, stand alone word processors, and the many diverse communications devices and systems that can link them together." (OTA,1984)

Figure 3-1 shows the history of technology used in the office, at the top of the diagram is the LAN. The LAN represents the third or latest phase of the continuing trend of automating the workplace. The nineteen eighties were a period of computerization in the workplace. Corporate America invested vast sums of capital in personal computers and peripheral equipment. All this was done to gain promised productivity in the workplace. By having the personal computers take care of the mundane and repetitive tasks, the office worker could be more creative and more productive.

Today the Navy sits at a unstable point in its life as defense spending is being cut back further and further with each passing month and manpower levels are being continuously revised downward. Yet the Navy is still expected to perform all of its varied missions around the world. Can the Navy do

more with less? If it is to do so it will need to become much more efficient in the way in which it conducts day to day operations. Office Automation is one way that the Navy may be able to perform more work with less people and less money.

A. ARGUMENTS FOR INCREASED PRODUCTIVITY

The most common reason used to justify the purchase of a personal computer is that it will increase the productivity of the user. This claim is widely held in the managers offices of the world, but there has been very little empirical and analytical study of just how much productivity is gained by the presence of a personal computer. There is evidence that the personal computer has increased the productivity of most office users, but it alone is not the sole answer to the problem of increasing the output of the office worker. (Murphy,Davis,1989); (OTA,1985)

LAN technology offers additional features that the stand alone personal computer does not offer. Are LAN's the office productivity tool that the Navy needs to remain fully ready to defend America from its enemies? The productivity argument is still valid for LAN's as they offer many new capabilities that stand alone personal computers did not offer. The design and implementation of networked personal computers will provide a more productive work place. Figures 1,2,3 in Appendix A illustrate the potential productivity increase from the implementation of office automation technology such as LANs.

(Urban,1986) The productivity argument has many different facets and each will be discussed below.

1. **LABOR SAVINGS**

The savings in labor cost is often held up as the prime reason for moving to computerized workplaces. The potential gain in productivity from upgrading an office or work place to a LAN would mean that either the same work force could perform substantially more work or perform the same work in less time or fewer people could do the same work load in the same time. The exact amount of labor saved is extremely hard to measure in any precise manner, but many sources report that labor savings of 30% are possible with the latest office automation technology in place in the workplace. (Urban,1986)

The value of this saved labor depends directly upon whose time it is. Is it the head of a department or just a secretary or clerical worker? Obviously if the managements time is saved it is perceived to be of greater over all value than if it is the labor of a clerical person. No matter whose time is saved, the workforce will have more free time so that they can begin to be more innovative and expand their creativity. This in turn leads to higher job satisfaction and reduces job stress which will further increase the productivity potential of the workforce.

2. NON-LABOR SAVINGS

There are also many other ways in which a LAN can reduce an office's expenses. The first of these is savings in equipment and supplies. The use of a LAN can potentially reduce the amount of paper used in an office by providing electronic alternatives to hard copies of documents or reports. It can also reduce the amount of notes, memos and other miscellaneous paper products used in the office by replacing them all with a single medium, that of the electronic mail system. The Navy has made great efforts to reduce the use of paper in the office. By using a LAN there can be some reduction in the paper usage in the office. (Sassone,1984)

There can also be a reduction in the use of postage and utilities and in travel of key personnel due to the connectivity provided by a network of LANs from base to base and squadron to squadron. Electronic mail is becoming more and more popular and sophisticated as it attains multimedia capabilities. These areas also lapse over into the labor or time savings area, because reduced travel implies less nonproductive time spent travelling.

3. SAVINGS OF TIME

The time saved by not travelling is important and can be significant for personnel at wings or other staff commands that do travel to other commands routinely. There is another

area where the time savings are significant. This is the time saved by having the capability to get information or data directly from a database or information source without having to send someone out for it or place a telephone call to some other person or office to get it. This may, at first appear to be a trivial case, but it occurs at a high frequency in most office environments. For the Naval aircraft squadron and wing this is especially true. There are few departments in a Naval aircraft squadron or wing that can perform their duties without accessing data from other departments or units. Having a network link to both the personnel in those units and to their databases would increase the productivity in all of these units.

4. **INTANGIBLE BENEFITS**

There is another benefit to having LANs in these units and this is that there is an increase in the quality of the product produced when this type of technology is placed in the office. This better product provides more job satisfaction which in turn will increase morale and provide higher productivity in the office.(Sassone,1984)

LANs also make it possible to make group decision support systems (GDSS) available to managers which can improve their decisions and make them more efficient and more productive. Administrative personnel will be better able to complete their jobs and will be able to provide better

customer service to the various departments that they serve. (Sassone, 1984)

5. VALUE ADDED SAVINGS

This category of benefit is largely lost in the military setting as there is no profit drive. There is some value added benefit as LANs provide greater output at lower cost (in terms of both manpower and resources) and there can be a higher level of quality for the same amount of work.

B. SUMMARY

Office Automation does provide increased productivity in the work place. The latest phase of Office Automation is the LAN. It turns stand alone personal computers into a cooperative processing system for the entire department and the entire unit. LANs can even connect the user with other related units at a single base or through other networks to units across the country and world. This technology can provide immediate access to locally held data or data at remote sites, providing the user with the capability to improve the quality of their work and to complete that work more quickly and with fewer errors. The LAN is an essential part of the workplace of today and tomorrow.

IV. ALTERNATIVES TO LAN'S

Naval aviation squadrons and their wings currently have ten desktop computers and up to four laptop computers at their disposal. Each of these computers represents an opportunity to increase productivity of the administrative personnel at the respective unit that it serves. Networking these computers into squadron LANs and then joining each of the squadron LANs together into a larger wing LAN would greatly improve the opportunity for increased productivity. What other alternatives exist besides forming LANs with these computers?

A. MAINTAINING THE STATUS QUO

The first alternative to networking desktop computers at Naval aircraft squadrons and wings is to simply do nothing. The money not spent on LAN hardware and software could be directed toward other projects that currently have insufficient funding. The money could also be used to upgrade all of the computers. By using the Navy Standard Desktop Companion contract the existing Zentith 248 desktops could be upgraded to 80386 CPU based computers, with 4 Megabytes of RAM, from the current 80286 CPU, with 1 Megabyte of RAM. With this upgrade the computers could be switched to a Graphical User Interface such as Microsoft's Windows 3.0 or IBM's OS/2.

The upgraded computers would be a great improvement in any case. These upgrades would move the squadrons desktop computers back into fold with the latest advancements in micro-computer technology and most likely make them functional for the remainder of the decade.

The problem with maintaining the status quo is that the current status quo at these units is already two generations removed from current "state of the art" systems. To make no attempt to upgrade or update the computer systems at these units in 1992 will mean that they will continue to have the only the capability of the computers built in the mid 1980's. The standards for correspondance and other processed data are continuing to advance while the capability of the computer systems at these units is fixed. As the defense drawdown continues the Navy will be forced to do more with less. The Navy's aircraft squadrons and wings not be able to overcome the technology gap that will have opened between them and the then current status quo. It is then essential that the Navy continue to modernize its office workplaces and it is vital that they do not merely maintain the status quo.

B. PRIVATE BRANCH EXCHANGE

There are two other network options that are currently available in the marketplace today. The first of these is the Private Branch Exchange (PBX). Plainly put a PBX is a private telephone system. A PBX system can integrate voice and data

and is a very economical way to connect micro-computers together without having to install a LAN. Unfortunately the PBX switches themselves are extremely expensive so if they are not already present at a site it would be cost prohibitive to buy a PBX system solely to gain the LAN features. For companies that own their own PBX this alternative is less expensive than a LAN and it provides integrated voice and data capability all in one package. The Navy at one time had its own PBX systems at many bases, but today these systems have been replaced by modern digital phones and the switching technology is back in the hands of the phone companies.

C. CO-LANs

The second of the LAN alternatives is the Central Office LAN (CO-LAN). This differs from the traditional Customer Premise Equipment LAN (CPE-LAN). The CO-LAN is not a LAN in the usual sense, rather it is a switch that is located at the phone company and conventional desktop computers and phone equipment at the LAN site. Traditional phone lines or twisted pair wire are used to connect phones, computers, faxes and any other office equipment that can transfer voice or data from one point to another.

The primary advantage to a CO-LAN is that it uses existing phone lines and phone company equipment so costs are minimal. The end user pays only the rent on required equipment and phone wires and has no other hardware costs. The phone

company can add additional capacity or lines as needed with a minimum of inconvenience. Adding additional computers is as simple as adding more phones.

The primary disadvantage is lack of control over the hardware. It is impossible to ensure that such a system is secure from tampering or unauthorized access. These two points alone are enough to rule out CO-LANs for use in most Naval units and certainly for all operational aircraft squadrons and wings.

D. SUMMARY

There are alternatives to networking the desktop computers of Naval aircraft squadrons and wings, but in reality the only sensible course for the Navy is to implement networks and the Navy is doing just that at many levels of its organizational structure. It is time for the basic operational units of the Navy's airforce to move forward to todays computer technology, it is time to network at the Navy's aircraft squadrons and wings. To fail to modernize the squadron and wing office place will cause the Navy's frontline fighting units to become overburdened with manual data and word processing tasks that could have been automated with the installation of a LAN.

V. POTENTIAL LAN TECHNOLOGIES

A. TOPOLOGIES AND MEDIUM ACCESS PROTOCOLS

There are two major types of physical topologies for LANs. The first is the bus. It consists of a linear transmission medium with a number of computer nodes connected directly to the medium. The bus topology (see Figure 4, Appendix B) is often referred to as an Ethernet LAN after the most common type of bus standard which was developed by Xerox. (Davis,1984) The bus topology can make use of several types of transmission media; they are twisted pair (normal telephone wire), coaxial cable (either baseband or broadband), or optical fiber. Wireless technology also is available for this topology.

The ring is the second topology available for LANs (see Figure 5, Appendix B). It is comprised of a set of repeaters joined by links in a closed loop. Each node in the network is attached at a repeater. Ring topologies always use a token passing methodology for transmitting data from node to node so they are often called "token rings". The ring topology can make use of twisted pair wire, coaxial cable (baseband only), or optical fiber.

There is one additional topology that is often referred to and that is the star topology (see Figure 6, Appendix B) which

is in fact either a logical bus or logical ring depending upon whether it is open or closed. There is no difference in the star, rather its physical layout looks like a star and so it has been differentiated from a bus or ring by its physical topology, even though it is logically either a bus or a ring network.

The difference between baseband and broadband discussed above is that with a baseband digital signaling is used, and the entire bandwidth of the cable is used to carry a single channel. The baseband signal will travel up to a few kilometers and is easier to install and maintain than the broadband signal. The baseband signal is bidirectional, meaning that it is sent in both directions from a given node out onto the network.

Broadband LANs use an analog signal, and its bandwidth can be split up into several channels, so that data, voice and video can be sent on the same cable medium. The signal will travel up to tens of kilometers, some ten times the distance of baseband, but it is more difficult to install and maintain than is baseband. The broadband signal travels in one direction on the network.

There are two major types of Medium Access Controls (MAC) for networks, and they are Carrier Sense Multiple Access/Collision Detection (CSMA/CD) and Token passing. The bus topology can use both of them while rings always use token

passing. There are advantages and disadvantages to both MAC's, some of these are as follows:

CSMA/CD Advantages:

- Effective for light traffic
- Provides better performance than token passing in small networks

CSMA/CD Disadvantages:

- No upper bound on the delay to accessing the medium
- Poor performance under traffic

Token Ring Advantages:

- The maximum delay to access medium can be determined
- Effective for heavy traffic or large number of nodes
- Has fault management devices to minimize down time

Token Ring Disadvantages:

- Less effective for small numbers of nodes
- Lost tokens can cause lengthy delays on the network

The bus and ring topologies have several protocol standards set for them by the Institute of Electrical and Electronic Engineers (IEEE). This group has committees which oversee the development and implementation of national

standards for LANs. The IEEE committee for LANs is 802. The 802 committee has developed standards for five CSMA/CD bus protocols (IEEE 802.3), Token bus protocols (IEEE 802.4), and Token ring protocols (IEEE 802.5). There is also one other protocol for token ring which is the American National Science Institute (ANSI) Fiber Digital Data Interchange (FDDI). FDDI is based on the token-passing protocol, but has some improvements in token control that are not available with the 802.5 token ring protocol.

The five 802.3 protocols for CSMA/CD LANs are broken down as follows:

PHYSICAL MEDIUM SPECIFICATIONS FOR IEEE 802.3 LANS

NAME	CABLE	BASE/BROAD	DATA RATE	MAX SEGMENT LENGTH
10BASE5	COAXIAL	BASEBAND	10 Mbps	500 M
10BASE2	COAXIAL	BASEBAND	10 Mbps	200 M
1BASE5	UTP	BASEBAND	1 Mbps	250 M
10BASE-T	UTP	BASEBAND	10 Mbps	100 M
10BROAD36	COAXIAL	BROADBAND	10 Mbps	3600 M

Abbreviations are as follows:

UTP - Unshielded Twisted Pair (telephone wire)

Mbps - Mega bits per second

M - Meters

The Token-bus has several physical medium options also, but they are not designed for the office environment. A more general list of the possible Token-bus physical mediums is given below:

PHYSICAL MEDIUM SPECIFICATIONS FOR IEEE 802.4 LANS

CABLE TYPE	SIGNAL TYPE	DATA RATES
COAXIAL	BROADBAND	1, 5, 10 Mbps
TWISTED PAIR	CARRIERBAND	1, 5, 10 Mbps
OPTICAL FIBER	DIGITAL	5, 10, 20 Mbps

Token-ring LANs use one of two token schemes: IEEE 802.5 standards, or ANSI FDDI standards. IEEE 802.5 Token-ring LANs use a physical medium of shielded twisted pair wire and have transmission capacities of either 1, 4 or 16 Mbps. ANSI FDDI uses optical fiber as its physical medium and has a transmission capacity of 100 Mbps. Shielded twisted pair wire is special telephone wire that has had shielding added to each of the wires within the bundle. This provides for less interference for the signal allowing for higher data rates.

B. CONSIDERATIONS FOR PORTABILITY

Portability as discussed in Chapter VI is essential to any squadron LAN. The decision about which LAN topology to use and which MAC and physical medium to use must be based upon where the squadron is homeported and where it will go (aboard an aircraft carrier or to forward deployment bases), and what type of LAN topology exists or will exist at these locations. Most aircraft carriers have some type of coaxial backbone running the length of the ship, and there are plans to put optical fiber backbones in carriers, the GEORGE WASHINGTON is being fitted with an optic fiber backbone. The choice of a MAC and physical medium should be based on what is currently in use at the squadrons homeport and aboard the carriers that the squadron deploys to. The problem of deploying to a carrier with a different LAN technology still exists and this problem can be solved with the use of a LAN bridge if the MAC's are homogeneous. If a squadron and an aircraft carrier had different MAC's then a protocol converter or gateway could be used.

The most important point here is to use common sense and have an overall plan and strategy based on what LAN technologies are being used at a particular Naval base or air station. Then the next step is to develop the squadron and wing LANs around the existing LAN being used at that site rather than deciding upon a totally different LAN that would require different technology and interfaces to link to the

existing networks, at that site and other local bases.

Ideally the squadron and wing nets will be connected to the Defense Data Network (DDN) rapidly after they are implemented so that world wide communications will be possible.

C. CONSIDERATIONS FOR COMPATIBILITY

The idea behind compatibility is closely related to the issue of portability, because to be portable a network must also be compatible with the environment it is to be portable to. The best way to ensure compatibility is to perform a thorough analysis of the existing networks that exist or are planned at a particular Naval base or air station and develop a strategy for implementation around the existing network and its topology. To this end, Ethernet is the most common network type in use today with as much as 75-80 percent of the market share, so in most cases one of the Ethernet topologies should be chosen.

A second compatibility issue is general hardware compatibility. The contracting bureaucracy that exists in the Navy means that there is often very little consideration about consistent purchases from a single hardware source. This in turn implies that there can be a serious problem with the compatibility of certain hardware items when they are purchased at different times and then placed together as will happen when a group of independent computers are networked.

To prevent hardware incompatibility from bringing a new LAN to a stand still, there must be careful examination of all the hardware components being used to ensure that there is not a compatibility problem with them. To that end there should be a specific reference to compatibility in any contract for hardware that will be used to network computers at squadrons or wings.

D. CONSIDERATIONS FOR FUTURE UPGRADES

Having the capacity to upgrade is a key element for a computer network. For computer technology that is not upgradeable is obsolete as soon as it is installed. Careful consideration of both available hardware and software technology must be made and only the technologies that offer the best guarantee of future upgradability should considered for use in the implementation of the squadron and wing LANs.

The Zenith 248 computers, now in use at all of the squadrons and wings under the control of COMNAVAIRPAC, have a host of upgrade options available for them under the Navy's Standard Desktop Computer Companion contract. This is essential to keep these computers from becoming more of a hindrance than a help in increasing productivity in the work place of the squadrons and wings under the control of COMNAVAIRPAC. The need for upgrade options will be even more important if there is a host of squadron and wing networks

from coast to coast; each with its own specific hardware and software mix.

E. CONSIDERATIONS FOR SECURITY

Security to a business is fundamentally different than the security required by military units. The National Security Agency (NSA) is responsible for determining security standards for DOD and the federal government agencies. There currently are several product developers who are attempting to gain approval from the NSA for trusted network products and for other related secure applications. The first question that must be addressed is, is there a need for a trusted network at a squadron or wing and if so what level of trust would be required? The full discussion of trusted networks is beyond the scope of this thesis.

The issue of security does not go away even if the decision is made so that a squadron LAN will not handle classified data. There are still a broad range of functions that are performed on desktops that are at least of a sensitive nature if not classified and they must be protected. This requires the LAN to be rated at least class C2. (DOD Computer Security Center, 1985) There are many excellent software and hardware products that will provide the C2 level of protection.

As for the physical security, network administrators must work to ensure that data placed on and in networks at

squadrons and wings remains secure and inaccessible by those who are unauthorized. A range of methods exist from physical keys on computers to multi-level password protection and removable media hard drives that can be locked in safes when not in use. All of these methods should be used when and where appropriate and according to the standards and policies set forth by DOD standard 5200.28-std.

F. CONSIDERATIONS ABOUT COST

The cost of hardware and software is an essential part of the decision to network computers. The savings in buying LAN versions of software can offset much of the hardware costs of a LAN if care is taken in planning the purchase of hardware. As the first section of this chapter detailed there are at least ten major classes of LAN technology that can be selected and the overall hardware cost of each is different. The 10BASE-T Ethernet LAN which uses simple telephone wire is the most affordable LAN, but has some disadvantages due to limited segment length between nodes. It also suffers from potential interference from outside radio frequency usage. This could be critical at Navy squadrons and wings where there is extensive use of the RF spectrum. The ANSI FDDI optic fiber LAN technology is the most expensive LAN technology and it is also the newest. It offers extremely high reliability and the highest throughput available for LANs. In between are the coaxial and shielded twisted pair (STP) LANs.

G. SUMMARY

The final choice of a technology should be made by weighing each of the concerns discussed in this chapter and reviewing the needs of the local squadron and wings. Then there must be an examination of the local LAN standards being used at the homeports or bases of the units in question. Next the aircraft carriers that the squadrons deploy to must be examined to review what LAN technology is in use or is planned for on these ships. After gathering all of this data a planning board should formed to meet with all of the interested units and final decisions should be made.

VI. LAN PORTABILITY ISSUES

There is more than one set of valid criteria for deciding what type of LAN to install at a given location, but for the Navy's aircraft squadrons there is one that is more important than all the rest. This is the need for the LAN to be portable to either an aircraft carrier or to a forward operating base. Installation of a LAN at a squadron's hangar would be of limited use if it was not capable of being moved with the squadron when it deployed.

A. PORTABILITY TO THE CARRIER

This issue at first seems daunting, how can a conventionally cabled LAN be made portable? After all each node of a LAN is connected to the others by a cable or cables and these cables are usually run through walls or conduits throughout the office spaces. The solution is actually a very simple one and it requires that two cable backbones be laid for the squadron. The first of these is in the squadron's hangar and the second is aboard the aircraft carrier that the squadron deploys to. All aircraft carriers either have a coaxial cable backbone loop, that runs the length of the ship, or are going to have such a backbone installed in the coming years. There is one additional problem and that is that squadrons don't always deploy to one aircraft carrier and even

when they do they often won't be given the same ships spaces. How then can a second set of cables be laid on the ship for the squadron when it is deployed on the aircraft carrier? There is no simple solution to this problem, but the best way to solve it is to just run cables off of the ships main network backbone into the spaces that are usually given to squadrons and let which ever squadron is occupying those spaces use those cables for their LAN. This would provide another advantage and that is that in connecting each squadron to the ships network backbone, the entire airwing would be connected into a larger network structure. There would actually be several layers of LANs all connected together through the ships backbone network so that the entire ship would be connected by networked micro-computers.

B. PORTABILITY TO FORWARD DEPLOYMENT SITES

The issue of portability for land based squadrons is similar to that of the aircraft carrier based squadrons, but with the deployment site being another hangar at an air base outside of the continental United States, and often on foreign soil. This forward base is usually an American outpost or a complete air station or base and can be considered a long term site for future deployments in almost every case. This implies that the solution to the portability issue is a similar one and that is to wire the office spaces of these forward sites for use by what squadron is occupying them.

Security is much more of a problem for these forward sites and extra care in securing the cabling should be taken to ensure that the LAN is secure whenever connected to the cable backbone at these sites.

C. PORTABLE COMPUTERS: LAPTOPS, NOTEBOOKS AND WIRELESS LANS

Wireless LAN technology does offer some alternative solutions to the traditional cable backbone LAN, but this technology is not yet mature enough for the Navy's aircraft squadrons. There will need to be a great deal of testing of this technology on aircraft carriers and around Naval air stations prior to their being accepted as an alternative to traditional wired LANs. The difficulty of ensuring security with this type of LAN will pose a serious problem if it is ever to be utilized in the squadron setting. When this technology has matured and its security problems are better understood it may provide the added flexibility of having laptop computers constantly connected to the LAN, so that personnel can be mobile throughout a squadrons spaces or even an air station and still be able to communicate with the squadron via the LAN.

Laptops are the one micro-computer technology that the Navy has rapidly embraced and they are already in use at squadrons and wings. The light weight and compact computers give the user the flexibility to take their wherever they go and the ability to keep their primary desktop management tool

with them at all times. The importance of having the ability to keep reference data and statistics at your finger tips for use wherever and whenever you need them cannot be over emphasized. In the near future wireless LAN technology will allow squadrons and wings to connect their laptops to the squadron or wing LAN.

Notebook computers are just a more compact and lighter laptop. They offer greater convenience as they fit into a briefcase or can be taken in hand from meeting to meeting with little bother. The brains of these computers is the same as in the more conventional desktop micro-computer, but less open to upgrading and with fewer options. The price of both laptops and notebooks is approximately 50 to 100 percent of a comparable desktop and this is due largely to the price of miniaturization of the components and the box that they are mounted in.

VII. SOFTWARE APPLICATIONS

The most important part of any computer system is its software, because if the right mix of software is not available to the user then the computer system won't get used. This is true regardless of whether the hardware system is a mainframe, mini-computer or desktop, stand alone or networked. Squadrons and wings have a specific set of software needs and it is essential to ensure that the right software applications are made available on a LAN system if it is to be a success.

A. NETWORK OPERATING SYSTEMS

The Network Operating System (NOS) is the heart of a LAN, it provides security and user access, data integrity, it defines management of the network and its configuration, it supports the operating system and all other applications, communications hardware and protocols, as well performing a host of other tasks that are vital to the operation of a LAN. The NOS study performed by COMNAVAIRPAC is an essential piece of work that will provide a wing and its squadrons with the information they need to select the best NOS for their network.

B. WORD PROCESSORS

The most often used applications on any desktop computer is its word processor. Selection of a word processor today is extremely difficult because there are so many excellent word processors to choose from. The first decision that has to be made is whether the word processor is going to be text or graphically based. Text based word processors are the traditional type that have been around from the beginning of desktop computing.

Graphically based word processors are a new type of application that presents what you are typing graphically as you would see it on the actual document page. This is called What You See Is What You Get (WYSIWYG) pronounced "wizywig" and it gives the drafter of a document a great deal of freedom in his or her creativity. This is so because the person writing the document can actually see what the final product will look like as it is created. Minor changes can be made rapidly on the screen instead of by continuously printing copy after copy of a document until it looks right. This manner of document creation has greatly changed the way in which people think about word processing. Today it is possible to produce printer quality graphics and text all in one document and all at one desktop computer.

Graphically based applications require significantly more RAM and faster computer processors than do standard text based applications so the choice over these two types of word

processors can be made only if sufficient RAM and processor speed exists in the computer that it is to be used on. The Zenith 248 computers with their 80286 based processor and 1Mb of RAM do not meet the minimum criteria required to use graphically based applications, so at this time the only type of word processors that should be considered are those that are text based. It is important to state that the Navy Standard Desktop Companion contract does have an upgrade card that would give the Zenith 248 computers the required processor speed and RAM to run the graphically based applications. If a decision is ever made that graphically based applications are the appropriate choice, then the upgrade cards will also have to be purchased. The most important issue, after deciding upon text or graphics based is to select a specific product. Currently there are at least a half dozen excellent text based word processors on the market. The market share leader is Wordperfect from Wordperfect Corporation, it is a full feature application that supports virtually every printer and has so many features to assist the writer in producing a high quality document that it would be impossible to discuss them all here. Several other companies also have excellent full function text based word processors.

C. DATABASE MANAGERS (DBMS)

The database application is one that can make a real difference in the productivity of an organization. This is true because today's relational database products allow the untrained user to create very powerful and functional databases that are tailored exactly to the needs of the user. By using a relational structure it is possible to link together several related, but separate databases. In doing this the user can create new relations or draw out new information about the nature of the data in the different relations. This allows the user to control and have instant access to much more information about the same data than was possible with separate flat file systems. In Naval aircraft squadron and wing settings this type of application can greatly increase the readiness of the unit by providing a much more thorough understanding of the relations between the personnel and their training, and the aircraft that they train on and in. It can also provide these units with better information on maintenance trends and problems.

Selection of a DataBase Management System (DBMS) is critical, because there are so many products and their complexity and functionality vary according to size and number of files or records that the database would contain. There are even database server applications that can control many of the functions of the network operating system. Selection is also difficult, there being so many high quality products on

the market. The best way to decide on a DBMS is to look at the organization, its size and scope and how its relates to other related organizations and then try and match these needs to the product that can deliver them and continue to deliver them in the future.

D. SPREADSHEETS

The electronic spreadsheet is one application that is much more useful than many people realize. From computing flight hours on a daily to monthly basis to forecasting and tracking budget expenditures, these applications can offer a wide range of functions that are not available with other programs. There is a tendency, once comfortable with a spreadsheet program to use it for things that it should not be used for such as for developing database system applications. This happens because spreadsheets are so easy to use once the learning curve is surpassed that people tend to rely on them for too much. A good way to avoid this is to purchase integrated applications, those applications that are produced by one company, that cover a range of areas, such as DBMS and spreadsheets. Borland corporation makes Paradox, a relational DBMS and Quattro Pro a spreadsheet and the two products can share data that is created by either. Enable/OA is another integrated product that provides the user with a word processor, spreadsheet and database as well as other Office Automation applications.

E. ELECTRONIC MAIL

Perhaps the greatest advantage that a LAN provides over stand alone desktop computers is a capacity to send and receive Electronic-mail (E-mail). This service gives each user the capability to talk with every other user individually or in groups of the senders discretion. The time savings provided by E-mail alone can often make a LAN a worthwhile proposition. Imagine being able to talk with any person in an organization or group of organizations linked by a network. Of course the telephone does this too, but the LAN does it so much better because the user can compose his or her thoughts completely, then send the whole idea to that person or group. The receiver of E-mail will receive it immediately if at their computer or as soon as he or she returns to it. This is something that cannot be reproduced by the telephone. Communications between a squadron and the wing is extremely cumbersome because they usually are not located closely together so trying to talk to someone in one location about a hot issue can be very frustrating. "Phone tag" often occurs as one person searches out the location of another only to find that they just left the office for lunch or another meeting. With a network and E-mail all that is required is the time to write one note and then to send it to the desired recipient, as soon as then recipient is available they will read the note and respond accordingly by E-mail or phone.

F. PROJECT AND PERSONNEL MANAGERS

Project and personnel management is perhaps the most difficult part of any managers job. The development of software applications that can assist the manager in proper utilization of his or her personnel can often save an organization in terms of meeting goals. These programs offer various statistical methods to plan projects, like PERT/CPM and networking algorithms, linear programming and queuing analysis to better understand a project or personnel problem. These types of software applications are newer than wordprocessors and spreadsheets so many managers do not know how useful they are.

G. SUMMARY

This chapter has covered many of the major software applications that are needed to make desktop computers, and especially networked computers, more productive. The important idea here is much like that of selecting the most appropriate LAN topology, There must be a cohesive plan in selecting software products, simply picking one of each type off of a contract list won't provide as much productivity as could be provided if some time is taken initially to think about the specific needs of a given group of units and trying to match those needs to a specific product offering. It is very important to select a single product from each class of

application and make it the standard for the LAN and if possible for the entire Navy as well.

VIII. COST BENEFIT EVALUATION OF A LAN VERSUS EXISTING STAND ALONE MICRO COMPUTERS

The use of cost-benefit analysis is usually a quantitative and scientific approach to evaluating the cost of one alternative set of goods or services over another. To properly perform this type of analysis for this set of alternatives requires that a body of analysts spend several weeks or months at a unit that currently has the stand alone micro computers. During this time the analysts would conduct interviews with the personnel at the unit and observe their working habits. After they had sufficient data the LAN would then be installed and after an appropriate training period the analysts would return and repeat their study to measure what if any productivity changes had occurred. Then after collecting the second set of data they could then compare the two sets of data to see if there had in fact been any changes in the work habits of the personnel. This type of research generally takes many months and is expensive. For these reasons it would not be feasible for this thesis. The next best way to use cost benefit analysis is to review literature to see if any other studies have been done on similar units to measure similar types of work changes due to changes in the office hardware. There have been studies of this nature and the conclusions about potential productivity gains from office automation are used as evidence of true cost benefit for the

implementation of LANs at Naval aircraft squadrons and wings.

There are some assumptions which should be made when using these studies due to the shift in office automation technology that was evaluated in the cited study. (Urban,1986)

A. ASSUMPTIONS

1. The cited study evaluates the change from an unknown state of office automation to one that closely approximates a LAN.

2. The elements of the office automation system of the cited study are very similar to those offered by a LAN.

3. The squadrons and wings discussed in this thesis would be upgrading from one level of office automation to the next higher level, therefore all of the productivity gains seen in the cited study may not be applicable.

B. BENEFITS

The identification and evaluation of benefits of Office Automation technology, which any desktop or networked computer is, is a difficult task. It is even more difficult to differentiate benefits of stand alone computers from benefits of networked computers. To avoid confusion between benefits gained by just having the desktop computer from the added benefits of having it connected to a network the following assumptions are made:

1. Stand alone desktop computers have provided an increase in office productivity, but the benefits discussed in this thesis deal with either additional increases to the existing benefits of stand alone computer or new increases that were not seen with stand alone computers.

2. Networked computers require administration and control by central authority which will optimize planning and utilization of the network and its computer assets.

3. Each wing and its squadrons will have their individual LANs interconnected by a common backbone to create a larger wing-wide network (wing-net).

4. Each wing/squadron wing-net will have connections to the DDN to provide worldwide communications capability.

5. Administration and control of the squadron networks and the larger wing-wide network will be performed by wing personnel with individual squadron assistance.

The benefits that can be seen by implementation of a squadron or wing LAN are:

- A reduction of the administrative workload for technical and administrative personnel.
- Storage for large quantities of data and information.
- A reduction of the space required to store data and information.
- Reduction of administrative costs.
- A reduction in the size and number of meetings.
- A reduction of the overall labor cost for a given amount of work.
- An increase in the communications capability of managers at the given unit.
- More effective and timely communications between personnel and between units. (Urban,1986)

Quantifying the actual value of these benefits in monetary terms would be extremely difficult. To properly quantify the value of these benefits would require an in depth study of work habits before and after implementation of the proposed

LAN systems, as discussed above. This is not possible for this thesis. There is evidence that modern office technology can provide these benefits (see Urban, 1986). Urban provides concrete evidence of the potential value of these benefits as they relate to office automation (OA) systems. A LAN is very much an office automation system in the functions and capability that can be provided by it. Use of the findings of this thesis are reasonable in that the essential capabilities of the OA system discussed in Urban's thesis and those of a LAN are practically identical. The Figures 1,2,3 in Appendix A illustrate the potential hours saved by automation technology for managers/administrators, technical/technical administrators and for support personnel. The actual breakdown of personnel types realizing these saved hours would vary by squadron and or wing.

C. SUMMARY

The overall benefit of a LAN system can only be truly realized after it is in place. The next best way to evaluate the cost benefit of such a change is to review literature on the subject. One such study has been cited to illustrate the tremendous potential for productivity increase at units of the same basic type as those considered in this thesis.

IX. A PLAN FOR LAN IMPLEMENTATION

The task of implementing one LAN requires careful planning and execution to ensure success. To plan for the implementation of over two hundred fifty individual LANs requires much more than just precise planning and execution.

The first step in developing a plan is to formulate a long range strategy for the entire project and then to seek out funding for it. Each LAN should cost between ten and twenty thousand dollars, so individually they don't represent a large capital outlay. When the larger goal of placing a LAN in every Naval aviation squadron and wing is considered the total capital outlay is between two and a half and five million dollars. This amount is significant and will need to be appropriated over several fiscal years. The appropriation process is complex and unpredictable. To counter this the plan for squadron and wing LAN implementation must include alternate plans for contingencies such as losing funding in a given year or reduction of funding dollars for all or part of the project. The success of the plan will depend largely upon the depth of planning for contingencies such as those mentioned above. There are several steps in this process; the following list of steps is provided to show a logical sequence of events and each step will be further broken down and discussed.

- Develop a clear set of goals
- Form the project team and organizing the effort
- Determine the order of implementation
- Determine when and how to link the LANs together
- Develop plans for administering and maintaining the LANS

A. DEVELOPING A CLEAR SET OF GOALS

The implementation of such a large project requires in depth planning. The first step in the plan is to establish clearly stated goals and then to develop a strategy to meet them. The goals should be clearly stated and understandable so that there will not be any misunderstanding about what the intent of the goals are. The primary goal of this plan is to implement LANs in every aircraft squadron and wing in the Navy by 1995. The secondary goals of this plan are to network the squadron LANs to their respective wings' LAN so that the entire wing will be able to communicate to each other, then to connect these wing LANs to the Defense Data Network (DDN) for world wide communications capability.

The size of this LAN project is so large that it will necessarily take several years to fully implement. The plan for such a large task must be one that is thought out carefully and implemented as quickly as possible. To take time during the implementation to consider elements that should have been thought out during the planning stage could cause a snowball effect over the entire project which could

drag the project out and dilute its effectiveness or even cause it to fail.

For these reasons the first steps toward installing networks in the Navy's aircraft squadrons and wings must be a deliberate and in depth planning effort. This planning effort should review every detail in the implementation process and makes precise decisions about direction and control of the project.

The Navy has approximately four hundred aircraft squadrons and wings roughly divided into two separate commands by geographical location. Those located on the Pacific Ocean are under the operational control of COMNAVAIRPAC while those units on the Atlantic Ocean are under the control of CONNAVAIRLANT. These two majors commands should be the central control point for the LAN implementation project.

B. FORMING PROJECT TEAMS AND ORGANIZING THE EFFORT

The next step in organizing the plan for LAN implementation is to communicate the intent of the project to all of the units involved and then search out personnel that want to act as local representatives for planning purposes. Support from every squadron and wing is extremely important for the overall success of the project. The first units to receive the new LAN technology should be selected, at least in part, by the level of support that is shown for the new LAN technology. Members of the planning team should visit every

base that has units that will receive the LANs and hold a meeting or forum to discuss the current plans. This will provide direct feedback to the end users. By reviewing the response to the plans discussed at these meetings the planning team can determine if the current plans will meet the needs of the users at the given location. If the plans are flawed this process of open discussion with the squadron and wing representatives will have an excellent chance of uncovering the flaws and thereby providing an opportunity to repair them.

The structure of the teams that will work on this project should be as follows:

- A central control team at each Naval Air command (These are COMNAVAIRPAC and COMNAVAIRLANT).
- Each functional wing should maintain a team of personnel that will plan for the local LANs implemented at the squadrons under their direct control.
- Each squadron should maintain a team of personnel that will plan for their squadrons LAN implementation.
- A central advisory group made up of the members of the central control teams, and a representative from each wing.
- A local advisory group made up of the local wing team and a representative from each squadron.

The central control teams will be responsible for tracking funding for the project and then allocating those funds out to the wings as is needed to meet the implementation plan. They

should be personnel assigned to the Force Information Systems department of the NAVAIR unit.

The wing teams will track the funding coming down from the NAVAIR units and then further allocate it to individual squadrons LANs as it is required to meet the implementation plan. They will review and update their implementation plan as needed to reflect the current level of funding made available by NAVAIR.

The squadron personnel assigned to oversee LAN implementation will ensure that the installation process proceeds on schedule and that any problems encountered are resolved immediately. The advisory groups will act as the primary means to pass the implementation plan down the chain of command so that each level involved in the plan will have a clear understanding of who, what, when, where and how the LANs will be installed at each unit. It is at these advisory group meetings that conflicts or problems will be discovered and worked out to ensure that the entire project will proceed smoothly and without serious problems. The local advisory groups will handle similar problems or conflicts as they occur at the local level. It will be important to keep track of all problems and conflicts that occur locally and report them to the central advisory group so that the knowledge learned can be shared to all other wings.

C. DETERMINING THE ORDER OF IMPLEMENTATION

There are two ways in which to start implementation. The first of these is to divide the funds for this project equally among each of the wings. Under this basic plan each of the five major wings would receive about twenty percent of the yearly funding for LAN implementation and would base its current year plan for implementation upon that amount. The second way to divide the funds is to provide certain wings with a larger portion of the yearly funding for one or more years and then shift the extra funding to other wings in following years until all squadrons and wings had been able to install their LANs. This method is a concentrated effort approach and would allow for all of the units at a given location to receive their LAN over a relatively short period of time. It would mean that most of the LAN installation would occur at one site and consequently most of the problems and conflicts would occur at one site rather than being spread out among the five wings. This could be an advantage or a disadvantage depending upon what types of problems occur. If a major problem is found at a given site and implementation must be halted then the entire project could be interrupted. If the funding was spread out equally then each wing would have the ability to proceed with a portion of their plan each year. If a major problem arises at one site only that site would be effected the remaining sites would still be able to

proceed and could siphon off some of the unused funding from the wing that was experiencing the problem.

Dividing the funding equally among the wings is the best plan for a project of this size. The division of funds should be made on the basis of the number of LANs that will be implemented at a given wings site. An example of this method is as follows: If one wing had twenty squadrons under its control while another wing had ten squadrons then the first wing would receive twice the funding of the latter for any given year. In this manner each wing would receive an equally proportionate amount of the funding based upon the number of LANs it has to implement.

The next issue is how should the wings decide which squadron is to receive their LAN first? The best way to proceed with this issue is to first decide how many squadron LANs can be funded this year, then proceed with an examination of needs of the squadrons. Funding is distributed by quarter so the total number of LANs that can be implemented for the year should be divided by four to determine a quarterly number. This value should then be used to select an appropriate number of squadrons for each quarter. Selection of squadrons will undoubtably have some politics involved, but common sense must not be ignored either. Selecting units that are going to be deployed during the implementation period would be absurd. It would also be foolish to select squadrons that are likely to be stood down in the near future, or

squadrons that may be moving or having major construction done on their building. Squadrons that are selected should be available during the implementation phase as well as for training classes, that should follow the installation of the LAN. Personnel should receive information and training classes on the new LAN and its capabilities as soon as possible after receiving the new equipment.

D. DETERMINING WHEN AND HOW TO LINK THE LANs TOGETHER

This issue is far easier than the issue of which units should receive the LANs when. It is more a decision of funding than planning. The first and most important step is to install LANs in every squadron and wing. Once this step has been accomplished the LANs can be connected together by either connecting each of them to existing LAN backbones that run throughout most bases, or running independent cabling from squadron to squadron and interconnecting them in this manner. If a LAN backbone does not exist at a given base then running cable between the squadrons and wing is the least costly way to interconnect all of the squadrons to each other and their wing. Planning for this phase is important as the funding requirement for a completely independent Wing-LAN will be much greater than tapping into an existing base-wide LAN backbone.

The final phase of the LAN implementation will be interconnection of the Wing-nets with DDN. The only decision that must really be made for this phase is when to connect the

LANs to DDN. Should each LAN be connected individually or should they be connected only after all squadrons and their wing have had their LANs installed? There is no right way to answer this question, and it may be that for some wings and or squadrons connection to DDN can and should be made at the time of installation of the LAN itself. For other units waiting until they are comfortable with the new capabilities of their own LAN is the best answer to this question.

E. DEVELOP PLANS FOR ADMINISTERING AND MAINTAINING THE LANs

Proper administration of a LAN is a truely difficult task and requires a unique mix of talents. Finding and training LAN administrators for all of the newly installed LANs will be the most difficult part of successfully implementing this project. Lack of properly trained and or experienced administrators can cause this project to fail. There is only one way to ensure that there will be sufficiently experienced personnel available to administer all of these newly created LANs, which is to hire contracted personnel to handle the LAN administration. This should be necessary for at least the first year of operation for the LANs and may need to continue for one or two more years depending upon how quickly the Navy can train appropriate numbers of its personnel to be LAN adminstrators.

The most important task that the administrators will face is maintenance of the LAN's hardware and software.

Maintenance is the most crucial part of keeping a LAN operating. The best way to ensure that there are sufficient trained personnel available to perform the maintenance is to contract for this service. The same problems arise as with finding administrators, and that is there just are not enough Navy personnel with the right mix of skills and experience to be responsible for so many LANs. The contract for maintenance personnel will need to extend for at least two years. Once the squadron and wing personnel have become accustomed to the LAN and how it should be administered and maintained there should be an effort to provide training for appropriately rated personnel to take over these tasks from the contractors.

F. FINAL CONSIDERATIONS

Developing a plan to install several hundred LANs requires alot of careful thought. There are several steps that must be taken to ensure that the plan has a good chance of success. These steps are repeated below along with the key elements that are involved with performing each step.

- Developing a clear set of goals
    1. Install a LAN in every squadron and wing by 1995.
    2. Interconnect squadron LANs with their respective wings' LAN to create a larger Wing-Net.
    3. Connect the LANs to the DDN.

- Form project teams and organize the effort

    1. Establish a control team at COMNAVAIRPAC and COMNAVARLANT.
    2. Establish a local control team at each wing.
    3. Establish squadron LAN team members.
    4. Establish a central advisory group comprised of personnel from the central and local control teams to meet and discuss the plans for LAN implementation.
    5. Establish a local advisory group comprised of personnel from local squadrons and wing to discuss the plans for local LAN implementation.

- Determine the order of implementation

    1. Establish a division of available funds by wing.
    2. Determine how many LANs can be installed per quarter based on the established funding level for each wing for the entire fiscal year.
    3. Determine which squadrons under each wing should be selected to receive a LAN by quarter for the entire fiscal year.

- Determine when and how to link the LANs together

    1. Establish on a wing by wing basis whether connecting individual LANs to the DDN is preferable to connecting them only via their Wing-Net link.
    2. Establish a timetable for DDN connection for each wing and its squadrons.

- Develop a plan to administer and maintain the LANs

    1. Determine the number of LAN administrators that will be required for the given fiscal year and contract for this service on a yearly basis.

2. Determine the number of LAN maintenance personnel required for the given fiscal year and contract for this service on a yearly basis.

3. Develop a training syllabus for LAN administrators and maintenance personnel and implement the training courses to provide Navy personnel with the skills required to perform these contracted services.

4. Develop a plan for phasing out the contracted personnel for Navy personnel based on syllabus training capaciies at each local wing.

X. RECOMMENDATIONS AND CONCLUSIONS

A. SUMMARY OF FINDINGS

The decision to embark on a specific course of action or towards a single goal is often a difficult one. The risk of failure often makes even the strongest of leaders second guess decisions that they know are correct.

The Navy sits at a cross road that leads either to continuing productivity and operational readiness or to continuing obsolescence and decreasing operational effectiveness. The correct road to take is clear, it is a road that calls for upgrading stand alone desktop computers to ones that are networked. It is the road that calls for precise planning of coordinated implementation of LANs throughout the operational units of the Navy. Naval aircraft squadrons and wings are the backbone of the Navy's ability to project power. The installation of LANs at these units and the aircraft carriers that they deploy to can provide them with a vital boost in administrative productivity.

Selection of LAN technologies should be done on a unit by unit basis. The decision to install a particular LAN technology at a particular unit should be made only after examining the units location, its computer usage, and its needs for portability to either a ship or to other bases.

The emphasis of the selection criteria used should be to provide maximum compatibility, upgradablilty, security, and portability. There must be a central control group that monitors overall progress with LAN selection and installation. The formation of advisory groups at both the wing and NAVAIRPAC/NAVAIRLANT level will ensure that there is a minimum of problems with selection of LAN technologies that are suitable for a given unit.

B. DIRECTIONS FOR FUTURE RESEARCH

The analysis of squadrons and wings prior to and after the installation of a LAN would provide a unique opportunity to perform a scientific analysis of the issue of cost benefits of LANs. It could also help to discover whether the potential productivity gains seen in other studies is also present at Naval aircraft squadrons and wings.

The issue of security of classified data and other sensitive information stored in computers will continue to be a problem for Navy units. There is a need for a thorough analysis of the need for security in LANs at Naval units. The problem of deciding what level of trust to establish for a LAN will not go away as long as there is any security threat. The desire to make a LAN both user friendly and accessible to other units will always cause a conflict with the need for security.

C. FINAL REMARKS

The change from stand alone desk top computers to networked computers is the trend of the 1990's and the Navy must carry out this conversion whenever and wherever ever it can. The aircraft squadron and wing are especially in need of the productivity gains promised by such an upgrade in office technology.

Selection of one LAN technology over another should not be the focus of debate by Navy personnel. They should instead concentrate on developing a cohesive network of LANs from Navy squadrons and wings up to COMNAVAIRPAC itself. The greater the penetration of the computer network into the Navy's workplace the better and smarter the Navy will work. In fact it may prove to be an advantage to have a robust diversity of network technology around the world so that each type of technology can be used and developed for and by the Navy. As the Navy and its personnel become more familiar with the advantages and disadvantages of the various LAN technologies it will be better able to select from them in the future.

APPENDIX A

"Projection of potential savings through the incorporation of office automation equipment at Naval Weapons Center China Lake, California

Figure 1, Figure 2, and Figure 3 are graphic illustrations of estimates made by the Maddox Group to illustrate the opportunities to automate various office functions at NWC China Lake (Maddox,1981)." (Urban, 1986)

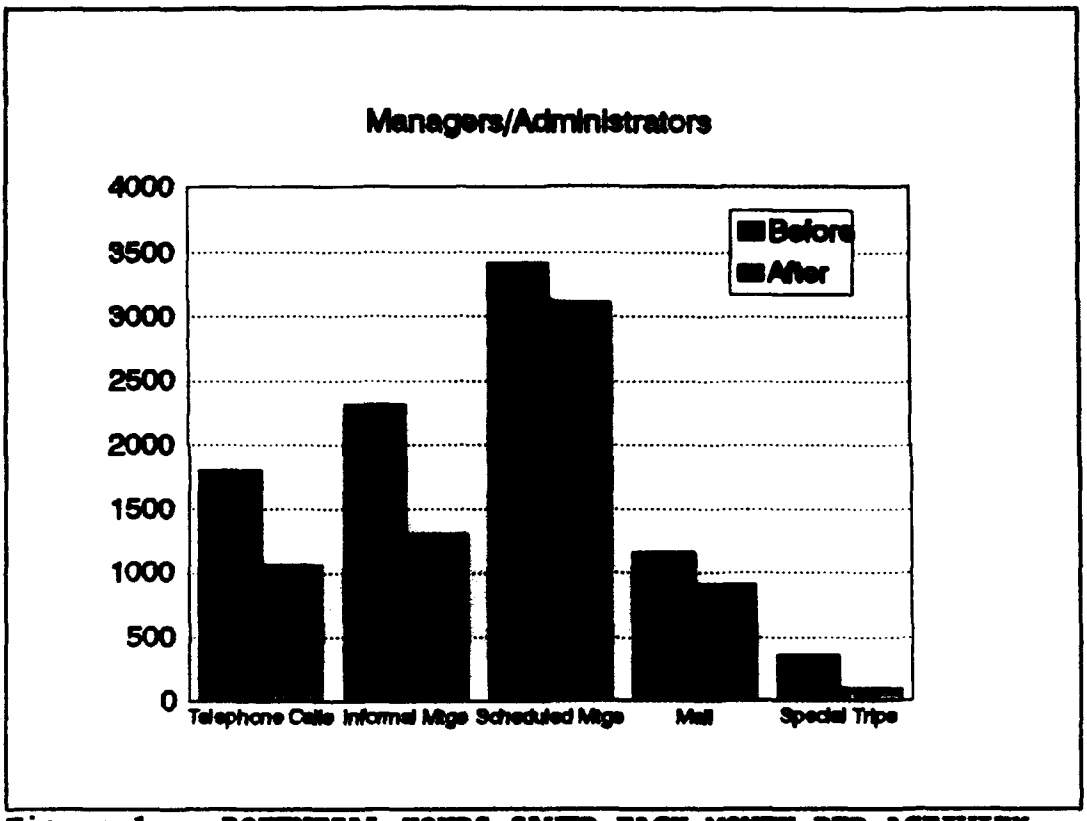

Figure 1 POTENTIAL HOURS SAVED EACH MONTH PER ACTIVITY

(The figure in the "after" column represents the projected percentage of change in the hours spent on each activity after automation.) (Maddox, 1981)

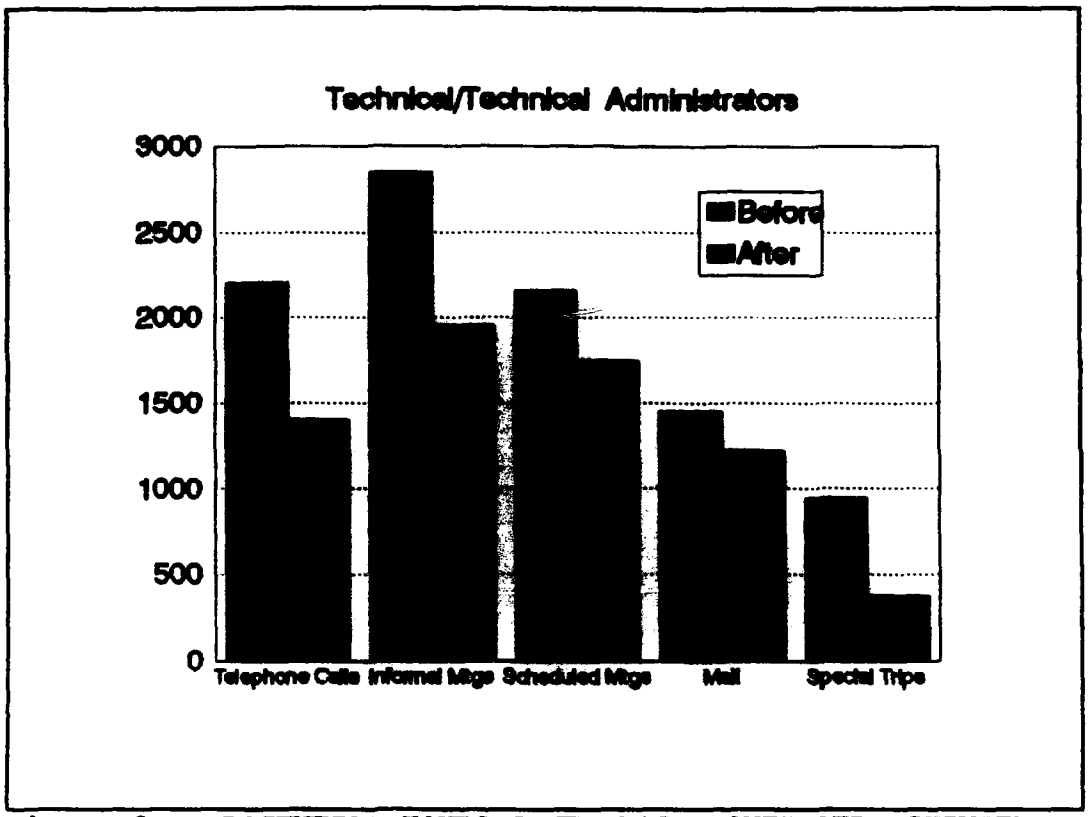

Figure 2 POTENTIAL HOURS SAVED EACH MONTH PER ACTIVITY

(Thr figure in the "after" column represents the projected percentage of change in the hours spent on each activity after automation.) (Maddox,1981)

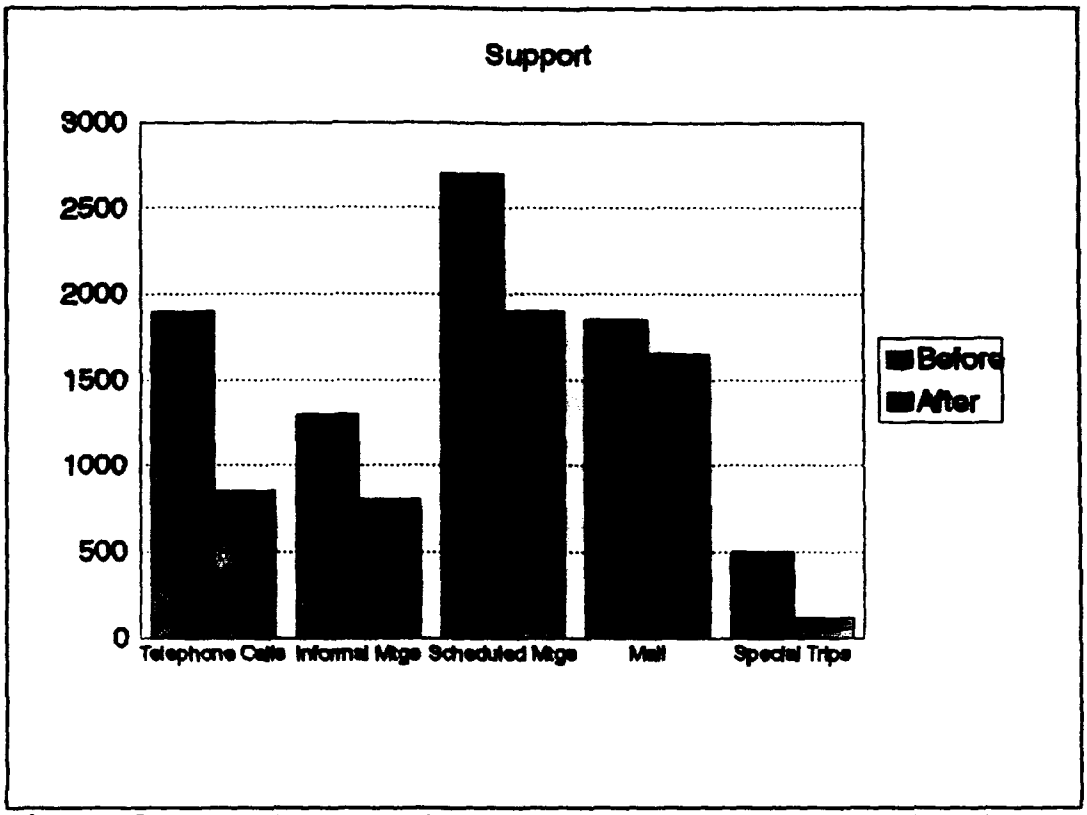

Figure 3 POTENTIAL HOURS SAVED EACH MONTH PER ACTIVITY

(Thr figure in the "after" column represents the projected percentage of change in the hours spent on each activity after automation.) (Maddox,1981)

APPENDIX B

The figures contained in this appendix illustrate the various physical designs of LANs. Figures 4, 5 are typical descriptions of the physical bus and physical ring respectively. Figure 6 illustrates the design of the physical star which can be either a logical bus or logical ring depending upon whether the backbone is left open (bus) or is a closed loop (ring).

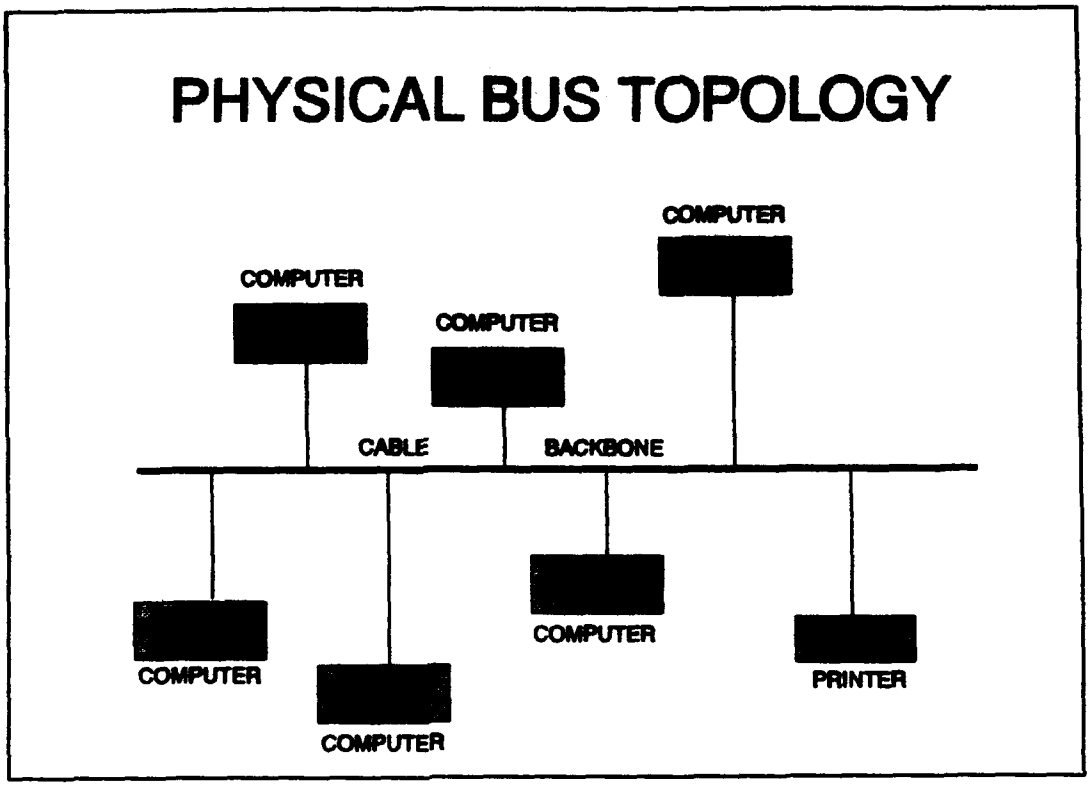
PHYSICAL BUS TOPOLOGY
COMPUTER
COMPUTER
COMPUTER
CABLE
BACKBONE
COMPUTER
COMPUTER
COMPUTER
PRINTER

Figure 4

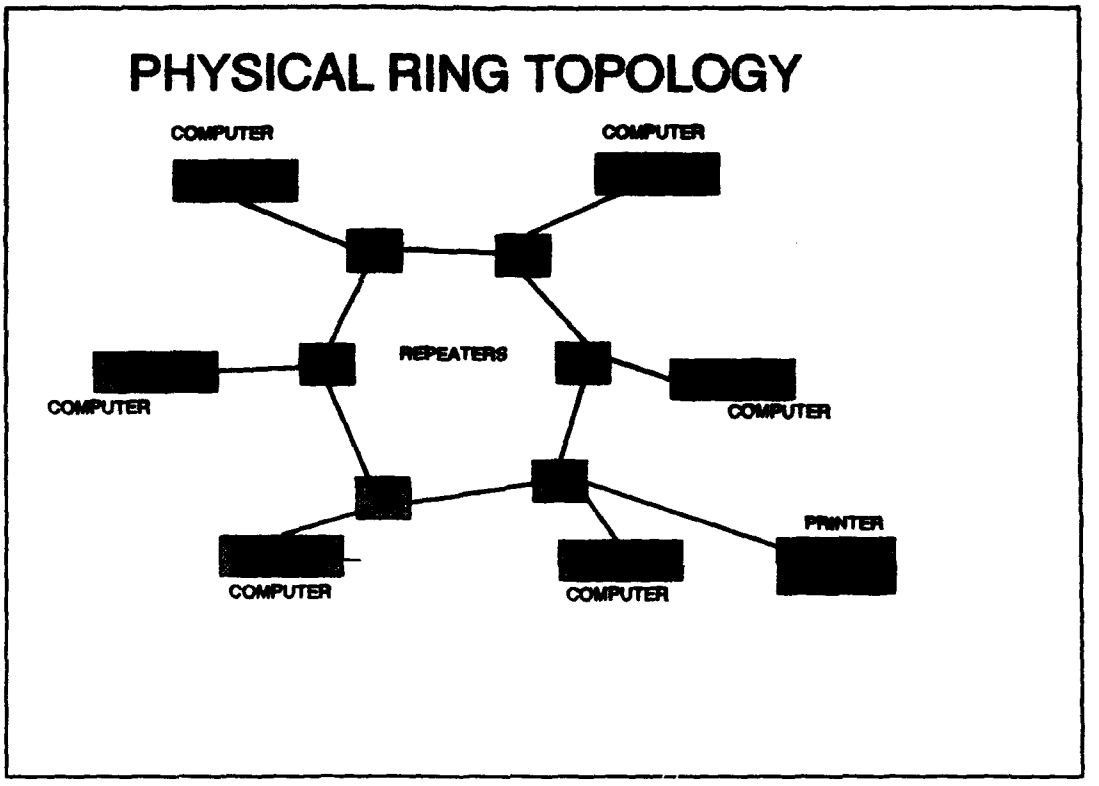
PHYSICAL RING TOPOLOGY
COMPUTER
COMPUTER
REPEATERS
COMPUTER
COMPUTER
PRINTER
COMPUTER
COMPUTER

Figure 5

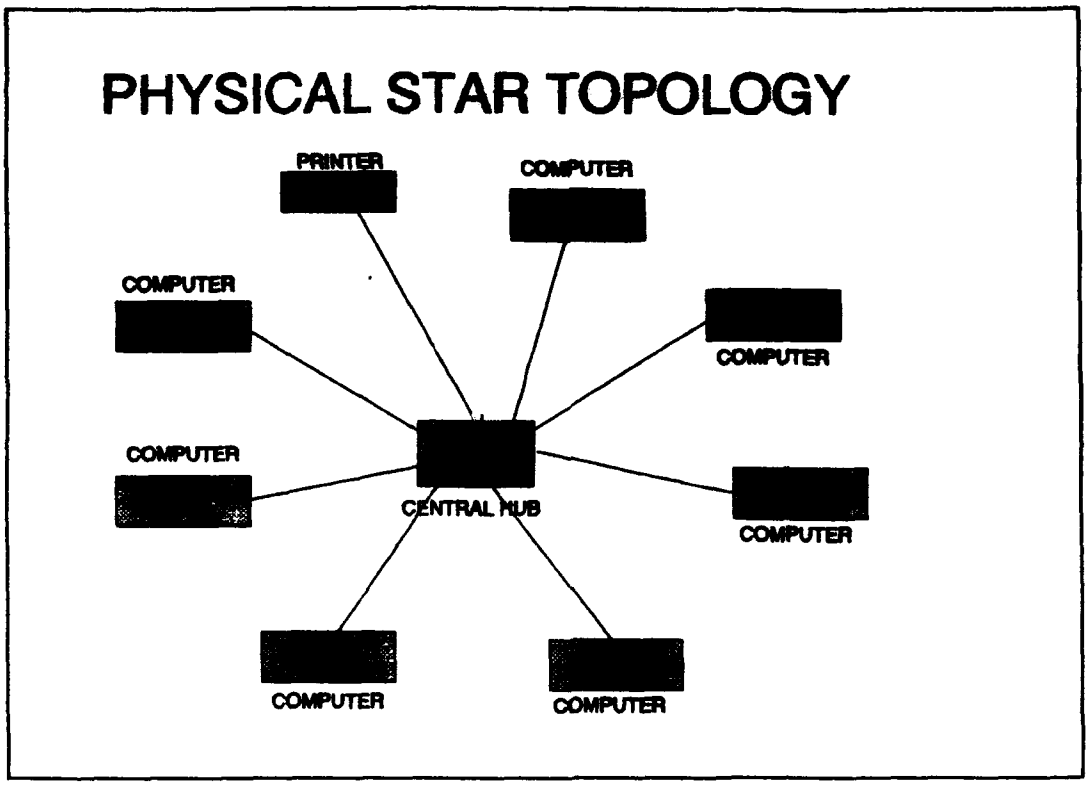
PHYSICAL STAR TOPOLOGY
PRINTER
COMPUTER
COMPUTER
COMPUTER
COMPUTER
CENTRAL HUB
COMPUTER
COMPUTER
COMPUTER
COMPUTER

Figure 6

ABBREVIATIONS AND ACRONYMS

ADP -	Automatic Data Processing
ANSI -	American National Science Institute
CD-ROM -	Compact Disc Read Only Memory
CO-LAN -	Central Office Local Area Network
COMNAVAIRLANT -	Commander Naval Air Force U.S. Atlantic Fleet
COMNAVAIRPAC -	Commander Naval Air Force U.S. Pacific Fleet
CPE-LAN -	Customer Premise Equipment Local Area Network
CPU -	Central Processing Unit
CSMA/CD -	Carrier Sense Multiple Access Collision Detection
DBMS -	DataBase Management System
DDN -	Defense Data Network
DOD -	Department Of Defense
E-Mail -	Electronic Mail
FDDI -	Fiber Digital Data Interchange
GDSS -	Group Decision Support System
GSA -	Government Service Administration
GTSI -	Government Technology Services Inc.
GUI -	Graphic User Interface
IEEE -	Institute of Electronic and Electrical Engineers
IT -	Information Technology
LAN -	Local Area Network
M -	Meter

MAC -	Medium Access Control
Mbps -	Mega bits per second
Mega -	One Million
NALCOMIS -	Naval Aviation Logistics Command Management Information System
NAMP -	Naval Aviation Maintenance Program
NOS -	Network Operating System
NSA -	National Security Agency
OA -	Office Automation
PBX -	Private Branch Exchange
PERT/CPM -	Program Evaluation and Review Technique Critical Path Method
RAM -	Random Access Memory
SNAP -	Shipboard Nontactical Automatic Data Processing System
STP -	Shielded Twisted Pair
UTP -	Unshielded Twisted Pair
VGA -	Video Graphics Array
WYSIWYG -	What You See Is What You Get

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