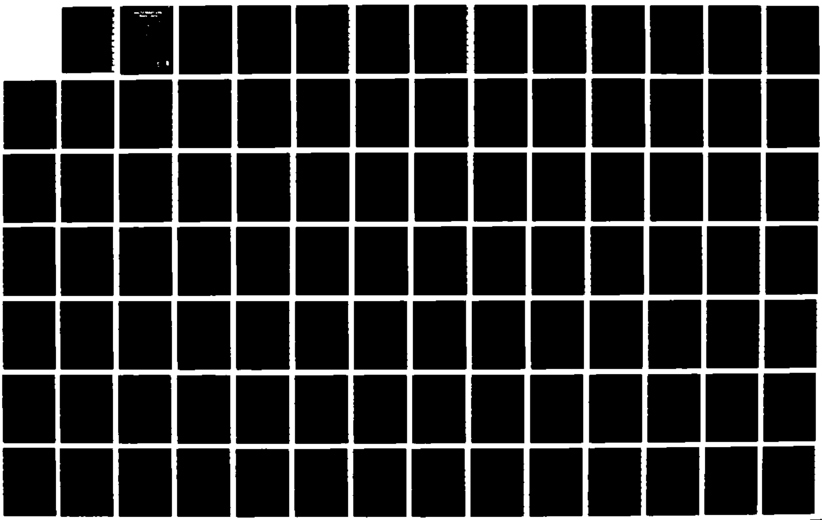
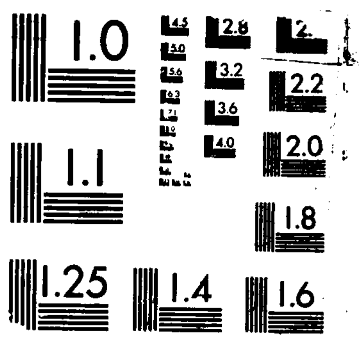
AD-A194 681 SNAP/DDN (SHIPBOARD NON-TACTICAL ADP PROGRAM/DEFENSE DATA NETWORK) INTERFACE FOR INFORMATION EXCHANGE(U) NAVAL POSTGRADUATE SCHOOL MONTEREY CA R W HUNT MAR 88 1/2

UNCLASSIFIED F/G 25/3 NL





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NAVAL POSTGRADUATE SCHOOL
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THESIS

SNAP/DDN INTERFACE FOR INFORMATION EXCHANGE

by

Richard W. Hunt

March 1988

Thesis Advisor: N.F. Schneidewind

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE A194681

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S)	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION Naval Postgraduate School 6b. OFFICE SYMBOL (If applicable) 62	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School
6c. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000	7b. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000
8a. NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO / WORK UNIT ACCESSION NO.

11. TITLE (Include Security Classification)
SNAP/DDN INTERFACE FOR INFORMATION EXCHANGE

12. PERSONAL AUTHOR(S)
HUNT, Richard W.

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Master's Thesis	FROM ____ TO ____	March 1988	112

16. SUPPLEMENTARY NOTATION The views expressed in this thesis are those of the author and do not reflect ~~the official~~ policy or position of the Department of Defense or the U.S. Government

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	DDN, SNAP II, NTS, message reduction, shipboard ADP, electronic mail, shipboard information exchange, NDCCA, SDSA, WMMS → Theses. ←

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This thesis examines shipboard non-tactical, unclassified information exchange and recommends a methodology which will reduce message traffic loading on the Naval Telecommunications System (NTS) and improve administrative performance in the fleet. The Navy's organizational information requirements are reviewed and evaluated. Specifically, it explores the advantages and difficulties of connecting Shipboard Non-tactical ADP Program (SNAP) systems to the Defense Data Network (DDN). A review of existing information exchange procedures, including NTS, SNAP II, and DDN, is provided. An overview of the future Navy Data Communications Control Architecture (NDCCA) is presented along with an interim proposal to connect current and future architectures. An analysis of present Navy and commercial organizations using DDN-type applications such as File Transfer Protocol (FTP) and electronic mail is presented. Keywords:

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED
22a. NAME OF RESPONSIBLE INDIVIDUAL N.F. Schneidewind	22b. TELEPHONE (Include Area Code) (408) 646-2768 22c. OFFICE SYMBOL 54Ss

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

Approved for public release; distribution is unlimited

SNAP/DDN Interface for Information Exchange

by

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Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF SCIENCE IN
TELECOMMUNICATIONS SYSTEMS MANAGEMENT**

from the

**NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

This thesis examines shipboard non-tactical, unclassified information exchange and recommends a methodology which will reduce message traffic loading on the Naval Telecommunications System (NTS) and improve administrative performance in the fleet. The Navy's organizational information requirements are reviewed and evaluated. Specifically, it explores the advantages and difficulties of connecting Shipboard Non-tactical ADP Program (SNAP) systems to the Defense Data Network (DDN). A review of existing information exchange procedures, including NTS, SNAP II, and DDN, is provided. An overview of the future Navy Data Communications Control Architecture (NDCCA) is presented along with an interim proposal to connect current and future architectures. An analysis of present Navy and commercial organizations using DDN-type applications such as File Transfer Protocol (FTP) and electronic mail is presented.

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I. INTRODUCTION

The world is becoming a more complex place. This results in an increased demand for information exchange capability. One area in which this is exhibited is the number of naval messages sent each day. Despite efforts to control the amount of naval message traffic this number continues to increase.

A. THE PROBLEM

The Navy is currently experiencing significant problems with information transfer and processing. Despite increasing demands for information handling the Navy is bound by: (1) the limited capacity of the Naval Telecommunications System (NTS) and (2) limited personnel resources. The impact of limited personnel becomes more critical each year as the availability of personnel is reduced due to budgetary and demographic constraints. Additionally, the complexities of today's ships and weapons systems require more attention from our sailors. This effectively reduces the time available for processing messages, reports, publication and instruction changes, and the assorted administrative data which is currently demanded of them.

This thesis deals with the difficulties of non-tactical, unclassified information exchange. This includes direct mission/support information as well as the myriad of administrative reporting requirements essential to the maintenance of combat ready ships and crews.

B. THE SOLUTION

The solution to this problem is threefold. First, improvements in information processing efficiency must be achieved. Second, improvements in methods of information exchange itself are necessary. Third, the Navy must examine, and when appropriate implement, new alternatives for information processing and transmission.

C. THE METHOD

1. SNAP-Current Action

The Shipboard Non-tactical ADP Program (SNAP) serves as the cornerstone upon which today's shipboard administrative functions are centered. SNAP is the focal point between the ship and shore based support activities. SNAP provides the capability to transmit and receive information via naval messages, magnetic tape, or electronically through the Defense Data Network (DDN). The latter is currently being demonstrated on several test ships. Improvements to the SNAP system will greatly aid in the solution to this information processing dilemma.

2. Long-range Action

The Navy's long-range effort to meet current and future demands is still in its infancy. A multilevel communications architecure, the Navy Data Communications Control Architecture (NDCCA), is being developed to handle all future communications requirements. This system has lower levels dedicated to providing afloat, base and long haul communications. Planned development and implementation of the NDCCA is scheduled for the mid-1990's.

3. Interim Action

In the interim, the Navy must provide a satisfactory method to handle its current demands. The solution must be able to provide communications between ships and shore commands, at-sea as well as inport. Provisions must allow for both the loss or restriction of normal communications channels and the ability to handle increasingly large volumes of data.

D. ORGANIZATION

This thesis is organized into eight chapters, each presenting background information or possible approaches to consider when developing solutions to this problem. Chapter II provides a discussion of the organizational requirements mandating increased information processing.

Chapter III reviews both the Naval Telecommunications System and current shipboard ADP capability. This provides the framework necessary for examining information exchange problems and potential solutions.

Chapter IV reviews the Defense Data Network. This is the key ingredient in the solution to the information exchange problem. A quick overview of the DDN is presented as well as an examination of applications which are directly beneficial to ships.

Chapter V provides a summary of current methods of information exchange. Additionally, a summary of the Navy Data Communications Control Architecture is presented. This elucidates long range Navy plans. Finally, an interim proposal is developed which provides for improved information exchange capability while maximizing utilization of present systems.

Chapter VI reviews two systems currently employing the DDN as a method to exchange information. This demonstrates the feasibility of both the interim and long range solutions.

Chapter VII presents an analysis of DDN applications for shipboard use and examines the inherent connectivity problems when dealing with ships.

Additionally, a discussion is presented concerning the difficulty of both educating and training naval personnel to maximize the potential of the SNAP system and its future telecommunications capability.

The final chapter, Chapter VIII, presents the author's conclusions and recommendations.

II. ORGANIZATIONAL REQUIREMENTS

A. BACKGROUND

Organizations may be viewed as information processing mechanisms. This is especially appropriate for large, complex organizations like the United States Navy. In such organizations, information serves as the dynamic glue that binds together the resources of people, capital and technology. [Ref. 1] It is critical that the mechanisms for processing this information operate as efficiently as possible to allow required information to move quickly and accurately throughout the organization.

1. Complex World

The world in which the United States Navy operates today is much more complex and dynamic than even a decade ago. The range of a battle group's sensors and weapons extend hundreds of miles. From the ocean's depths, to space above, the Navy exists in a greatly expanded sphere. As with the range of the sensors, the speed and accuracy of weapons has also greatly improved. Mach-plus weapons are common and cruise missiles hit targets with an accuracy measured in feet after traveling distances measured in hundreds of miles. Satellites instantaneously provide information to the fleet which is limited only by the imagination of designers and the desires of the operators. The up, down and out credo of the Navy's surface warfare community serves to focus on the tremendously difficult and complex problems faced by today's Navy. [Ref. 2]

2. Complexity Requires Slack

It is important to realize that as the world becomes more complex there is a concurrent rise in uncertainty. The world can no longer be viewed as black and white, but tends to exist as multiple shades of grey. This increase in uncertainty requires that a greater amount of information must be processed in the same amount of time. Increased resources are required to process this information. Failure to provide these resources, essentially a failure to increase the amount of organizational slack, results in decreased performance levels. [Ref. 3]

3. Resulting Problems

The degree of complexity in which the Navy exists encompasses all aspects of the organization. The Navy has responded to this requirement to expand its information processing capacity by increasing shipboard computers, both tactical and non-tactical, and greatly increasing its use of communications systems to disseminate this information. What is often overlooked is that the complexities of the weapon systems and sensors, mentioned above, are directly related to the logistics, personnel and administrative functions necessary for their support. This thesis concentrates on the essential area of mission support. Much can be gained by streamlining procedures through automation and by providing systems which support efficiency and timeliness in accomplishing information exchange.

The information processing requirements imposed on the operating forces at-sea have increased greatly in response to the demands of a more complex environment. This has resulted in two problems.

a. Increased Workload for Fleet Personnel

First, the workload of at-sea operating forces has dramatically increased in its attempt to provide required information to the system. The impact of the large amount time spent on recurring reports and messages has been viewed by the Secretary of the Navy as critical. Time spent on administrative matters directly reduces available training and maintenance time. This negatively impacts operational readiness.

A flag level review in 1985, ordered by then Secretary of the Navy John Lehman, found that Navy and Marine aviators spent an average of two-thirds of their time performing administrative duties unrelated to their mission. It is the author's experience that this figure is even higher aboard Navy surface ships. In response to this finding, Secretary Lehman ordered reviews of the Navy's reporting requirements in an effort to reduce the administrative burden on the operating forces. This was ultimately transformed into an order to reduce by fifty percent all administrative related reports and duties imposed by Secretary of the Navy (SECNAV) directives. [Ref. 4] Unfortunately, upon completion of the Navy's chain of command review, only a negligible number of reports were eliminated which directly reduced the administrative burden on the operating forces. This is predictable following the premise that increasing complexity requires greater information exchange to maintain current performance levels.

b. NTS Overload

Second, this demand for increasing information exchange has resulted in a continuing growth in the amount of naval message traffic sent through the NTS. The NTS is limited by the number of satellite channels available. As a result, only a finite amount of information can be handled by the system. As the number of messages grow, system saturation occurs resulting in slower delivery of critical operational messages.

4. Navy Action

Historically, the Navy has segregated information into either textual message traffic or batch data. The Navy's response to the above stated problems has centered in two separate areas. One area attempts to improve data handling and the other attempts to minimize the number of messages.

a. Automation-SNAP

The development and implementation of the shipboard SNAP I/II systems are designed to provide automated handling of many administrative requirements. These include shipboard Maintenance and Material Management (3-M), supply and financial management functions, shipboard administrative management, file access and word processing. This automation improves efficiency and lowers error rates thereby reducing administrative time demands on personnel and increasing organizational slack.

b. Message Constraints

The Navy Telecommunications System has made a concerted effort to reduce the load on the message system by the establishment of message reduction systems. These efforts concentrate on the reduction or elimination of administrative message traffic. [Ref. 5]

(1) Navgrams. The Navy Mailed Message Program (NAVGRAM) was developed as an alternate method

to naval messages. It allows an originator the simplicity of the naval message format, while actually transmitting the information through the postal system. This program was created to help reduce the number of messages sent over the NTS.

(2) Administrative Message Designation. The NTS also established the requirement that all administrative message traffic be designated as such by the addition of "ZYB" in the date-time-group line of the message. This allows the NTS to segregate administrative messages for delayed transmission when system saturation occurs.

(3) Message and Report Reduction. The Navy's message reduction program was established by the Chief of Naval Operations (CNO) in 1985 to produce a twenty percent message reduction in traffic. This, combined with the Secretary of the Navy's report reduction program, demonstrates the Navy's effort to reduce the administrative burden on Navy personnel.

c. Evaluation of Current Actions

This Navy action, described above, has not improved information exchange. While the introduction of SNAP has been a great asset to those ships with the system installed, the lack of a telecommunications package, or an alternate method for timely information transfer, has severely limited system effectiveness.

As a result, duplication of effort and excessive paperwork remains commonplace. The Navy's attempt at message reduction also fails to satisfy information exchange demands. Message traffic reduction attacks only the short-term problem of system saturation. This may in fact be counter productive to the needs of the Navy as a whole. The demand for information is valid and this demand must be met. It is absolutely essential that the Navy realize that it cannot allow the present capacity of the system to restrict the amount of information transmitted. The Navy must ensure that system capacity be developed to handle all required information. Efforts must be directed in the area of improving information exchange, not in attempts to restrict this information flow.

d. Solution Must Provide Slack

The solution to this problem should include the following characteristics. One, it must provide for efficient, timely information exchange. Two, the demand upon shipboard personnel should be minimized. Specifically, information should be entered into a database once and easily retrieved upon demand as needed. Three, an effort must be made to minimize and reduce the impact on the NTS. These efforts include total message traffic reduction and impact minimization by using prioritization and queuing schemes.

It is important to realize that it is the increasing complexity of today's environment that is driving this demand for increased information processing capability. Additional information must be exchanged throughout the organization or the Navy will see a decrease in its level of performance. The need to accommodate this information exchange requirement is exhibited in the increasing number of messages transmitted annually. This increase in volume is expected and necessary. The Navy should attempt to introduce methods to handle the increased demand, not to impose limits on information transfer. Specifically, attempts should be made to develop more efficient and capable methods to process the required information. A SNAP/DDN interface is a method to help meet these requirements which is examined in this thesis.

Uncertainty is reduced by information, but information is costly. In the Navy, the users are operationally experienced commanders. They must decide whether to buy missiles or communications equipment. These users are in the best position to determine the degree to which information is worthwhile. It should, therefore, be required that support organizations like the Defense Communications Agency (DCA) and Naval Telecommunications Command (NTC) provide complete and accurate costing information to allow operational commanders the data necessary to decide on the optimal information capacity to purchase. For the support communities to impose information constraints upon the operating forces, without inputs as to the value of information, is simply foolish.

B. SYSTEM CONSTRAINTS

In the evaluation of this problem several constraints must be addressed.

1. Department of Defense (DOD) Long Haul Directive

"The DDN will be used by all DOD ADP (Automatic Data Processing) systems and data networks requiring interconnection by telecommunications." [Ref. 6] This specifies the DDN as medium of long haul communications and requires that all data communications be compatible with the DDN. The DDN is the only long haul electronic medium allowed by current directives.

2. Shipboard Requirements

There are specific shipboard unique specifications which must be adhered to. These include manpower and training limitations, equipment space and weight constraints, and cost and performance requirements. Specific applications must also be designed to meet the needs of the shipboard operators. This necessitates user friendly systems, ad hoc query capability, and structured programs for recurring, formatted reports. Examples in this area include 3-M system reporting, supply processing, pay and personnel record keeping, and correspondence files.

C. INFORMATION EXCHANGE REQUIREMENTS

1. Organizational Requirements

Several key factors directly effect the amount of information exchanged within organizations. The impact of these factors on large organizations like the Navy is dramatic. The following factors each generate the need for increased information exchange: (1) increasing organizational size (2) increasing organizational interdependence (3) increased uncertainty caused by faster environmental changes and a higher degree of external environmental complexity (4) increasing time pressure (5) closer supervision, due to either actual requirements or the perceived need, which occurs naturally as an organization ages. [Ref. 7]

This demand for higher levels of information exchange may be handled in several ways. The organization may simply handle messages at a slower rate. Screening procedures may be established at lower levels or the vertical hierarchy may be increased to distribute the information more evenly throughout the organization. The organization may be reconfigured into groups composed of similar functions. These alternatives, however, will not allow the Navy to function at its required level of performance and are therefore unacceptable. A viable method which allows the Navy to satisfy this higher information demand is to improve communications efficiency. This includes improving the speed-of-service, developing better methods of presenting the information and increasing the reliability of the information thereby reducing uncertainty and providing more data when required. Essentially there is a need to create additional organizational slack. [Ref. 8]

Organizations have several internal communications networks. There are formal, structured communications which are recognized as "official" and there are informal networks which provide for "non-official" communications. Formal communications channels generally match the formal authority structure. Informal communications are developed where necessary to meet needs not satisfied by the formal structure. Informal communications are often further divided into subformal and personal categories. Informal communications occur naturally, possessing a great capacity to create increased organizational slack by improving efficiency and effectiveness. Informal communications are much faster than formal communications. They provide a means to float "trial balloons" and test the waters before going official. People are normally more open and honest when communicating unofficially. In general, informal communications provide a method to greatly increase an organization's ability to process information and meet the need to develop increased slack. A goal of good management is to develop the organizational framework to maximize the potential of a well developed informal communications network. [Ref. 9]

Electronic mail is extremely well suited to optimizing informal communications within organizations. Electronic mail is fast and easy. It is proving to be of great benefit to those organizations which implement it. Electronic mail is currently available for shipboard use on the SNAP system. A telecommunications connection between SNAP and the DDN would provide this capability throughout the Navy. This is quite feasible for ships inport. The inport, homeport advantages of this capability would be enormous. Rapid, informal messages between sister ships and squadron commanders would facilitate efficient and effective communication, benefitting all parties.

2. Commanding Officer's Requirements

Commanding Officers have demonstrated a requirement for recorded communications. Their performance indicates a preference for message transmission over mail. The reasons lie in the advantageous characteristics which messages provide. First, from a command point of view, naval messages are faster and easier to prepare. Additionally, this preparation is less manpower intensive. Second, they provide the capability for multiple addressees with de facto receipt acknowledgement. This is a significant benefit to commands which must be able to demonstrate compliance of reporting requirements and to requests from seniors. Three, speed-of-service for naval messages is measured in hours as opposed to the days or weeks which may be lost using mail. Delays, which can occur due to inefficient routing at the receiving command, are generally minimized by message traffic. In many cases this time delay directly results in additional dollar expenditures. For example, time savings in parts procurement or contracting services often precludes expensive material expediting or costly, crisis mandated overtime.

Electronic mail sent over the DDN provides the identical characteristics of the naval message without the necessity of increasing the demand on the NTS. In fact, this capability allows inport ships to transmit required information via electronic mail thus reducing the traffic volume on NTS.

III. CURRENT SYSTEMS

A. NAVAL TELECOMMUNICATIONS SYSTEM

1. Increasing Message Demand

The number of naval messages in the first half of the 1980's increased at a rate of ten percent per year. This rapidly began to strain the capacity of the NTS and has the potential of crippling vital command and control functions. In 1985 the CNO initiated message reduction actions which lowered this increase to a one to two percent annual growth rate. While this improvement is significant, the increase continues to consume valuable satellite channel bandwidth. [Ref. 10]

The NTS was designed to provide command, control and intelligence communications capability between afloat and ashore units. This system "does not currently have sufficient capacity to provide full time data communications services for decision/mission support (administrative) information systems." [Ref. 11]

It is apparent that additional methods of reducing the amount of naval message traffic are necessary to ensure adequate speed-of-service for operational traffic. The purpose of this thesis is to explore the affects of implementing a shipboard interface with the DDN. This would serve as an alternate method of transmitting information currently sent via the NTS while also providing a more efficient means of completing shipboard administrative work.

2. Naval Telecommunications System Description

Satellite communications have become the most utilized medium for rapid information exchange in the U. S. Navy. The Fleet Satellite Broadcast Subsystem (FSB) has evolved as a natural expansion of the Fleet Broadcast. The Fleet Broadcast has historically served as the primary communications medium for naval operating forces. [Ref. 12] General service naval messages are transmitted over either the Fleet Satellite Broadcast Subsystem or the Common User Digital Information Exchange/Naval Modular Automated Communications Subsystem (CUDIXS/NAVMACS).

The FSB provides shore to ship transmission of messages from shore based terminals at Naval Communications Area Master Stations/Naval Communications Stations (NAVCAMS/NAVCOMMSTAs) to ships via Ultra High Frequency (UHF) satellites. The ships monitor the communications traffic and copy information intended for their unit. Message traffic is controlled and queued automatically by the Naval Communication Processing and Routing System (NAVCOMPARS) located at the NAVCAMS. Messages may be entered into the

NAVCOMPARS processor from the over the counter facilities of NAVCAMS/NAVCOMMSTA or from the interface to the Automatic Digital Information Network (AUTODIN). This subsystem operates with a data rate of 75 bits per second (bps) per channel. [Ref. 13]

The CUDIXS/NAVMACS system provides the alternate method of satellite transmission for naval messages. CUDIXS consists of shore based message processors and peripheral equipment. NAVMACS is the shipboard counterpart of CUDIXS, consisting of message processing and distribution equipment. Together, CUDIXS/NAVMACS forms a ship to shore and shore to ship system capable of providing operational communications at the relatively high rate of 2400 bps. [Ref. 14]

It is important in evaluating available bandwidth for message transmission over the NTS to examine the entire NTS UHF Satellite System. All satellite communication subsystems compete for the limited channel assets. The Commander, Naval Telecommunications Command (COMNAVTELCOM) provides operational direction and management of the satellite system to best satisfy the requirements of the CNO and Fleet Commanders in Chief (FLTCINCs). [Ref. 15] There is increasing demand for these satellite channels. As the demand for subsystems such as Officer in Tactical Command Information Exchange Subsystem (OTCIXS), Submarine Satellite Information Exchange Subsystem (SSIXS), Tactical Intelligence Subsystem (TACINTEL), Secure Voice Subsystem, and Tactical Data Information Exchange Subsystem (TADIXS) increase, the availability for the traditional naval message channels, like FSB, becomes much more restricted. [Ref. 16]

Improvements in multiplexing techniques, such as Demand Assigned Multiple Access (DAMA), have enabled the more efficient utilization of available bandwidth. However, this has been matched with a decreasing number of available satellite channels. The current Fleet Satellite Communication (FLTSATCOM) satellites are being replaced with Leased Satellite (LEASAT) satellites. FLTSATCOM satellites have ten 25 kilohertz (Khz) channels dedicated to Navy communications. The LEASAT satellites have only six 25 Khz channels for the Navy. These trends mandate strict control of the limited communication resources. Requests to expand each of the subsystems have also increased. Through strict circuit management communication requirements have been met. As fleet commanders develop reliance on the various satellite subsystems, FSB and CUDIXS/NAVMACS channels become limited with no room for growth. Maximum utilization of the existing bandwidth becomes critical and methods which minimize usage become essential.

When the volume of message traffic increases there is a concurrent increase in the backlog of message traffic to be sent. This results in increasing the time of receipt for message transmission. The time it takes for an outgoing message to be received at its destination is referred to as speed-of-service. The Navy has established a maximum allowable speed-of-service for the different classifications of naval messages (Table 1). When an increase in the backlog results in the speed-of-service approaching these maximums the NAVCAMS take action to ensure these times are not exceeded. The implementation of the removal of administrative traffic from the fleet broadcast is an example of how the NAVCAMS can react to maintain the required speed-of-service. [Ref. 17]

SPEED-OF-SERVICE

PRECEDENCE	PROSIGN	OBJECTIVE
FLASH	Z	10 MIN.
IMMEDIATE	O	30 MIN.
PRIORITY	P	3 HOURS
ROUTINE	R	6 HOURS

TABLE 1 [REF. 18]

3. Message Control

Three methods of control are used to help manage the message loading and ensure that critical naval message traffic is transmitted in a timely manner during periods of heavy demand. Additionally, EMCON is discussed regarding its impact on electronic transmission of information.

a. MINIMIZE

The first method is MINIMIZE. MINIMIZE may be implemented whenever an emergency arises, or is anticipated, which requires a reduction in communications transmitted over U. S. telecommunications facilities. The imposition of MINIMIZE requires that all message releasing officers review and certify that the following condition has been met. Only message traffic that directly concerns the accomplishing of a mission or safety of life is considered essential and may be transmitted electronically. All non-essential messages will be transmitted by other means. This action both informs the operating forces that the NTS is limited in its capacity to handle the normal volume of message traffic and places the ability to manage the information transmitted directly in their hands. [Ref. 19]

b. Administrative Message Designation

The second method of control allows the FLTCINCs to stop administrative message traffic from being transmitted over the fleet broadcast during periods of crisis or when overloads occur. This administrative traffic is stored until conditions return to normal, allowing transmission. Currently, all naval messages of an administrative nature are required to include the word "ADMIN" in the message handling instructions. "ADMIN" messages are identified by the addition of "ZYB" at the end of the date-time-group line. The administrative designation is assigned by the message drafter. When the FLTCINC orders the removal of administrative traffic, the effect is to add additional levels of precedence to the messages. This results in higher priority "operational" messages having a faster speed-of-service, thus ensuring that vital messages are transmitted first. [Refs. 20,21]

c. NAVGRAM Program

The third method to aid in the control of the number of messages is the establishment of the Navy Mailed Message Program (NAVGRAM). This was established as part of the message reduction program initiated in 1985. The NAVGRAM program provides a means to reduce the number of electrically transmitted messages. The message is written on the DD 173 Joint Messageform but is mailed instead of being electrically transmitted. NAVGRAMs are given priority over routine correspondence, may contain up to fifteen addressees, may be readdressed and may be referenced. They are designed to provide the originator the ease and priority of a naval message without increasing the load on the NTS. This is essentially a newer version of the Naval Speedletter. [Ref. 22]

d. EMCON

An additional policy which impacts message transmission is Emission Control (EMCON). EMCON may be imposed at the discretion of the officer in tactical command. EMCON policies prohibit using specific frequencies of electromagnetic transmission. Depending on the particular EMCON plan imposed, the impact may vary from partial to total loss of communication equipment. It is conceivable that EMCON may be imposed for extended periods of time thereby requiring alternate methods of information exchange. This suggests the use of physical transfer of data on magnetic tapes, disks, Compact Disk-Read Only Memory (CD-ROM) or Write Once, Read Many (WORM).

4. NTS capacity limitations

a. Fleet input

In discussions with communications personnel, several important points have been made. [Refs. 23,24] Communications demand is being met. Management policies dictate that speed-of-service requirements be attained and this is being accomplished. A trade-off does occur, however, in that FLTCINCs specify which users get what channels. It is not possible to grant all requests for bandwidth due to limited assets. Some users must exist with less than optimum data rates as a result. On both coasts the deletion of "administrative" traffic has been imposed to maintain speed-of-service for operational traffic. Essentially, while the NTS is able to satisfy operational message requirements, it occasionally experiences difficulty. This difficulty is only getting worse and is limiting the NTS's ability to meet the demand for administrative/mission support messages and data. Mission support information is as important as operational information in ensuring the continued preparedness of Naval forces.

b. Administrative versus Operational Messages

(1) Definitions. As stated above, current telecommunications procedures require that administrative messages be labeled as such. Presumedly, traffic not labeled administrative is, in fact, operational. Examples of traffic that is administrative in nature include "personnel actions, newsgrams or USN publication changes." [Ref. 25] This very general and nondescript definition of "administrative" allows the strong probability that additional message traffic could, and perhaps should, be placed into the administrative category. Many communicators have indicated a desire to change this

requirement by requiring an "operational" label instead of "administrative" as an attempt to obtain a more accurate segregation between the two. A very specific, but classified description of "operational" is provided in Naval Warfare Publication (NWP) 4. [Ref. 26]

(2) Policy. The administrative definition has been left intentionally vague to allow operational commanders to exercise their command authority in the determination of message traffic classification. During operational exercises the speed-of-service often degrades significantly in response to the increase in message traffic. Commanding officers respond by increasing the priority classification assigned to their messages to ensure timely receipt. It is logical to assume that these same commanding officers will exhibit similar tendencies by excluding the "administrative" designation of administrative messages when they feel the necessity for timely transmission.

(3) Lack of Enforcement. There is no concerted effort to ensure that commands properly designate administrative traffic. The Naval Communications Area Master Stations (NAVCAMS) do not have adequate manning levels to verify compliance. The Naval Communications Processing and Routing System (NAVCOMPARS) is programmed only to act on messages

designated "administrative" when directed to delete such traffic from the fleet broadcast. The NAVCOMPARS does not, for example, check Standard Subject Identification Codes (SSICs) as a method of separating operational from administrative traffic. The FLTCINCs do spot screen traffic on a random basis and notify non-complying units.

(4) Statistics. While statistics are not kept on this type of information, it is reasonable to assume that less than fifty percent of the message traffic is truly "operational" during non-crisis operations. Current figures indicate that approximately twenty percent of naval messages are designated as "administrative" by their originator. [Ref. 27]

CNO policy calls for ship schedules providing a minimum of fifty percent time spent in homeport. By having inport ships transmit these messages over the DDN instead of the NTS, the number of NTS messages would be significantly reduced. Allowing for the fifty percent inport time and using the twenty percent administrative traffic figure, we could expect the number of messages transmitted over the NTS to be reduced by at least ten percent. Additionally, it may also be true that more efficient communications in homeport will result in a higher level of preparation thereby reducing the demand for at-sea communications.

B. SHIPBOARD ADP

1. Shipboard Information Problems

In December 1987, VADM J. Metcalf III, Deputy Chief of Naval Operations (Surface Warfare), lead the introduction of the "Paperless Ship" initiative. He did this to alleviate the problems caused by "the present methodology of using, storing and maintaining paper products (which) was having an adverse affect on the ship's warfighting capability." [Ref. 28] The problems addressed are twofold. First, ship's force personnel currently spend an excessive amount of time processing information resources. This time could be better utilized in other areas. Second, the volume and weight used by these paper products directly impacts the ship's combat capability by reducing stability and endurance.

The intent of the Paperless Ship" is best summarized as follows:

> (The)...reduction of paperwork is not the objective of this initiative, but rather the improvement in information transfer and management. The real issue of the 'Paperless Ship' is information; how to improve access to information and how to wean the ship from paper. Integration of information is important toward this end. Moreover, the concern should be on information flow in the ship with the responsibility for maintenance of this information transferred to the shore establishment. [Ref. 29]

a. Too Much Paper

The initial investigations of the "Paperless Ship" initiative revealed that enormous quantities of paper are maintained aboard ships. This included over 20 tons on a FFG-7 class frigate and 37 tons on a CG-47 class cruiser. [Ref. 30] Both of these ship types are extremely weight critical. This large quantity of weight is simply not acceptable. Additionally, this vast amount of paper requires many man-hours for processing, updating and information retrieval. Much of the paper is required for recurring reports which must be completed on specified forms.

Initially, proposed solutions to this problem center on optical storage technology. CD-ROM and WORM systems could be integrated with SNAP or the proposed intelligent Z-248 Zenith terminals for the SNAP system. CD-ROM could provide technical manual and instruction type information. This would eliminate the need for ship's personnel to perform manual updates by simply receiving regularly updated copies of all necessary information via new CD-ROM disks. [Ref. 31] This information would also be much more accessible through the use of computer driven indexes which would quickly display the information requested. Required information and reports could be maintained using WORM technology, thereby reducing large volumes of paper to several small disks.

b. Duplication of Effort

The SNAP system is currently experiencing problems in the area of acceptability. This occurs both within and outside the command. Feedback indicates that there is an apparent policy lag in the acceptance of afloat automation. Examples include the fact "that some inspection teams are not accepting SNAP records" [Ref. 32] and hard copy data is often required by receiving organizations in addition to magnetic tapes. Internally, some commands require that reports and messages be reviewed on paper as opposed to the computer screen. This requires additional or duplicate work to be generated on the very system which was designed to eliminate this problem. The extra generation of this information also increases the probability of errors being introduced into the data.

2. Shipboard ADP Systems-History

During the 1970's, technological advances in microprocessors produced significant cost reductions in electronics and communications. This spawned an increased interest in computers. At the same time constrained budgets and increasing personnel costs were driving manpower officials to begin to examine methods to increase the productivity, efficiency and accuracy of administrative personnel. Several studies involving the use of ADP equipment on ships were conducted. Commercial procurement of minicomputer systems which were provided to test platforms yielded positive results. Studies were conducted aboard USS Gridley (1975) [Ref. 33], and USS Coontz and USS Arthur W. Radford (1980) [Ref. 34]. The bottom line in the findings of these studies indicate that: (1) "a microcomputer system with a data management and word processing capability can have a major impact on reducing shipboard administrative burden and, in turn, can contribute to day-to-day ship operating efficiency" [Ref. 35] (2) the amount and type of training, documentation and on-board expertise directly impacts the benefits obtained from the system (3) the degree of system use and application development was related to the command interest generated by the commanding officer and to extent to which the system is "user-friendly." [Ref. 36]

In 1975, the Chief of Naval Operations established the Shipboard Non-tactical ADP Program (SNAP) to provide assistance in the accomplishment of shipboard administrative functions. The Fleet Non-tactical ADP Requirements Definition Working Group identified requirements for SNAP application programs in their November 1976 report. [Ref. 37]

3. SNAP

The Shipboard Non-tactical ADP Program exists as two separate programs. SNAP I was established in response to problems created by the aging AN/UYK-5 (V) computers used aboard large Naval ships and shore activities. This involved replacement of existing hardware with the AN/UYK-65 (V) and upgrading application software. SNAP I is installed aboard supply ships, repair ships, amphibious ships, aircraft carriers afloat, Shore Intermediate Maintenance Activities (SIMAs), Naval Air Stations and training commands ashore. SNAP II is designed for the remainder of the surface navy and submarines, providing these ships with ADP capabilities compatible with SNAP I computers.

a. System Overview-Purpose

SNAP II evolved around the 1980 CNO Objective Number 5 to "reduce the administrative burden on the fleet." [Ref. 38] SNAP II systems are designed to run in unmanned spaces without dedicated operators. Maintenance and operation is to be accomplished without increases to existing shipboard manning levels. The hardware used in SNAP II systems is the Harris series-300 minicomputer with ruggedized off the shelf commercial peripheral equipment.

It is the objective of the SNAP II to provide automatic data processing equipment to all submarines and surface ships...Through the use of ADP equipment in support of maintenance, supply, pay and personnel, the timeliness and accuracy of data and reported information will be greatly improved. Additionally, the time consuming and error prone manual preparation of forms will be reduced. [Ref. 39]

b. System Capabilities/Applications

Navy Management Systems Support Office (NAVMASSO) is tasked as the SNAP Central Design Activity (CDA) to be responsible to identify ADP requirements, analyze, design, program, implement, maintain and provide life cycle support for the system. NAVMASSO serves as a single point of contact for overall coordination of SNAP I and II. NAVMASSO is responsible for the development, testing, installation and documentation maintenance of both hardware and software. NAVMASSO provides training and assistance to fleet users in the implementation, use and operation of SNAP. Additionally, they review training curricula lesson plans and monitor courses for accuracy and method of presentation. [Refs. 40,41]

The following subsystems serve as the foundation of the SNAP system. Additional subsystem modules are currently being developed and installed to augment the core group discussed below. These include Food Service Management Afloat, Resale Operations Management and SNAP Automated Medical System. [Ref. 42]

(1) System Management Subsystem (SMS).

This performs system management and system service tasks in support of the other subsystems. It protects system data integrity through transaction backup, recovery, and transaction logging functions. Although most SMS functions will be invisible to the system user, two functions a user knowingly will use are the send/receive mail function and the on-line users manual. The mail function will allow users to send, receive, and display mail or messages throughout the ship. With an on-line users manual, users can view or print guidance for any available subsystem included with their SNAP II equipment. [Ref. 43]

(2) Maintenance Data Subsystem (MDS).

This subsystem provides an automated maintenance capability. The Current Ships Maintenance Program (CSMP) is maintained up to date with on-line interface with maintenance actions recorded by OPNAV 4790/2K or 4790/CK forms. The on-line interface between supply and maintenance functions to assist in parts ordering with direct access provided to the ship's Consolidated Ships Allowance Listing (COSAL). Equipment identification, maintenance action deferral and accomplishment, and parts ordering and approval are also automated through this subsystem.

(3) Supply and Financial Management Subsystem (SFM). This subsystem automates current supply procedures providing support in supply and financial management areas. Both maintenance and supply personnel use this system. Parts requisitioning, requirements review, COSAL access, and

budget review are functions commonly utilized by maintenance personnel. Supply personnel perform the majority of their functions on SFM. Financial reports, files and records are maintained by this system. Examples include COSAL file, budget operating target (OPTAR) file, constants file, requirements file, requisition status file, stock record file, transaction ledger maintenance, and cross reference file. [Ref. 44]

(4) Administrative Data Management Subsystem (ADM). This subsystem provides administrative support capability for both shipwide functions and departmental/divisional requirements. Examples include basic word processing, watchbill assignments, career counseling records, Watch, Quarter and Station assignments, general personnel records and medical/dental records.

(5) Source Data System (SDS). This subsystem provides for bi-directional communications of pay and personnel data between the ship, Navy Finance Center and Naval Military Personnel Command. SDS is the precursor of the Source Data System Afloat (SDSA) system discussed in Chapter VI.

IV. DEFENSE DATA NETWORK-THE CONNECTOR

This chapter provides a quick overview of the Defense Data Network and the specific applications directly beneficial to the operating forces.

There are many good references which provide excellent descriptions of the evolution of the Defense Data Network [Refs. 45,46,47]. Documentation explaining the DDN as it exists today is also readily available [Refs. 48,49,50,51]. The interested reader is invited to review these references.

A. BACKGROUND HISTORY

The Defense Data Network evolved from the Advanced Research Projects Agency Network (ARPANET), a research and development project sponsored by the Defense Advanced Research Projects Agency (DARPA). ARPANET was established in 1969 as an experimental network for the advancement of state-of-the-art computer resource sharing. This system proved extremely successful and operational users quickly began to proliferate. By 1975 the number of operational users was great enough to transfer control of the network from DARPA to the Defense Communications Agency. In 1982 the Defense Data Network was created using ARPANET technology to link Department of Defense computers together. The DDN currently exists with separate classified and unclassified segments. It is the unclassified, Military Network (MILNET) segment of the DDN that this thesis deals with. [Refs. 52,53] As mentioned previously, Department of Defense policy states that all data networks requiring long-haul communications will be connected by the DDN.

B. NETWORK OVERVIEW

The DDN architecture utilizes packet switching as its method of handling data transmission. In this case the information to be transmitted is passed from the "host" computer with its destination address to a local Packet Switching Node (PSN). The PSN divides this information into small "packets" of a prescribed size and routes these packets with a sequence number to the original destination address. These packets are individually routed from PSN to PSN with each packet using the best route available at the time. The route chosen may vary depending on congestion and availability of circuits. The destination PSN reassembles the packets in the proper sequence and forwards the original information to the destination computer. Error checking and correction are provided by each PSN to ensure that the transmitted information is complete and accurate. [Ref. 54]

The DDN is composed of two functional areas; the backbone network and the access network. The DDN backbone is designed to be highly survivable with a network of over 200 PSNs located throughout Europe, the United States and the Pacific. Backbone transmission links are land-based circuits capable of 56,000 bps data rates. European circuits are 9,600 bps lines.

The access network consists of host systems connections and terminals.

> The host systems are connected to the DDN packet switches using either X.25 or ARPANET (1822) interfaces. The transmission speeds of the host access circuits will be 9,000 to 56,000 bps. Each host system can be directly connected to one or more packet switches by one or more circuits.
>
> Terminals are directly connected to the network through either a Terminal Access Controller (TAC) or a mini-TAC, or may be indirectly connected through a host which is itself directly connected to the network. The TAC supports 63 terminals; the mini-TAC supports 16. Terminals are connected to TACs or mini-TACs with either direct lines operating at speeds ranging from 110 to 9,600 bps or dial-up lines operating from 110 to 2400 bps. Each of the TACs is connected to a packet switch in the network backbone via direct line operating at 9,600 to 56,000 bps. [Ref. 55]

The DOD standard Transmission Control Protocol/Internet Protocol (TCP/IP) is used to handle end-to-end data flow between two systems. This is used for both host-to-host and host-to-TAC connections.

C. SHIPBOARD APPLICATIONS

While the DDN provides many capabilities and applications for information exchange the following are the most applicable for immediate utilization with shipboard ADP equipment. In the near term, DDN connections will only be possible with ships inport.

1. Electronic Mail

Electronic mail is the most used service on the DDN. This capability allows messages to be sent to users on the same host or to be sent to users residing on different hosts. Electronic mail programs automatically translate messages to the correct format for the receiving host and store messages until the recipient is ready to receive them. The recipient can then read, print, move or delete the messages. Readdressal and reply capabilities are available on electronic mail programs. Text editors are available for message preparation and separate files may be inserted as the text of a message for transmission. [Ref. 56] Simple Mail Transfer Protocol (SMTP) is used to provide transfer of electronic mail over the DDN.

Electronic mail provides a capability similar to naval messages. It satisfies the requirements for information transfer that are necessary for commands. Electronic mail is easy to use and eliminates the necessity of administrative personnel. It allows the sender to provide information to multiple recipients while keeping a record copy for the originator. If the mail is undeliverable the originator is informed of that fact. Finally, the speed-of-service is extremely fast. This system would satisfy the requirements of administrative message traffic, while reducing the human overhead needed when using the NTS.

Of all the DDN services, electronic mail could become the most beneficial. Its greatest benefit lies in the fact that it can be used effectively for both official and informal communications. Messages could be identified as "official" when desired by the originator. Information transmitted in this manner would have the same impact as naval messages sent over the NTS. The NTS, however, would not have these messages entered into its system, thereby reducing NTS traffic volume.

Equally important are the potential benefits gained by the use of electronic mail in informal communications. It serves as an excellent medium for improving subformal communications. This results in increased productivity due to improved information flow throughout the organization.

Efficiency improvements include less lost time in attempting to complete phone conversations. Phone conversations are often disruptive for both parties. Callers spend too much time getting busy signals or finding that the person he is attempting to reach is not available. The recipient is often called away from important functions, interrupting daily schedules. With electronic mail, messages are sent and replied to at the convenience of the individual parties. An obvious example would be the benefits of having officer and enlisted detailers with electronic mail capability. Efficiency on behalf of both the detailers and personnel would be improved. There are also intangible benefits to be gained through increased personnel satisfaction.

2. File Transfer Protocol

The File Transfer Protocol (FTP) provides the capability to transfer files from one computer to another. The files may be data, text or programs. FTP handles the transfer even when the computers use different operating systems or file storage formats. All that is required is the remote host's address, a username and password for that host, and the specific file name. File transfer may be accomplished either to or from the remote host. Individual files are provided protection which permits file transfer, prohibits transfer, provides read only access or prevents access to all except the originator himself. [Ref. 57]

FTP provides the capability to easily send a variety of information to required recipients. Conversely, it provides the ability for other organizations to obtain information from files without requiring intervention from the originator himself.

Examples of benefits derived from this capability include the electronic transfer of work packages from a ship to a SIMA or allowing a destroyer squadron to extract required ship's personnel information from the ship's database without requiring the ship to perform additional work.

The potential of FTP for shipboard personnel is most impressive. The ability to transfer required information off ship without additional work would be a huge time saver. Currently, information sent off ship must be prepared, formatted and transmitted. This is a redundant, time consuming process.

The vast majority of the information needed for recurring reports is maintained on file, often in existing SNAP system programs. This includes general administrative items in addition to the 3-M and supply information. Safety reports, personnel reports, training status and personnel qualifications are examples of information often requested from senior commands. This information could simply and immediately be transmitted to the requesting command. Additionally, strong programs or good instructions from a particular ship can be shared throughout the squadron with minimal rework required by the receiving ships.

Currently, it is common for this information to be shared via paper copies or in some cases magnetic disks. This often requires much manual intervention by each receiving ship. There is often a breakdown in the transfer of this type of information resulting in inadvertent omission of some commands. FTP ensures that all information is available in usable form to all ships. A FTP capability would reduce paperwork and administrative time, resulting in increased organizational slack.

3. Others

The DDN provides other capabilities which, although not essential, could prove beneficial and should be considered for inclusion in the shipboard ADP/DDN interface. Bulletin boards could be established to address points of interest in specific subject areas, for example, surface-to-air missiles, gas turbine engines, administrative procedures, etc. This could serve as a near real-time forum for the discussion of problems and sharing of solutions. WHOIS functions as an electronic white pages which provides information on DDN users including their DDN address, mail address and phone number. WHOIS provides search capability based on name, partial name, DDN handle, hostname, TAC name or Node name. TELNET allows users to log on to a remote host and to use its capabilities just as if logged on directly. TALK allows real time interactive communication between two locations residing on the same host. [Ref. 58]

A most promising area to explore is that of using the combination of TELNET and FTP capability to allow senior commands the ability to extract required information from ship's databases. This would allow these commands to query individual ships when information is needed. While FTP would be used for providing information for recurring reports, special and one time reports could be best handled by logging into the ship's system and examining the required information. This eliminates the additional administrative burden imposed upon ships and transfers it to the shore establishment.

Side benefits of this type of system include the extra pressure on the ships to keep their administrative data current. The database would need to be maintained in an up to date status since there would be no warning of reviews by seniors. This provides long term benefits on the ship's overall readiness status and minimizes crisis management techniques used to prepare for administrative and material inspections.

D. SUMMARY

The capabilities provided by the addition of DDN services would have a tremendous impact towards reducing the administrative burden on the fleet and easing the demand on NTS. It should be noted that the largest amount of time devoted to shipboard administrative requirements occurs while the ship is in homeport. DDN connections at homeport are certainly obtainable with minimal financial outlay. A key advantage in the DDN services is that they could be used to shift the administrative burden ashore, exactly where it should be.

As a final comment, if costing schemes are implemented for communications services these types of services would shift the cost to the requesting command. This would result in a critical review of existing requirements and the elimination of unnecessary reports.

V. CONNECTIVITY

A. PRESENT SYSTEM

Currently information provided by ships to other organizations can be grouped into two areas. First, there are communications which are generated as naval messages. Second, there is data type information which has been automated through the introduction of SNAP and is transmitted physically, usually by mail. This type of information includes 3-M information, Military Standard Requisitioning and Issue Procedures (MILSTRIP) information, Fleet Accounting and Disbursing Center (FAACD) data, pay and personnel data, and administrative information including official mail.

1. Naval Messages

The Naval Telecommunications System (NTS) provides message traffic connectivity between naval forces within a local area. While in US Navy ports, this transmission is from ships into the NTS via Naval Communications Stations (NAVCOMMSTAs) or Naval Telecommunications Centers (NTCCs) via over the counter hand carried service. While at-sea, messages are transmitted from ships into the NTS at NAVCAMS/NAVCOMMSTA's receivers via fleet UHF satellites or over High Frequency circuits. Messages sent to a destination activity within the same local area remain within the NTS. Messages requiring out of area transmission interface with the Defense Communications System (DCS) through AUTODIN Switching Centers (ASCs). Presently long haul communications are provided by the DCS Automatic Digital Information Network (AUTODIN) which routes messages between ASCs. Messages going to Naval activities then re-enter the NTS for ultimate delivery to the final destination.

2. Physically Transmitted Data

This information is sent off ship via mail or is hand carried by messenger to the receiving organization. It may be hard copy, magnetic tapes or disks. The system is essentially the same during both inport and at-sea periods. The time it takes for information to be physically transported to the receiving organization is the controlling factor in determining the usefulness of the information. While ships are in the United States, the mail is reasonably fast. Express mail provides overnight service. When ships are underway or inport overseas, the mail becomes much less reliable and time of delivery can become excessive. This often reduces the usefulness of the information significantly. Methods to speed up information exchange need to be reviewed to determine the benefits of improved speed-of-service versus the increased cost.

3. DOD DDN Directive

On April 2, 1982 the Deputy Secretary of Defense issued a memorandum directing the termination of the AUTODIN II system and the continued development of the Defense Data Network as its replacement. [Ref. 59] This decision was made after an extensive review of the AUTODIN and DDN systems, examining their ability to meet the requirements of the future. The study determined that the DDN design provided increased survivability at less cost. [Ref. 60]

It was later directed that the DDN would be the common user network over which all long haul communications of the DOD would be transported. [Ref. 61] This directive has a tremendous impact upon the way information exchange is viewed in the Navy. It impacts not only the way computer information is transmitted but also the way in which messages are routed when they are transported out of a local NTS area. In the future, naval messages will be routed into the DCS via the more capable Inter Service/Agency Automated Message Processing Exchange (I S/A AMPE) DDN equipment instead of the current ASCs. This major equipment change presents an opportunity for critical review of the present system and an examination of the potential impact of the DDN interface on other applications.

4. Present System Shortfalls

The current system has several significant inadequacies. Essentially, the system is unable to provide satisfactory speed-of-service in the quantities required. The NTS was not designed with the capability to handle administrative information. As a result it is unable to provide this service when the system is stressed due to increased operational tempo. The "administrative" message designation was created to accommodate this situation. While the NTS can maintain the present level of non-operational traffic, additional methods of transmitting this information are required.

When naval messages are not used, the result is excessive delivery times. Mail service does not provide sufficient speed for many types of information. Personnel pay records, obligational financial information, maintenance information and parts procurement are examples of data which is very time sensitive. There is also significant administrative effort consumed in the preparation and mailing of the data and the coinciding repeat performance on the receiving side.

The Navy's information demands are rising at the same time that budgetary and personnel constraints are becoming limited. The present system's inadequacies have resulted in examining new methods to meet this demand.

B. THE FUTURE: THE NDCCA

The Navy is currently exploring the development of an all encompassing data communications system: Navy Data Communications Control Architecture (NDCCA). The Director of the Department of the Navy Information Resources Management has assumed the lead role as coordinator for this program which has a implementation target date of 1995. NDCCA will establish the baseline for all decision/mission support data transfer between ship and shore units. Decision/mission support data is essentially all data exchange of a non-tactical nature. [Ref. 62]

A review of information, available only in draft form, shows great insight and promise.

NDCCA is the top level architecture which describes the overall system for Navy data communications. It provides for the identification and promulgation of policy, standards and guidance for future evolution. This top level structure is broken down into three physical locations; afloat, ashore and long haul. The afloat architecture includes shipboard and ship-to-ship components. Two additional segments, security and protocol, have recently been included to specifically address these particular areas of data communications. [Ref. 63]

1. Base Information Transfer System (BITS)

Base Information Transfer System (BITS) will integrate voice and data for intrabase communications, interbase communications and decision/mission support systems. Intrabase communications includes electronic mail, data access and file transfer between office automation networks (OANs) located throughout the base. Interbase communications are provided through AUTODIN, DDN, and commercial data networks. This will include OAN to DDN connections and an interface to AUTODIN via NTCCs for formal message traffic transmission. The decision/mission support system will provide pier facility connections allowing ships to interface with BITS directly. BITS will then make the required connections for long haul communications. [Ref. 64]

Essentially, BITS will handle all local communication requirements ashore. This specifically will include file transfer, interactive terminal to host computer capability, electronic mail, video teleconferencing, record (naval message) communications, voice transmission and connections to both SNAP and long haul systems. Voice communications will initially be handled through Private Automatic Branch Exchange (PABX) and then updated to the

Integrated Services Digital Network (ISDN). Data communications will initially provide for LAN to DDN connections, with DDN being upgraded to Integrated Data Services (IDS). Message communications will initially be handled through AUTODIN and eventually upgraded to IDS. [Ref. 65]

2. Long Haul Data Communications Architecture (LHDCA)

The Long Haul Data Communications Architecture (LHDCA) will be satisfied by the DDN. This includes both data and naval message communications. For message communications the current AUTODIN Switching Centers (ASCs) will be replaced by the automated I S/A AMPE during the conversion to DDN. ISDN architecture is planned which will integrate voice, secure voice and data services. Users will have a single access for these services. The backbone networks include Defense Switched Network (DSN), DDN and commercial services. [Ref. 66]

3. Afloat Data Communications Architecture (ADCA)

The Afloat Data Communications Architecture (ADCA) establishes:

> ...the baseline for enhancing the transfer of decision/mission support data between ships (at-sea and in-port) and the interface tc the shore-based connection to the long haul communications network, as well as ship-to-ship and shipboard. [Ref. 67]

It is subdivided in to four segments.

a. Ship-at-sea

This will be designed to handle the increased volume of traffic using technology improvements. These improvements include using data compression techniques and conversion from character oriented message formats to bit oriented message formats. Additionally, information filters are to be developed to screen data to determine the best method of transmission. This system would also include automatic format conversion where necessary. This system would allow the segregation of data into essential information, to be transmitted over the NTS, and information of a lesser priority which could be sent on tape, disk, CD-ROM or WORM. [Ref. 68]

b. Ship-in-port

This will allow ships inport to by-pass the existing NAVCAMS/NAVCOMMSTA structure and handle file transfers directly using BITS connections to enter into the DDN. In addition to file transfer, this system will provide the capability for interactive communications and electronic mail. [Ref. 69]

c. Ship-to-ship

File transfer and interactive communications are necessary to provide the ability to conduct parts screening aboard local ships and work package transmittals to tenders. The current proposal is to conduct these transfers inport over direct communications links and to continue to investigate new methods for at-sea transfers. [Ref. 70]

d. Shipboard

Methods to reduce manual intervention requirements will be implemented. This will include the installation of a direct SNAP/NAVMACS interface. The decision filters discussed above will be an integral portion of this architecture. Shipboard LANs are proposed to upgrade SNAP installations. [Ref. 71]

4. Evaluation

The NDCCA demonstrates the Navy's interest in developing a long term solution to its increasing information exchange requirements. It provides a top down, modular approach utilizing standardized interfaces to connect the entire system. While still in the developmental stages, the NDCCA is examining various standards and policies. It will then promulgate these standards as the new requirements for the Navy. The great advantage in this approach is that it is evolutionary in nature while still utilizing state of the art technology. Current systems will be merged into NDCCA. This serves to minimize risk while allowing for ongoing cost benefit reviews of each segment. The NDCCA appears to be a well conceived architecture which should satisfy the Navy's communications requirements of the future.

C. INTERIM PROPOSAL

With NDCCA scheduled for implementation around 1995, an interim solution to handle the Navy's information exchange requirements must be developed. The following is offered as a method to meet current demands while growing towards the planned NDCCA.

1. NAVDAC Host Computer Service

The DDN replacement of AUTODIN for long haul communications transfer will produce a direct interface with the NTS. This provides the opportunity for orderly evolution towards the NDCCA. Any information exchange proposal should provide for the connection of shipboard SNAP computers to the DDN. This can be accomplished through the use of host computers providing storage capability ashore in the form of "mailboxes" for individual ships. These mailboxes would accept information and store it until the ship is capable of downloading it to it's own SNAP computer. The host computer would likewise accept information from the ship for further transfer to activities connected to the DDN. Navy Data Automation Command (NAVDAC) would be the logical choice to provide host computer services. The DDN would be connected to both the host computer and the NTS.

This proposal addresses information exchange connectivity problems by dividing them into three areas determined by the ship's location. The first area is when the ship is inport in its own homeport. The second area is when the ship is inport but not in homeport. The third area is when the ship is underway. This at-sea segment must also address periods of no or reduced NTS message communication due to the imposition of EMCON or MINIMIZE.

2. Inport Homeport

While inport homeport, ships would utilize NTCCs and NAVCOMMSTAs as the interface for all electronically transmitted information. This includes Naval messages and SNAP data. DDN electronic mail and file transfer protocols could be added as an upgrade to information exchange capabilities. NTCCs/NAVCOMMSTAs are the logical interface point since both long haul naval messages and DDN information exchange applications will be transmitted over the DDN. Pier connections could be provided for high speed data lines, preferably fiber optics, to join ships and NTCCs/NAVCOMMSTAs. These communications facilities would provide TAC services for DDN functions, routing appropriate information to the DDN and into the NARDAC host computer. NAVCOMPARS processing protocols would be updated to permit automatic routing and the required format changes of electronic mail, FTP requests and naval messages for entry into the DDN. The NARDAC host computer would provide services for each ship homeported in its region of responsibility. Naval messages requiring long haul transmission would be routed to the assigned I S/A AMPE and into the DDN. Naval messages staying within NTS would be transmitted over satellite or HF fleet broadcast circuits using current procedures.

3. Inport Not Homeport

Connections can be made using modems. Dedicated leased data lines are preferred, when available, and dial phone lines are acceptable. These phone connections would tie in to the nearest available DDN TAC. Via this connection, electronic mail and FTP requirements would be transmitted to the ship's host computer mailbox. At the same time the ship would download all new information being held in its mailbox. Unclassified message traffic would then be sent from the host computer to a NTS interface where it would be converted into the correct message format and forwarded appropriately. Unclassified, administrative naval message traffic could be downloaded to the ship in a reverse procedure. This entails conversion by NAVCOMPARS equipment at the NAVCAMS, changing the naval message format into electronic mail format capable of being transmitted over DDN.

4. At-sea

The real problem in providing DDN connections for information exchange occurs with ships at-sea. While the NTS can provide a limited capability in this area, it is virtually impossible with current equipment to handle all of the required information. Several approaches are available for consideration. A combination of these approaches is necessary to optimize information exchange overall.

a. NAVMACS

The CUDIX/NAVMACS provides transmission to NAVCAMS where naval messages are transmitted following current procedures. SNAP data transfer can be accommodated using this means when necessary. Presently some ships have papertape interface between SNAP and NAVMACS systems. This can be upgraded to electronic transfer using tape or disk as the interface media. By using the same switching protocol addressed in the previous section this information could be automatically be converted to proper format and forwarded to the correct destination. Information for transmission in this manner could be placed in a queue in the NAVMACS system aboard ship and transmitted when the loading on NTS assets permits. Close attention to a prioritization scheme which would allow only high priority information to be sent via this method is essential. Alternate methods of information exchange would be preferable from a cost and equipment point of view. It is, however, important to remember that commanding officers should be allowed to make the determination as to the value of the information. A costing scheme for information exchange would enable this to occur in a logical manner.

b. Commercial Satellite

Commercial satellites provide a potential method of handling DDN type information exchange. Information would be transmitted using a SNAP to transmitter interface as above. This transmitter would be separate from those currently used with the NTS. Several systems are available for use.

(1) INMARSAT. The International Maritime Satellite Organization (INMARSAT) provides global coverage through a system of geostationary satellites and should be investigated as a possible transmission medium. Costs are decreasing as capability improves. INMARSAT is presently used for MLSF ships for message communications with satisfactory results. INMARSAT has been selected as the communications channel for the TRANSEAVER (Transportation by Sea, Verifications) system which provides a continual monitoring capability

for ensuring the security of nuclear material being transported at-sea. This system allows for regular communications between ships and land based monitoring centers. The computer link is between the ship, the land-based INMARSAT shore station, the public switching network and the monitoring computers. [Ref. 72]

(2) VSAT. Another variant in the commercial satellite arena is that of the very small aperture terminal (VSAT). The VSAT industry is rapidly establishing itself in the telecommunications area. VSAT provides an excellent means of handling data communications networking for businesses. The system uses a "star" network with all communications being directed through the hub station and then on to multiple remote stations. Communications originating at remote stations are sent to the hub station which can then relay information to other remote stations if desired. [Ref. 73]

VSAT uses C or Ku bands for transmission and produce bit error rates of 10^{-7}. Data rates are available from 9,600 bps to 2,048,000 bps. The antenna size is small, usually a 1.8 meter reflector. [Ref. 74] The cost of remote terminal sites range from $6000 to $12,500. The monthly space segment cost for a 56,000 bps network will be approximately $1000 to $1200. Commercial vendors estimate cost savings of 20 to 40 percent over their terrestrial communication counterparts. [Ref. 75] Present commercial coverage is available for the United States, Europe, the Mediterranean, Indian Ocean Region, Pacific Ocean Region, Atlantic Ocean Region and Caribbean. [Ref. 76]

As an additional note, it is important to realize the advantage of this system for crisis military operations. The system has great redundancy due to the large number of satellites and possesses the capability for spread spectrum techniques. Finally, should the decision be made to include non-tactical data transfer as one of the mission requirements for NTS, VSAT technology should be considered as an alternative to FLTSATCOM. VSAT can provide improved communications capacity and increased survivability at low cost. [Ref. 77]

The capability for data communication is presently available commercially and can be added to the cost equations in deciding how best to quickly transmit needed information.

c. Physical Delivery

There will always be times and circumstances when electronic transmission of data from ships at sea is not possible. The ship may be operating under EMCON or MINIMIZE conditions precluding the use of NAVMACS and NTS. Additionally, large volumes data with lower priority may reasonably be transmitted by physical means. This would include the mailing or hand carrying of data tapes or WORM disks.

A host computer can be configured to provide mailbox services for each ship. When the ship goes to sea the mailbox becomes the holding point for all incoming data. The ship will provide routing information in the same method in which mail routing information is currently handled. This information allows the host computer to forward the accumulated data to DDN sites in proximity with the at-sea unit. These facilities will make tapes or WORM disks of the data and forward them to the ships along with mail, personnel or parts deliveries. This is normally accomplished via Carrier Onboard Delivery (COD) and helicopter flights or replenishment ships. This exchange also allows the ship to send outgoing tapes for return delivery to the DDN site where the information is then transmitted back to the ship's host computer mailbox. [Ref. 78]

An accounting system is required to ensure that information is retained by the sending unit until a receipt acknowledgement is obtained. This would necessitate large buffer or off-line storage facilities both on the ship and at the host computer. This system would handle electronic mail, and more importantly, database and file transfer information including MILSTRIP, FAADC obligational reporting, 3-M information, and pay and personnel information.

The host mailbox can function as a duplicate ship's database, containing identical information to that in the ship's SNAP computer. This provides the added advantage of being a backup to the ship's system. Currently there is no off ship backup for the SNAP system. Fire or flooding could destroy a ship's entire database. The host mailbox and the shipboard SNAP computer would be updated whenever possible.

The development of a priority scheme would allow the optimum method of transmission to be chosen. WORM could be used if it is determined that magnetic tapes become a weight and space problem for COD or helicopter delivery. The capability of transmitting the data from overseas DDN sites would decrease the time delays and significantly improve performance.

5. <u>Connectivity Costs</u>

The Space and Naval Warfare System Command conducted a review in 1987 to determine the costs of providing connectivity between SNAP computers and DDN. The review proposed using to NARDAC sites on each coast and Naval Telecommunications Centers (NTCCs) overseas to provide the connection to the DDN. The following summary of this cost study demonstrates the relative low cost necessary to provide connectivity similar to interim proposal presented in this section.

a. Shore Requirements

Hardware costs include upgrading current Honeywell DPS 6/54 computers to DPS 6/75s at NARDAC Norfolk and NARDAC San Diego. The costs also include providing circuit connection to the DDN from these NARDACs and from overseas NTCCs. The total projected hardware cost is $425,000.

Software costs include obtaining DDN standard File Transfer Protocol, Simple Mail Transfer Protocol and TELNET Terminal Emulation Protocol for one time license fees. Annual service costs are estimated at $15,000. The total software costs are $105,000.

Initial integrated logistics support for cable connections and training are estimated to be $50,000.

This results in a total cost for the inport SNAP data transfer plan to be $580,000. [Ref. 79]

b. Ship Requirements

The shipboard hardware costs include the purchase of SNAP Intelligent Terminals and their supporting equipment. Provisions for one terminal per installation for 400 ships would cost $1,800,000. This is a representative cost to allow connection to the DDN inport. To complete the connection and provide for disk transfer of information from a SNAP connected terminal to a NAVMACS connected terminal in Radio Central would increase the cost to $5,190,000.

Software costs to support the shipboard installation are estimated at $610,000. This includes the software development costs required to execute the SNAP to SNAP terminal to NAVMACS terminal to NAVMACS in both directions. It also includes the one time commercial software cost for emulation and file transfer programs.

Integrated logistic support is estimated at $380,000. A total long term cost, to include backfitting of terminals on previously installed SNAP ships and to provide for direct hardwired connections between the two intelligent terminals, is projected at $13,490,000. [Ref. 80]

VI. CURRENT DEVELOPMENTS

Currently, there are two programs which have actually implemented a SNAP/DDN interface. In each case the objective has been to increase speed-of-service in transmitting large amounts of data. On the ship side, information has initially been entered and processed in the SNAP system. This information is transmitted via modem to a host computer and then, when long haul transmission is required, sent over the DDN to its final destination. One system, SDSA, uses the NTS to provide data transmission capability while at-sea.

A. SOURCE DATA SYSTEM AFLOAT (SDSA)

The Source Data System Afloat (SDSA) is a SNAP automated disbursing and personnel management system. SDSA provides for pay and personnel data entered in the SNAP system to be electronically transmitted to and received from ashore processing activities. These activities are the Naval Finance Center (NFC) for pay transactions and Naval Military Personnel Command (NMPC) for personnel information. Information is transferred via the NTS while the ship is underway and via the DDN while inport.

The SNAP systems aboard these two ships are configured with a papertape output from the SNAP computer which is compatible with the NAVMACS system in Radio Central. Data is prepared in the SNAP computer and inserted into the NTS without the need for reentry into message format. This provides a tremendous manpower savings due to the eliminated duplication of effort previously required and concurrently eliminates potential errors formerly introduced when data was being retyped into message format. This method of transmission is being used while the ship is at-sea.

When the ships are inport, information is transmitted over the DDN. A SNAP II Intelligent Terminal and a 2400 baud Hayes compatible modem provide the connection. This allows the ship to interface with commercial grade telephone line and connect to a dial-up TAC as the entry to the DDN. [Ref. 81] Again, additional duplication of data is eliminated and data is provided to NFC with same day service.

This system is currently undergoing Operational Evaluation (OPEVAL) aboard USS Fox (CG 33) and USS Trenton (LPD 14). The Naval Ocean Systems Center (NOSC) in San Diego is providing DDN host computer services. From NOSC the data is transmitted via DDN lines to NFC Cleveland or to NMPC Washington. The OPEVAL will serve to certify functional performance of

SDSA measured in terms of integrity and timeliness. "Integrity is defined as the percentage of good records received as compared to the total records transmitted. Timeliness is defined as an average number of hours to complete a given process." [Ref. 82] These results are independently examined for both NTS and DDN transmission methods.

Initial data from the USS Fox during the period from 21 January to 13 March 1987 demonstrated a NTS integrity percentage of 94% when corrected for initial format problems. This pay related information had an average processing time of two days. Magnetic tape was also forwarded to verify accuracy of data. The regular mail forwarding of magnetic tapes had an average delivery time of 5.5 days once it was introduced into the U. S. Postal System. Ship personnel also stated that payroll processing using this system has been reduced from days to hours. [Ref. 83]

The USS Trenton was evaluated during the period of 1 June to 28 August 1987. This portion of the OPEVAL included testing the inport DDN connection and HF communications at-sea. DDN integrity, both ship to headquarters and headquarters to ship was 100 percent. Average total transfer time was 20.5 minutes. The HF tests were inconclusive with only one message being sent during the test period. [Ref. 84] Informal correspondence concerning later HF testing shows positive results.

Fleet impact is elucidated by several comments made from a SDSA status report made by the USS Fox during her recent deployment.

> Data transmission is the intended strong point of SDSA. Events may now be transmitted and posted in a one day turnaround for a deployed unit. This is a dramatic improvement.
>
> SDSA has all but eliminated the large consumption of time and effort required for the preparation and submission of OCR documents.
>
> SDSA will keep pay accounts current and eliminate long delays between entitlements and their liquidation. Sailors will be able to understand their pay better and provide intelligent feedback to the Disbursing Office. [Ref. 85]

An additional function of the OPEVAL is to examine the ability of SDSA to reduce existing message traffic volume over the NTS. This will be accomplished by comparing all pay and personnel message traffic of the SDSA test ships to that of two non-test ships, the USS Bunker Hill (CG 52) and the USS Duluth (LPD 6). An analysis of the traffic volumes of the ships being monitored will provide important information on the expected impact that fleet-wide implementation of SDSA would have on the NTS. An initial report is due 31 March 1988.

While the OPEVAL is still on-going, the initial results indicate that this will become a successful program. The benefits of ease in processing, reduction of errors and improved transmission time are achieved with minimal dollar costs and impact on existing systems. Advantages gained by the DDN interface appear to be substantiated and should be continued. The results of the NTS traffic analysis study will be most interesting and merit close attention. This may provide the single most important factor in the determination of the viability of this system for at-sea use.

B. WATERFRONT MAINTENANCE MANAGEMENT SYSTEM (WMMS)

The Waterfront Maintenance Management System (WMMS) was established by the Commander Naval Surface Force, U. S. Pacific Fleet (COMNAVSURFPAC) in response to the need for improving fleet maintenance and logistic support. WMMS serves as a management aid in efficiently coordinating shipboard maintenance thereby ensuring that materially ready ships are available for the Fleet Commander. [Ref. 86]

> (Ship's) required maintenance is programmed through the 3M system in each units Coordinated Ships Maintenance Project (CSMP). Specific work items from each units CSMP are organized into Work Packages, the work is scheduled and accomplished at Repair Activities, and the labor and monetary costs of the work then reported to a central Navy data base at Navy Maintenance Support Office (NAMSO). This process is highly dynamic due to changing "customer" ship schedules...WMMS has provided automation of this data base and communication of work packages to provide maintenance to the Pacific Fleet and thereby ensure Fleet Readiness. [Ref. 87]

The primary objective of WMMS is to maximize the effectiveness and efficiency of maintenance dollars through the improved maintenance management provided by the system's decision support and communications capabilities. The use of a near real-time database and supporting telecommunications capability is essential in effectively meeting the ever changing needs of the Surface Force. Maintenance management demands that large amounts of detailed information be transmitted to appropriate logistic and maintenance activities as quickly as possible. Ship's schedules compound this problem by adding an ever changing geographic variable. [Ref. 88]

The enemy of the maintenance problem is time. Ships have operational commitments and maintenance availability is accommodated within these time constraints. Lost time due to communications and processing delays shorten parts procurement lead times. Parts expediting, required to meet operational commitments, is expensive. Additionally, emergent work requests for mission essential repairs requires that accurate information be quickly transmitted to allow specifications to be validated, parts procured, and when necessary, repair teams established and transported to the appropriate location. Finally, when commercial industrial support (CIS) services are required, the timeliness in which accurate and complete information is provided directly impacts the quality of work as well as the total cost.

WMMS provides shore based computers the ability to store and process required information. During fiscal years 1986 and 1987 this system was converted for operation on Digital Equipment Corporation (DEC) VAX series mini and microcomputers. This computer system is centered at COMNAVSURFPAC in San Diego. This master site has clustered DEC 8530 and 8250 minicomputers. Other sites include Pearl Harbor, Subic Bay, San Francisco, Yokosuka and Guam. This system is programmed in basic and has the following software modules: Current Ship's Maintenance Project, Work Package Tracking, Boiler/Diesel Inspection Tracking, Casrep Tracking, CIS Fund Tracking, Departure from Specifications Tracking, Ship Alteration Packages, and Industrial Plant Equipment Tracking. [Ref. 89]

WMMS requires an efficient telecommunications capability to become useful and this is provided by the DDN which allows:

User capable CSMP file transfer between sites, and user groups at sites, in fully automated form without technical assistance.

Use of electronic messaging systems between site users using MILNET or other DDN networks.

Provisions for high speed data connections to site area DDN Hosts.

Internet connections and usage via DDN access. [Ref. 90]

WMMS hosts use the Wollongong Group's WIN/VX package to provide the required DDN protocols.

WMMS is currently scheduled to evolve into the Maintenance Resource Management System (MRMS). The MRMS will combine and supersede existing Type Commander systems, developing into a standardized, SNAP compatible system for both the Atlantic and Pacific Fleets. Like WMMS, the MRMS will support Fleet and Type Commander maintenance staffs, Readiness Support Groups (RSGs), Intermediate Unit Commanders (IUCs), Intermediate Maintenance Activities (IMAs), and Ship Repair Facilities (SRFs). The standardized automated information system provided by MRMS is expected to significantly contribute to improvements in personnel productivity and material condition throughout the Fleet. This will be attained through "efficient allocation of maintenance resources, reduction in paperwork, and improved flow of information between key activities in the maintenance management process." [Ref. 91]

C. SUMMARY

The significance of WMMS and SDSA is that they demonstrate the Navy's perceived need for increased information flow. Each has independently accomplished the same goal of connecting shipboard SNAP systems to shore based computers by using the DDN. The DDN functions as the transmission medium for both ship-to-shore-to-ship and host-to-host information exchange. These successful systems portend the future where this capability will be expanded to include all of the ships information exchange requirements.

These programs represent the beginning of a new era in data exchange. It is important that a continued effort is maintained for development and expansion. In both cases the programs are evolutionary requiring constant feedback and review. Efforts must be made to ensure that the costs and benefits of these programs become available to the operational commanders. Proper evaluation of these programs will allow intelligent decisions to be made concerning their viability and the cost effectiveness of more inclusive programs using this technology.

VII. ANALYSIS

The most appropriate method of examining the potential value which a SNAP/DDN interface could provide is to review similar systems currently in existence. Any attempt to assign dollar values to the applications provided by the DDN would be mere speculation at this point. Even when considering SDSA and WMMS, the youth of these programs precludes sufficient data to determine actual dollar values. The number of major companies presently using computer systems with telecommunications capabilities similar to those provided by DDN are rapidly rising. The following discussion presents the impact that these systems have had on selected companies.

A. DDN APPLICATIONS

1. Electronic Mail

During the 1970's private industry began using various forms of electronic mail. Most of these systems were internal in nature and often used in multinational companies. Response in the commercial sector has been positive and it is expected that electronic mail will become a common form of information exchange in the future, much like mail today. The following industrial systems provide examples of applications similar to those required for use by the Navy.

a. Texas Instruments

Texas Instruments began using electronic mail in 1977. Electronic mail was rapidly accepted as demonstrated by the trends in the number of transactions. These numbers have increased from 10,000 per day in 1977 to 25,000 per day in 1979. Costs have decreased from eight cents to four cents per message during this same period. TI views this increase as positive and beneficial to the company despite of the overall expense of the system. They believe that increased speed-of-service, reduction of copying and messengering time, and better privacy of communications makes electronic mail cost effective with direct productivity increases. Company studies provided statistics demonstrating overall productivity increases for managers and administrators of 13 percent and 20 percent increases for secretarial/clerical personnel. These results suggest that the savings from productivity increases are of significant magnitude to recover system development costs in three years. [Ref. 92]

b. Volvo

Volvo implemented a private electronic mail system in 1980, connecting the company's management throughout the world in 1983. In 1986 they had over 350,000 transactions daily. This represents a steady growth rate since 1980. Volvo research has shown that "...in the business world, four out of five phone calls fail to reach the intended party on the first try. Internal mail correspondence at Volvo averages two to two-and-a-half days as opposed to Memo (electronic mail), which is immediate." [Ref. 93] This is compounded with the difficulties of time differences that a world wide organization must content with when voice communications are used. Volvo studies show that their use of electronic mail increases productivity about five percent in addition to making communications easier for their personnel. [Ref. 94]

c. Digital Equipment Corporation

Digital Equipment Corporation initiated their electronic mail system in 1977. It was done to minimize the lost time between engineers when they attempted to contact each other. The system was rapidly developed and expanded. Digital conducted a cost justification study to determine the economic impact of electronic mail. The study compared the cost of electronic mail versus the costs incurred by methods of communication which would have been used in lieu of electronic mail. The study revealed a bottom line figure of thirty percent savings using electronic mail over more conventional communications methods. This figure increases as the number of recipients per message increases. Additionally, Digital felt that there were many intangible factors not taken into account which makes electronic mail even more advantageous. [Ref. 95]

d. Electronic Mail Assessment

Electronic mail provides an excellent method for rapid communication. It affects organizations in the following ways. First, it provides the potential to improve subformal communication within the organization. This can directly improve organizational effectiveness. Second, it can transmit information instantly, at low cost. Systems are now available which can transmit messages throughout the world crossing between private and public networks with a typical cost of twenty cents [Ref. 96]. Third, it can improve organization efficiency. A study by the Navy Personnel Research and Development Center revealed that officers felt that electronic mail reduced both the number of memos sent and the number of meetings held [Ref. 97]. The overall conclusion is that electronic mail is a great benefit to an organization and is a wise investment.

2. File Transfer Protocol

An equivalent commercial application of file transfer protocol is demonstrated by a technique called electronic data interchange (EDI). This technique is being used by companies including Wal-Mart and J. C. Penney Co. to transmit formatted documents between different company's computers.

> It lets companies use fewer data-entry employees, thus eliminating human error and avoiding delays of days or weeks. It can lower inventory levels, eliminate lost invoices, and improve customer service, since customers can respond faster to customer needs. [Ref. 98]

While using this system at Wal-Mart, specific savings were observed including, a fifty percent reduction in delivery time and a 31 percent sales increase. This was attributed to the more responsive stocking of product lines facilitated by EDI. J. C. Penney Co. saw a 59 percent sales increase in its Stafford brand suits, again attributed to the quick turnaround and ability to immediately adjust to the customer's demands. [Ref. 99]

The ability to quickly transmit data between locations is directly related to costs. The above examples demonstrate the type of cost saving possible. Significant saving are also expected in Navy applications. In addition to cost savings, there are also intangible benefits derived from this type of capability. These include the reduction of paperwork and improved performance gained through the ability to rapidly share instructions, directives and programs.

The addition of TELNET to FTP provides the capability to actually enter another command's database. This allows requesting commands access to information without imposing additional administrative demands on fleet units.

It is important to consider two factors when evaluating electronic information exchange. First, there is a synergistic effect which occurs in this area of electronic automation. As the number and variety of applications increase, the overall benefits of such systems multiply at a faster rate. Specifically, the more capable the system is as a whole, the more efficient the utilization of the system. Second, the value of electronic information exchange to a specific organization increases as the number of users increase. The analogy here is that of the telephone. The true value of the telephone system was realized once the entire country was interconnected. These factors hold true in the evaluation of the Navy's systems. A capable system which is interconnected with a large number of like users provides maximum benefits.

B. CONNECTIVITY

As discussed in previous chapters, the difficulty of connectivity is the most significant problem to overcome in establishing a workable SNAP/DDN interface. Costs are relatively inexpensive to provide ship to DDN connections for ships inport. At-sea connectivity is an entirely different matter however. The most readily available and inexpensive approach to accommodate information exchange for ships at-sea is to implement an efficient system for physical transfer of tapes and WORM disks as described in Chapter V. This improves the speed-of-service and has no adverse impact upon the NTS. Long range solutions should include the possibility of increasing satellite capability, both Navy and commercial. Until the utilization of the limited bandwidth of the NTS is improved, the NTS will simply not be able to provide the desired quantity of administrative data.

C. PEOPLE PROBLEMS

During the author's review of the SNAP system, it became obvious that significant problems exist in the fleet concerning the use and understanding of the system's capabilities. These problems must be addressed before the true benefits of a SNAP/DDN interface can be realized. A large number of problems can be discussed by examining the two areas of education and training.

1. Education (Understanding of capabilities)

Education is that area concerned with the understanding of the system's capabilities. This needs to be addressed during the instruction of personnel who are dependent upon data maintained by the SNAP system. This includes commanding officers, executive officers, department heads and division officers. A managerial approach to using the SNAP system as a method to more effectively perform in supervisory positions must be presented. The system will not function effectively if active involvement from the top does not occur. Supervisory personnel must be taught the potential of the system as a management tool. An understanding of the query system for ad hoc requests is necessary. These personnel should know the kinds of information available through SNAP and that additional requirements can be obtained by own ship programming or through requests submitted up the chain of command.

Active involvement will be required to ensure that officers become aware of the services available through the DDN. Only through their support and effort will the system become effective.

2. Training

Training deals with the actual operation of the system. It goes hand in hand with education. User personnel at all levels must be provided hands on training. This training should provide sufficient time for the users to fully acquaint themselves with the system. Currently this is not occurring. Formal training is non-existent for work center personnel and there are no plans to provide this training in the future [Ref. 100]. This is viewed as a significant shortfall by the surface type commander's ADP officers on both coasts. [Refs. 101,102] Discussions with recent graduates of Surface Warfare Officer Department Head School also indicated that they felt the training was inadequate.

Until a concerted effort is mounted to both educate and train officer and enlisted personnel, SNAP will not be used to its true capabilities. The administrative burden that SNAP was created to reduce will not be improved. To effectively implement a SNAP/DDN interface, proper training and education are essential. Personnel must appreciate and understand the capabilites of SNAP and combine that knowledge with that of the DDN. This instruction is as important as the hardware itself. The Navy must direct sufficient resources to this area to obtain the benefits that the system is capable of providing.

VIII. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

The results of this study indicate that the additional services provided by a SNAP/DDN interface would be most beneficial to the United States Navy. The immediate value of DDN pier connections is the relief that would be provided to the NTS by serving as an alternate means for electronic communication. Even a message reduction of ten percent, gained by this connection, would buy years of additional time to implement long term information exchange solutions.

An equally significant result of this connection is the improvements to organizational efficiency which it can provide. The improvements of informal communications and the resultant increase in organizational slack are significant. Paper reductions gained from improved methods of maintaining and transmitting required information would be extremely valuable. This could reduce the administrative effort required of shipboard personnel by eliminating the necessity for paper-prepared reports and the time devoted to shipping and receiving them. The reduction of the paper itself is beneficial from storage, ship's endurance, and damage control perspectives. The fact that most information will be maintained in the SNAP system creates standardization of administrative processes between the fleets. The ability of shore commands to extract information from ship's systems effectively acts to shift a portion of the administrative load ashore.

Direct electronic at-sea connectivity is available in the near term only through the NTS. This provides a valuable capability for ships which can be exploited when necessary. It is essential, however, that the Navy rapidly develop alternate means of handling high volume information exchange at-sea. WORM provides a cheap, light weight, small volume medium for transferring data ashore. Information thus provided to DDN capable commands can greatly improve upon current speed-of-service. Host computers providing mailbox services complete the loop. Commercial satellites could also provide a cheap and readily available method for transmitting this information ashore.

B. RECOMMENDATIONS

The shore portion of the SNAP/DDN interface should be implemented at the earliest possible time. Improvements to our capabilities at-sea require immediate consideration.

A training plan must be developed and implemented at the time of the connection. This plan must contain provisions for ongoing training with emphasis on

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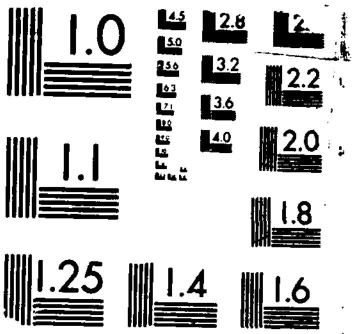

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off-ship training. Mobile training teams with classroom capability need to be established. This program must include the education of management applications in addition to simply providing operator level instruction.

The development of costing data for the various types of information exchange is a necessity. Armed with accurate information on the actual costs for different methods of information transfer, intelligent decisions can be made on the value of these capabilities. When combined with the forthcoming data from WMMS and SDSA, investigators will be able to assign weights to the time value of information. This allows for determining the optimum mix of the different technologies. Expert systems could then be designed to act as a filter to route information from the ship to the required destination in the most cost effective manner.

The most important recommendation is that continuing studies of the pilot programs must be maintained. The results of these studies need to be promulgated to the senior operational warfare commanders. It is these operational commanders who must become involved with the process of determining the correct mix of telecommunications capabilities. The Navy can ill afford to continue to have support communities dictate the limits of the Navy's information capacity. The warfare communities must make those decisions by determining their requirements and evaluating them concurrently with ships, planes and weapon systems.

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APPENDIX

GLOSSARY OF ACRONYMS

ADCA	Afloat Data Communications Architecture
ADP	Automated Data Processing
ADM	Administrative Data Management Subsystem
ARPANET	Advanced Research Projects Agency Network
ASC	Automatic Switching Center
AUTODIN	Automatic Digital Information Network
BITS	Base Information Transfer System
BPS	Bits Per Second
CDA	Central Design Activity
CD-ROM	Compact Disk - Read Only Memory
CIS	Commercial Industrial Support
CNO	Chief of Naval Operations
COD	Carrier Onboard Delivery
COMNAVSURFPAC	Commander Naval Surface Force, U.S. Pacific Fleet
COMNAVTELCOM	Commander Naval Telecommunications Command
COSAL	Consolidated Ships Allowance Listing
CSMP	Current Ship's Maintenance Project
CUDIX	Common User Digital Information Exchange
DAMA	Demand Assigned Multiple Access
DARPA	Defense Advanced Research Projects Agency
DCA	Defense Communications Agency
DCS	Defense Communications System
DDN	Defense Data Network
DOD	Department of Defense
DSN	Defense Switched Network
EMCON	Emission Control
FAADC	Fleet Accounting and Disbursing Center
FLTCINC	Fleet Commander in Chief
FLTSATCOM	Fleet Satellite Communications Satellite
FSB	Fleet Satellite Broadcast
FTP	File Transfer Protocol
HF	High Frequency
IDS	Integrated Data Services
IUC	Intermediate Unit Commander
IMA	Intermediate Maintenance Activity

INMARSAT	International Maritime Satellite Organization
IP	Internet Protocol
I S/A AMPE	Inter Service/Agency Automated Message Processing Exchange
ISDN	Integrated Services Digital Network
LEASAT	Leased Satellite
LHDAC	Long Haul Data Communications Architecture
MDS	Maintenance Data Subsystem
MILNET	Military Network
MILSTRIP	Military Standard Requisitioning and Issue Procedures
MLSF	Mobile Logistics Ship Force
MRMS	Maintenance Resource Management System
NAMSO	Navy Maintenance Support Office
NARDAC	Navy Regional Data Automation Center
NAVCAMS	Naval Communications Area Master Station
NAVCOMPARS	Naval Communications Processing and Routing System
NAVCOMMSTA	Naval Communications Station
NAVDAC	Navy Data Automation Command
NAVGRAM	Navy Mailed Message Program
NAVMACS	Naval Modular Automated Communications Subsystem
NAVMASSO	Navy Management Systems Support Office
NDCCA	Navy Data Communications Control Architecture
NFC	Naval Finance Center
NMPC	Naval Military Personnel Command
NOSC	Naval Ocean Systems Center
NTC	Naval Telecommunications Command
NTCC	Naval Telecommunications Center
NTS	Naval Telecommunications System
NWP	Naval Warfare Publication
OAN	Office Automation Network
OCR	Optical Character Reader
OPEVAL	Operational Evaluation
OPTAR	Operating Target
OTCIXS	Officer in Tactical Command Information Exchange System
PABX	Private Automatic Branch Exchange
PSN	Packet Switching Node
RSG	Readiness Support Group

SDS	Source Data System
SDSA	Source Data System Afloat
SECNAV	Secretary of the Navy
SFM	Supply & Financial Management Subsystem
SIMA	Shore Intermediate Maintenance Activity
SMPT	Simple Mail Transfer Protocol
SMS	System Management Subsystem
SNAP	Shipboard Non-tactical ADP Program
SSIC	Standard Subject Identification Code
SSIXS	Submarine Satellite Information Exchange System
SRF	Ship Repair Facility
TAC	Terminal Access Controller
TACINTEL	Tactical Intelligence Subsystem
TADIXS	Tactical Data Information Exchange System
TCP	Transmission Control Protocol
TELNET	Terminal Network Protocol
TRANSEAVER	Transportation by Sea, Verification
UHF	Ultra High Frequency
VSAT	Very Small Aperture Terminal
WHOIS	A DDN user directory
WMMS	Waterfront Maintenance Management System
WORM	Write Once, Read Many
3-M	Material Maintenance Management Program

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