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THE IMPACT OF THE DEFENSE MESSAGE SYSTEM (DMS) ON THE UNITED STATES SURFACE NAVY

by

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The Impact of the Defense Message System (DMS) on the United States Surface Navy

by

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TABLE OF CONTENTS

I. INTRODUCTION....................................1

A. SCOPE....................................2

B. THESIS OUTLINE....................................2

II. AN OVERVIEW OF THE DEFENSE MESSAGE SYSTEM.........4

A. CONDITIONS FOR CHANGE....................................4

B. THE SCOPE OF DMS....................................5

1. AUTODIN....................................7

2. E-Mail....................................8

C. THE PHASES OF DMS....................................9

1. The Baseline (Naval Systems Emphasis).....10

2. Phase I (1989 - 1994)....................................11

3. Phase II (1995 - 2000)....................................15

4. Phase III: The Target Architecture (2001 - 2008)....................................17

D. CONCLUSION....................................19

III. DMS NETWORK LINKAGE TO BASE-LEVEL USERS: BITS......21

A. BITS/DMS NETWORK TERMINOLOGY: AN OVERVIEW....21

1. ISDN....................................22

2. OSI....................................24

3. GOSIP....................................25

4. X.400/X.500 Protocols....................................26

B. BITS ARCHITECTURE....................................27

1. BITS Objective....................................28

2. Planning Phases....................................29

3. Network Security....................................31

4. BITS Architecture....................33
C. CONCLUSION....................36
IV. AUTOMATED SHIPBOARD MESSAGING: AN EVOLUTION....................38
A. CURRENT SHIPBOARD MESSAGING SYSTEMS....................38
1. In Port Messaging....................39
2. At-Sea Messaging....................41
B. HOW DO WE GET THERE FROM HERE?....................43
1. Shipboard LAN: SAFENET II....................43
2 The Future: Copernicus....................46
C. CONCLUSION....................51
V. CONCLUSION: FUTURE EFFECTS OF DMS ON THE NAVY....................52
A. SURVIVABILITY....................52
B. LOGISTICS CONSIDERATIONS....................53
1. Manning....................54
2. Training....................56
C. SECURITY....................57
D. LOOSE ENDS....................58
LIST OF REFERENCES....................59
INITIAL DISTRIBUTION LIST....................62

I. INTRODUCTION

The Defense Message System (DMS) is a bold attempt to bring the Department of Defense (DoD) and its communications and message distribution systems into the twenty-first century. This communications evolution will rely heavily on technologies being developed in industry which promise to revolutionize both the computer and telecommunications fields (i.e., Integrated Services Digital Network (ISDN), fiber optic communications, Open Systems Interconnection (OSI), etc.).

The DMS is merely an aggressive "phased" plan of action which will overhaul and combine aging DoD communications systems that have suffered in the past from labor-intensive procedures, antiquated equipment and the inability to meet the tremendous demands that are being placed on them. This much needed renovation will be achieved by the complete redesigning of a worldwide telecommunications network to replace the DoD's aging Automated Digital Network (AUTODIN).

The AUTODIN is often overtaxed as it is limited in its capacity to expand due to its reliance on outdated, inflexible technologies. DMS will be based on highly efficient and inexpensive computerized communications networks that provide sufficient capacities to meet future DoD messaging demands.

A. SCOPE

This thesis will examine, from the messaging system user's perspective, the basis of the DMS program as it pertains to the DoD in general and the Navy specifically. A closely integrated DMS development program requires the evolvement of all the components of the DoD, from the highest levels in the Pentagon down to the "radio shack" on Navy surface ships, to circumvent the potential "pitfalls" of technological renovation on this scale.

As DoD-wide telecommunication innovations are set in motion, it is anticipated that there will be tremendous cost savings as a result of reductions in the manual processing that has plagued the current messaging system. Along with the promise of cost savings is the unfortunate potential for cost growth. This cost additive condition might occur as a result of needs to provide duplicate communication systems, as the technological advances of the "new-age" in digital communications find themselves heavily dependent on other, simultaneously developing technologies (i.e., ISDN, X.400/X.500, etc.). These "other technologies" will be defined in terms of their role in the DMS development and their potential to either revolutionize DoD telecommunications or hopelessly entangle it due to program delays.

B. THESIS OUTLINE

To lay the foundation for the total revamping of the DoD messaging system, the DMS establishes a starting point as it maps its way toward an intended target architecture by the year 2008. Chapter II will outline the justifications and objectives of the DMS program as it passes through each phase of its metamorphosis.

Chapter III examines a vital link to the DMS evolution, that establishes the groundwork for a user-level connection to the worldwide messaging network. This vital link, as it pertains specifically to the Navy, is the Base Information Transfer System (BITS). BITS is a Navy specific, base communication modernization plan, that will provide the vital shore-based interface to the DMS network.

As DMS planners approach the waterfront, the system design becomes complicated by the fact that most Navy ships go to sea periodically and, therefore, require special consideration. The established ship-based ship-to-shore message system currently requires two systems, one for in port periods and another while at sea. Recent developments in shipboard telecommunications will be presented in Chapter IV in an attempt to close the gap between shore-based messaging and the special requirements for at-sea users.

Chapter V presents a novel twist to the DMS evolutionary process as it concludes the thesis by examining the ramifications of a rapidly shrinking gap between communications and computers in the DoD while reshaping shipboard messaging as "The Impact of the Defense Message System on the United States Surface Navy" becomes significant.

II. AN OVERVIEW OF THE DEFENSE MESSAGE SYSTEM

The Defense Message System (DMS) is a Department of Defense (DoD) evolutionary implementation plan that is intended to provide an integrated messaging system based on the concept of standardization and interoperability, while remaining flexible enough to be responsive to individual organizational needs [Ref.1:p 1-4]. The starting point of the DMS will be the DoD messaging system as it existed in September 1989, and will pass through three major phases before it arrives at its expected target architecture in the year 2008. This final architecture will establish a direct link between the writer of the message and its intended reader in an attempt to speed-up the message communication process while reducing costs by taking advantage of modern computer and communications systems.

A. CONDITIONS FOR CHANGE

The problems and costs of the current messaging system were compounded by the lack of standardization and the heavy reliance on manpower-intensive procedures. This slow and expensive system suffered from the absence of a DoD-wide communications architecture, as each individual service struggled to meet operational requirements with a mixed bag of antiquated networks, computers, protocols and procedures. Adding to the argument for modernization was the fact that as the computing speed and available transmission bandwidth increased in the marketplace, the costs associated with these advancements were decreasing rapidly.

In January 1988, as budgetary constraints became ever more prevalent and the existing messaging systems began to reach their operating limits, the Assistant Secretary of Defense for Command, Control, Communications and Intelligence (ASD/C^3I) brought together a working group to establish a strategy for the development of a DoD-wide system. This working group was a joint DoD effort, and by February 1989 they had developed and validated a comprehensive planning document known as the Multi-command Required Operational Capability for the Defense Message System (DMS MROC 3-88). [Ref.1:p. 1-1]

To date, the DMS has been driven by MROC 3-88 tasking, and DoD working groups have since produced several iterations of very extensive planning documents. The remainder of this chapter will be dedicated to the examination of the planned phases of the DMS, development criteria and key evolutionary considerations.

B. THE SCOPE OF DMS

The focus of the DMS will concentrate on all hardware, software, procedures, standards, facilities and personnel that are currently involved in any aspect of the existing DoD strategic messaging system, to include both tactical and allied interfaces [Ref. 1:pp. 1-1 -- 1-2]. The primary DMS development efforts will concentrate on a rather extensive set of objectives that have been mandated by MROC 3-88 [Ref. 1: pp. 1-5 - 1-8]:

* Connectivity/Interoperability
* Guaranteed Delivery/Accountability
* Timely Delivery
* Confidentiality/Security
* Sender Authentication
* Integrity
* Survivability
* Availability/Reliability
* Ease of Use
* Message Preparation Support

Each DMS objective has been measured against the service quality of the existing system (Baseline system) to ensure that there is true progress during the evolutionary process, with the underlying goal being to reduce cost and staffing requirements [Ref. 1:p. 1-7].

The DMS will gather under one umbrella all forms of narrative messaging systems currently employed in the DoD. The term "narrative message" is defined in allied communication publications as "any thought or idea expressed briefly in plain or secret language, prepared in a form suitable for transmission by any means for communications." Within the scope of the DMS, of "means of communications" will be limited to electronic methods. Under "electronic means", there are currently two primary classes of message in use and those are:

* Organizational - These are commonly known as "Commanding Officer-to-Commanding Officer" messages. Because of their official nature, these messages impose critical operational requirements on the communication system [Ref. 1:p. 1-3].

* Individual - This class of message has found an electronic foothold with the advent of computer networks. It is often in the form of "working" communications between DoD personnel and of an administrative nature [Ref. 2:pp. 10 - 12].

The mission of the DMS will be to handle every message with an appropriate level of service quality with respect to its classification, content and precedence. Currently, electronic messages are being handled by the following components:

1. AUTODIN

AUTODIN is the primary of the current messaging system, and will increasingly be required to interface with Local Area Networks (LANs) and Office Automation Systems (OASs) as DMS evolves. It is for this reason that DoD has selected the X.400 Message Handling System protocol (MHS) as the DMS standard. Like the current AUTODIN system, X.400 uses the store-and-forward message transfer system. The AUTODIN system is of 1960s vintage and is comprised of many outdated, labor-intensive elements, which are the prime target of the DMS automation.

The following is a listing of the major components of AUTODIN [Ref. 2:pp. 12-14]:

* AUTODIN Switching Centers (ASCs). The 15 ASCs are distributed around the world and provide the primary store-and-forward message switching, message validation, format conversion and routing functions [Ref. 1:p. 2-1].

* Automated Message Processing Exchanges (AMPEs). There are over 100 AMPEs and despite the fact that they all perform roughly the same mission they have different equipment, procedures and names (i.e., Army's Automated Multi-media Exchange (AMME), Navy's Local Digital Message Exchange (LDMX) and the Air Force's Air Force Automated Message Processing Exchange (AFAMPE)) [Ref. 3:p. 59].

* Telecommunications Centers (TCCs). There are over 1000 TCCs and they are the primary input and output points of the current AUTODIN messaging system. It is these TCCs that are targeted by DMS planners for limited messaging system automation, but eventually they will be phased out.

2. E-Mail

Currently, the Defense Data Network (DDN) is providing the backbone for the transportation of the bulk of the data being transmitted in the DoD [Ref. 4]. In the near future, the DDN will be acting as the primary transportation medium for the DMS as the message traffic currently transmitted via the AUTODIN network will be migrated to the DDN backbone [Ref. 5:p. 76].

The existing DDN backbone system includes [Ref. 2:p. 13]:

* Host computers that support E-Mail
* On-line directories
* User terminal access for Personal Computers (PC)
* DoD Classified Internet:
  - DSNET 1. Defense Secure Network 1 for classified General Service (GENSER) Messages.
  - DSNET 2. Worldwide Command and Control System (WWMCCS/Classified Messages).
  - DSNET 3. Sensitive Compartmented Information (SCI/Classified Messages).
* DoD Unclassified Internet
  - MILNET
  - ARPANET

Each equipment that operates on DDN serves a double function: first as a general purpose Automatic Data Processing (ADP) machine, and secondly as an E-Mail handler, which adds to the diversity of the system. [Ref. 2:p. 13]

C. THE PHASES OF DMS

The phased implementation, as designed by DMS planners, is intended to deliver the message directly from the writer to the reader by gradually pushing the so-called AUTODIN "line-of-demarcation", currently located at local TCCs, directly into each command. This evolutionary transition will span nearly 20 years, beginning with the Baseline system of 1989, and culminating with the Target Architecture by the year 2008. Figure 1 summarizes the more significant elements of the DMS phased evolution [Ref. 5:p. 9].

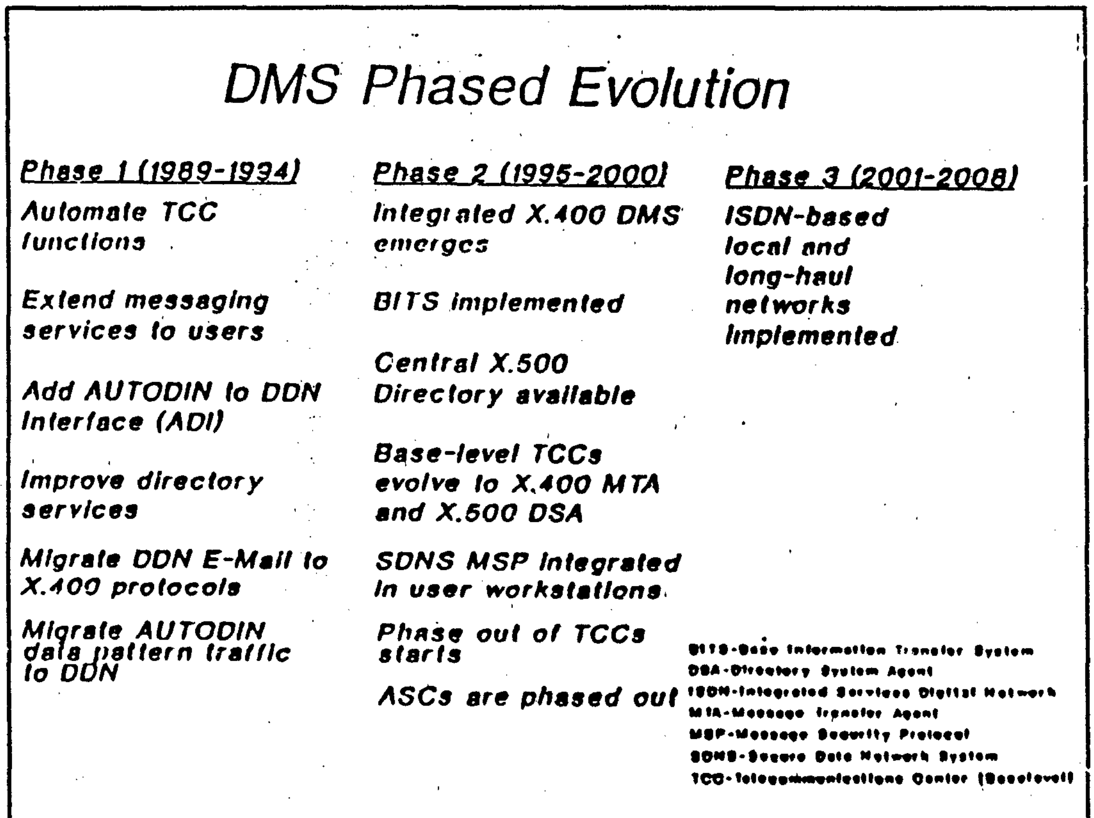

Figure 1. Summary of DMS Phases

1. The Baseline (Naval Systems Emphasis)

Figure 2 illustrates the Baseline Architecture for the DMS which has two main elements, the AUTODIN for organizational messages, and the DDN E-Mail service for individual messaging [Ref. 1:p. 2-2]. Naval organizational messaging is supported by the linking of a TCC to the Naval

Communications Processing and Routing System (NAVCOMPARS), which houses the Navy-operated ASCs and provides directory services based on the Message Address Directory (MAD).

Processing a Naval message through the AUTODIN system is very laborious and often requires additional processing at local TCCs on either an LDMX, a Regional Information Exchange Terminal (RIXT), or if all else fails, by hand. Once these messages arrive at this "line-of-demarkation", the user part of the baseline messaging system ends, and additional manual processing and routing must occur before the message reaches its intended destination.

Individual messaging (E-Mail) is provided via the DDN, with directory services provided by the Network Information Center (NIC). The Navy currently has no applicable policy or standards established to cover E-Mail carried over the DDN. [Ref. 5:p. 12]

2. Phase I (1989 - 1994)

The first phase emphasizes the automation of TCCs in an attempt to reduce manning, while starting the push to extend the messaging system to the users [Ref. 1:p. 4-1]. To aid in this automation, the DoD plans on deploying additional transitional components into the field, such as AUTODIN directory improvements, AUTODIN to DDN Interface (ADI) capability, and the transition of DDN E-Mail from the Simple Mail Transfer Protocol (SMTP) to X.400 (MHS) [Ref. 6].

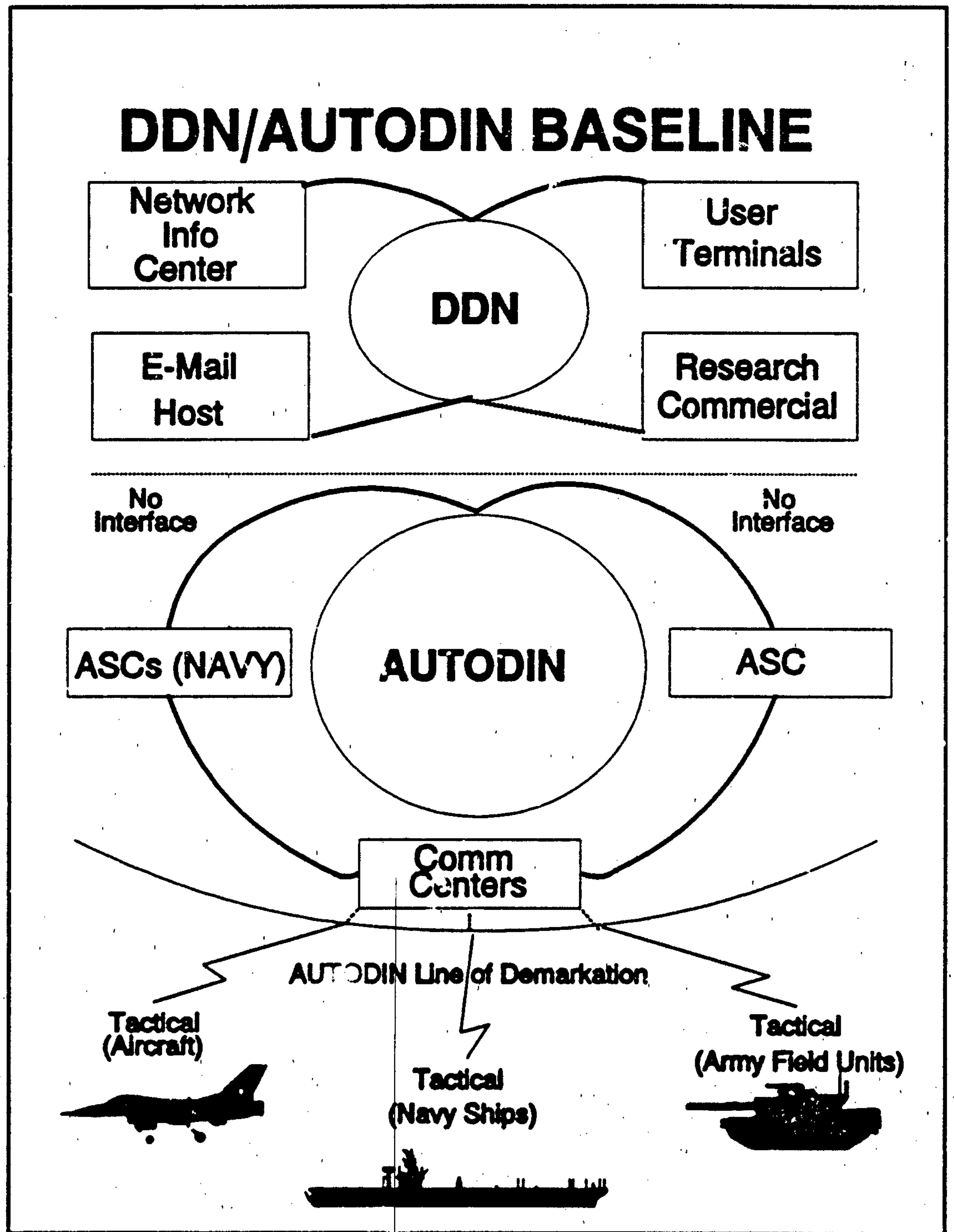

Figure 2. DMS Baseline (1989)

Finally, during this period, AUTODIN data traffic will begin to migrate to the DDN for transport purposes [Ref. 5:p. 32].

TCC automation promises significant cost savings as the DoD will be able to plan on reducing certain manning requirements of TCC which is characterized by labor intensive procedures and the "hard copy message" generations to provide Over-the-Counter (OTC) services. Currently, there are PC-based systems available that will allow users to deliver and receive messages via diskette media. (The MTF Editor, a PC-based messaging systems, will be covered in Chapter IV.) This state of the art computerized automation is the first true step toward the intended writer-to-reader relationship that DMS planners envisioned.

Figure 3 depicts the proposed DMS Phase 1 architecture which, for the first time, shows an AUTODIN-to-DDN linkage [Ref. 7]. Of special noteworthiness is the AUTODIN-DDN Interface (ADI) gateway that is outlined in Figure 3 by a dotted-line. This gateway has significant security problems because it will link, for the first time, the AUTODIN, a multi-level secure system, to DDN which does not currently meet Defense Communications Agency (DCA) message security requirements [Ref. 6]. At the end of this phase, AUTODIN and DDN E-Mail will continue to act as separate yet interoperable systems [Ref. 5:p. 33].

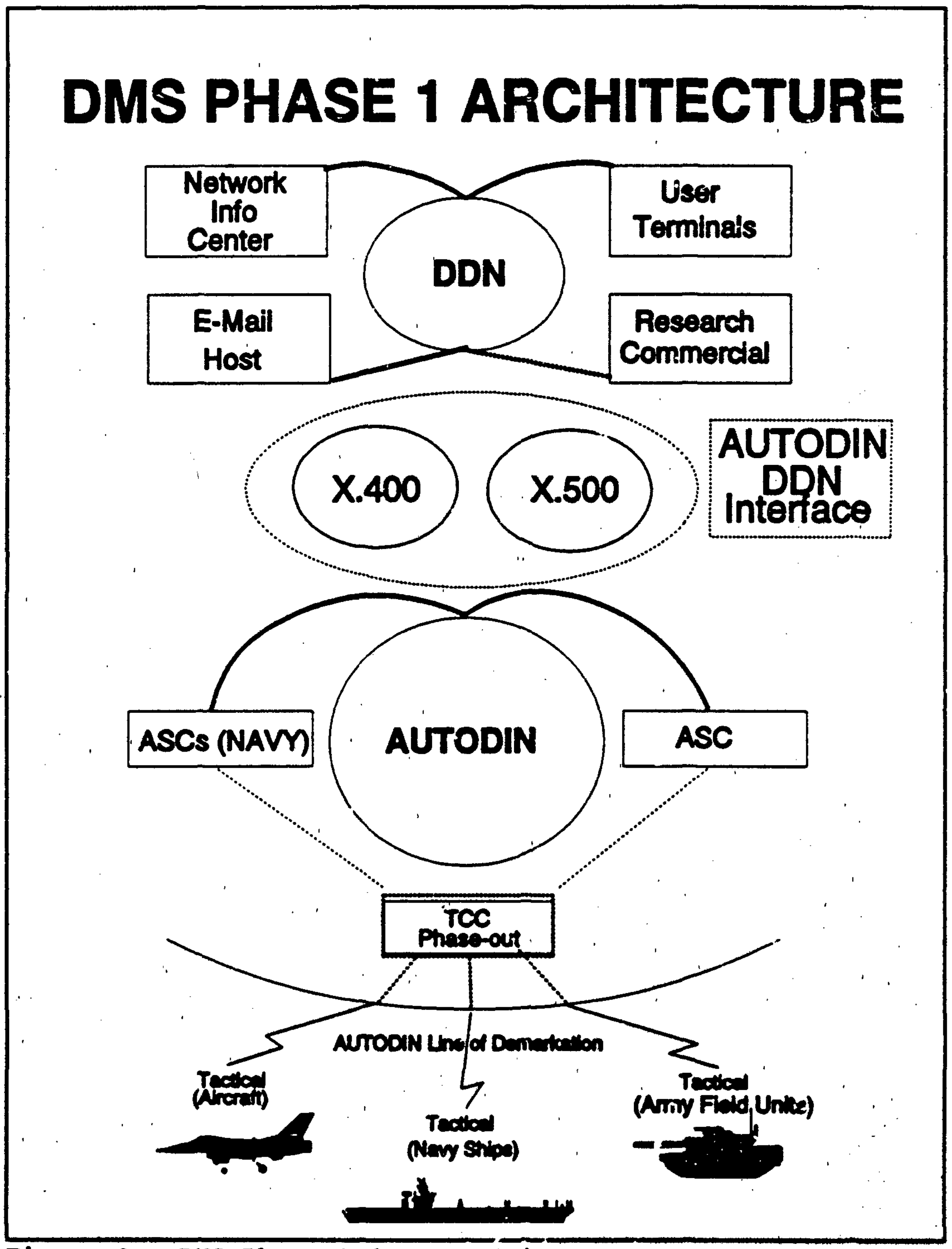

Figure 3. DMS Phase 1 (1989-1994)

3. Phase II (1995 - 2000)

Figure 4 represents the Phase II architecture which is scheduled for completion by the year 2000 [Ref. 7]. During this period, tremendous modifications are planned that will overhaul DoD messaging such as [Ref.1:p. 4-3]:

* Accelerated phaseout of TCCs.
* Combining DSNET and MILNET for the purpose of inter-base connectivity, which will form the Secure Data Network System (SDNS), with data security provided by Message Security Protocol (MSP).
* Base level deployment of the Installation Information Transfer Systems (IITS). IITS is one of the first key elements of the planned Base Information Transfer System (BITS) and will lead to the complete phaseout of TCCs (BITS planning will be examined in Chapter III).
* Installation of the Organizational User Agents (OUA) and User Agent (UA) as defined by the X.400 protocol will shift message transmission and receipt responsibilities closer to the user.
* An integrated X.400 Message Transfer Agent (MTA) and X.500 directory services shall be completed.
* Phaseout AMPEs and ASCs.

The use of international standards and protocols such as Government Open Systems Interconnection Profile (GOSIP) will allow the DoD to take advantage of systems and softwares developed by industry, as opposed to having everything customized to meet "militarized" specifications (GOSIP and X.400 will be discussed in Chapter IV). This new computer and communication "systems" development mindset goes hand-in-hand with current DoD purchasing mandates such as Commercial Off-the-Shelf (COTS) buying, Non-Developmental Items (NDI) and Commodity Purchasing (CP).

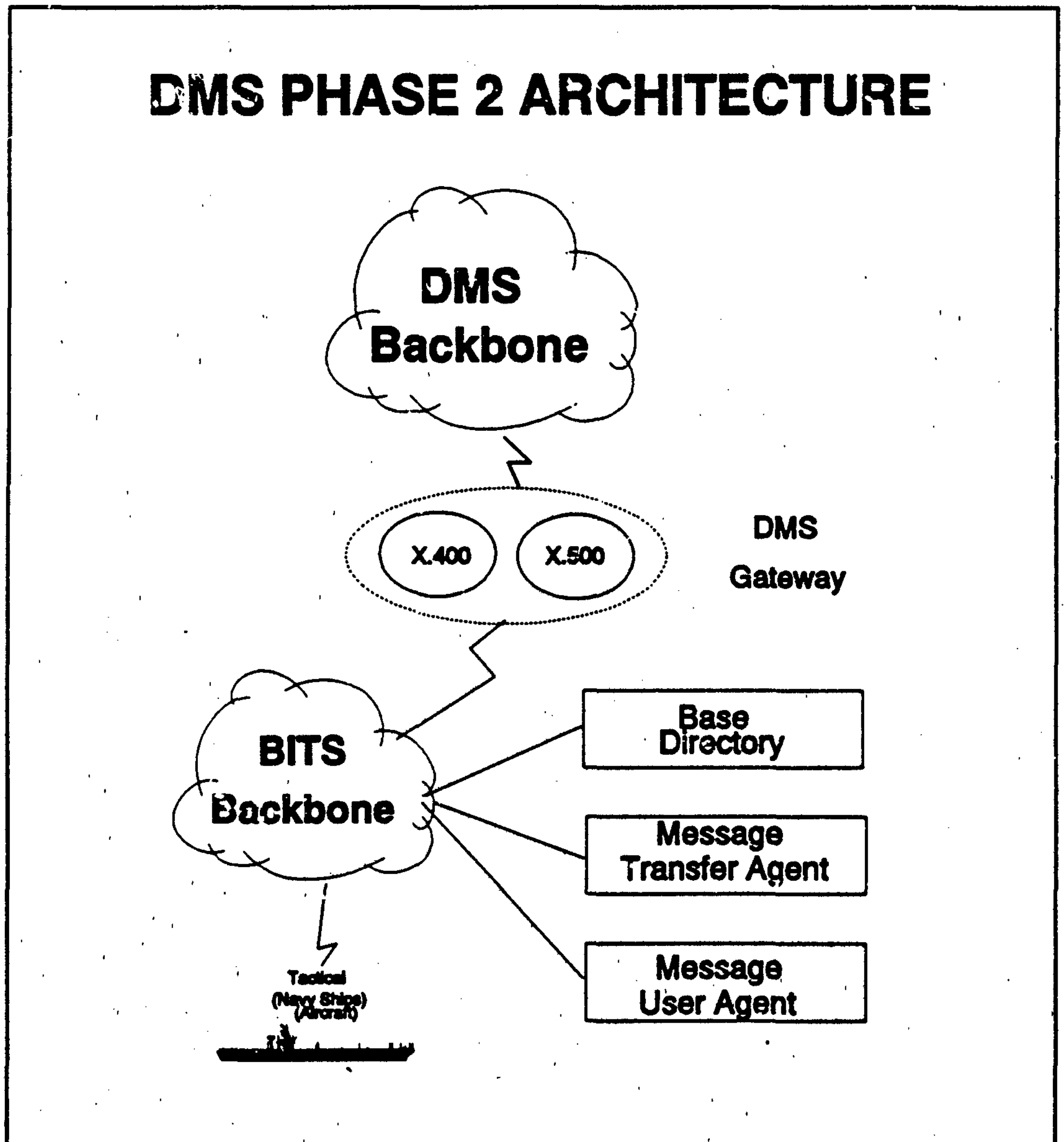

Figure 4. DMS Phase 2 (1995 - 2000)

By the completion of Phase II the foundations of Integrated Digital Network Services (ISDN) shall be laid at the base level (BITS). ISDN technology, which sports a relatively large bandwidth and high data transmission rates, will allow the ultimate integration of voice, data, video and narrative messaging via one transmission media. However the Navy still has ships that deploy and are not able to take advantage of the larger ISDN bandwidth using present transmission capabilities. It is for this reason that special accommodations for fleet interfaces are being planned that will modify the large "overhead" required to transmit X.400 messages so that "at-sea" messaging will not be all that much different from that being performed in port.

4. Phase III: The Target Architecture (2001 - 2008)

The third and final phase of the DMS, as depicted in Figure 5, actually begins when the last AUTODIN ASC is finally phased out [Ref. 7]. During this phase, the local and long-haul backbone networks will be fully integrated to form the Defense Information System (DIS). The DIS will be an ISDN-based global network, of which the DMS segment will continue to be the SDNS. Although the development of BITS local loops are not actually part of the DMS, their maturity along with other DMS components is essential for the successful completion of the Department of the Navy's (DON) portion of the overall system [Ref. 5:pp. 132-134].

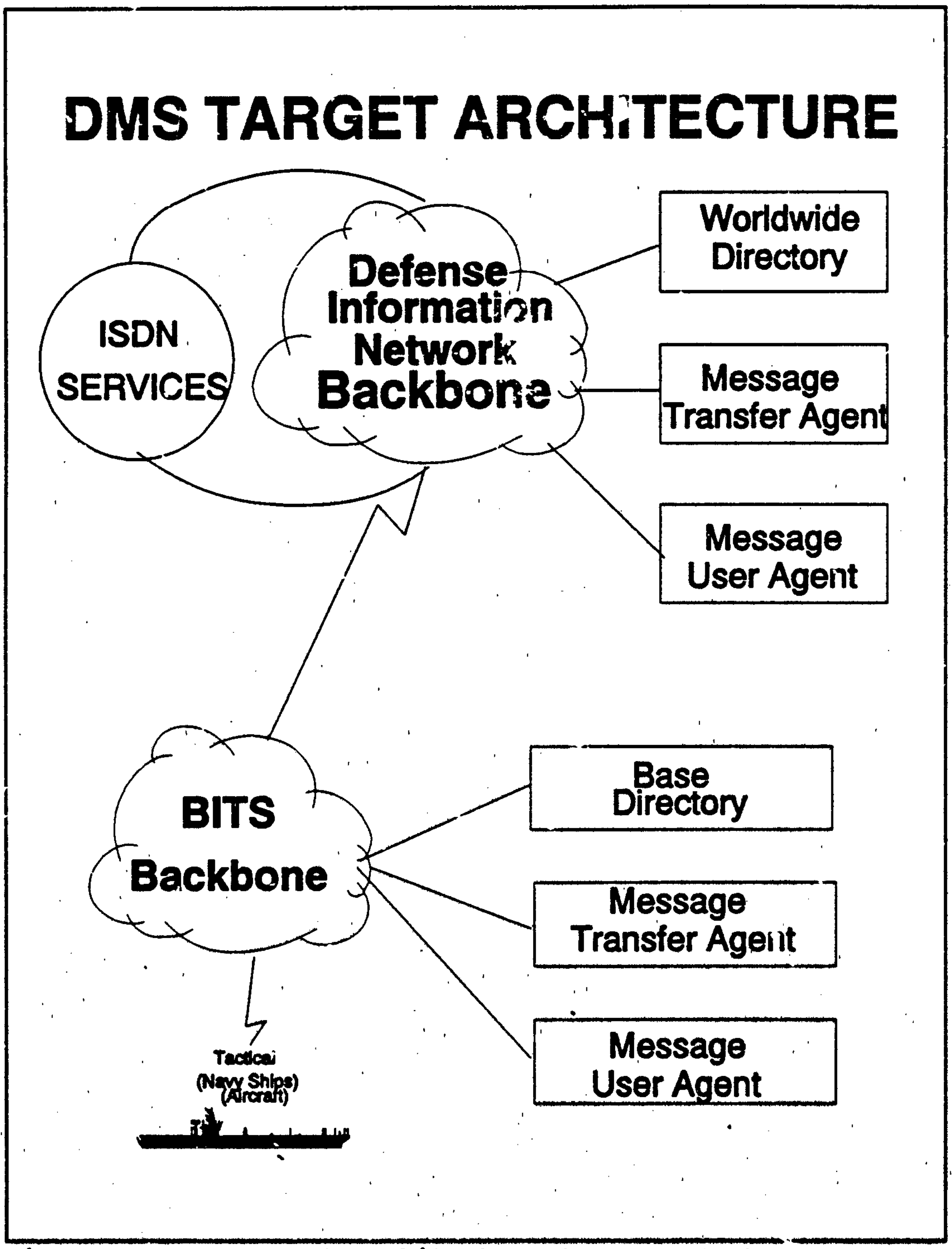

Figure 5. DMS Target Architecture (2001 - 2008)

Transition from AUTODIN message text format, known as U.S. Message Text Format (USMTF), to the X.400-compatible Common Message Format (CMF) will put an end to the different styles and procedures currently used to generate individual and organizational messages [Ref. 1:pp. 4-3 - 4-4].

As more advanced signaling techniques become implemented on ships for at-sea users, transmission speeds great enough to support X.400 will allow complete DMS messaging availability to all DoD components. (At-sea messaging will be covered in Chapter IV.) Communications planners anticipate that by the year 2008, the DMS, as it is intended today, will be a fully operational messaging system for the DoD. [Ref. 6]

D. CONCLUSION

The underlying drive to implement the DMS is the requirement to increase the productivity of the DoD messaging system while trimming a considerable amount of its operating expense. Cost savings and service improvements are always noble goals for any management project. A quick review of the phase implementation planning of the DMS reveals that while the objectives are aggressive, the use of international standards and commercially developed automation communication systems and components will go a long way in meeting these goals.

The only foreseeable drawback to the DMS planning is that each phase is closely tied to one another, with multiple and overlapping systems, which may create delays. The division between phases is blurred by the requirement to be able to link the new with the old at all times. The DoD's track record for holding onto and extending the service life of equipment may become a stumbling block to DMS planners. Finally, by placing a heavy reliance on technological advancements and "other" independent yet interoperable systems' concurrent development (i.e., BITS, ISDN and Fleet Interfaces), the intended Target Architecture completion by the year 2008 may be a difficult mark to hit.

III. DMS NETWORK LINKAGE TO BASE-LEVEL USERS: BITS

In the previous chapter, network jargon was used to explain the implementation planning of the DMS system, i.e., ISDN, GOSIP, X.400 and X.500. The scientific definitions behind this network terminology are beyond the scope of this thesis. However, a fundamental understanding of concepts surrounding these key telecommunication/computer technologies are important to the DMS/BITS user. Therefore, a brief overview of several significant network concepts will be presented in the following pages. These concepts will serve as the building blocks to explain the linkage between DMS and the Base Information Transfer System (BITS).

A. BITS/DMS NETWORK TERMINOLOGY: AN OVERVIEW

The key to the successful implementation of the DMS system is to provide a computer-based (digital), high-speed and inexpensive transmission medium to transmit large volumes of data (messages). In communications, the measure of transmission capacity is euphemistically known as "the size of the pipe". In the past, the DoD had been shackled to a very narrow "pipe" in the form of copper wire-line and radio (Microwave Line-of-Sight (LOS), Satellite Communications (SATCOMM) or High Frequency (HF)) for its long-haul messaging systems, all of which are based on slow and costly analog methods for transmission.

With the advent of high speed, inexpensive computing, coupled with tremendous improvements in digital transmission methods and rapidly decreasing prices in fiber optic technologies, we now have access to networks that can handle transmission rates in the millions of bits per second (MBPS). The rub lies in the fact that currently there are smaller Local Area Networks (LANs) that can operate at rates around 100 MBPS, and when they and other communication services (voice, image, data and video) demand integration, the networks will require tremendous transmission capacity which is not currently available. This is where technologies based on Integrated Services Digital Network (ISDN) and the Open System Integration Reference Model (OSIRM) begin to bridge the gap between the long-haul networks and LANs, or the DMS and the BITS.

1. ISDN

The BITS architecture will be built around the installation of ISDN technologies at the base-level. ISDN is a set of telecommunications rules and standards, set by an international communications organization known as CCITT. The CCITT defines ISDN as [Ref. 8]:

> An ISDN is a network, evolved from the telephony Integrated Digital Network, that provides an end-to-end digital connectivity, based on CCITT recommendations, supporting a wide spectrum of user needs including voice and non-voice services.

End-to-end digital connectivity simply means that if you pick up the phone in your office and make a call, the person on the receiving end will be the recipient of a totally digital transmission, all the way down to the wire that connects the phone to the wall. This DoD-wide digital connectivity is what BITS and the DMS are banking on to provide a rapidly maturing worldwide communications backbone. ISDN goes well beyond mere voice communications as the CCITT definition implies. Ultimately, ISDN will provide digital transmission services including data, text, graphics, music, video and voice, all of which will be integrated through one "pipe." The benefits of ISDN are in the following three areas [Ref. 9:p. 743]:

* International standardized services for world-wide compatibility.
* User-to-network interface standardization to bring down the price of terminal equipment and network equipment, while increasing their capabilities.
* Improved network-to-network communication, to increase the throughput of data from end-to-end.

As ISDN technologies take root around the world, there are industry experts that claim that the channel architecture currently being developed is too restrictive and will quickly become inadequate to handle the data rates required for such things as High Definition Television (HDTV) and 100 MBPS LANS. To respond to these critiques, ISDN is looking at its second generation, known as Broadband ISDN (B-ISDN), which will provide a very large "pipe". [Ref.10]

2. OSI

Computer and communication technology has evolved quickly over the last few decades, and recently the boundaries between them have become blurred. Most recently, computer based networks, from the prevalent PCs to the powerful mainframes, have become the communicator's fare. This rapid growth suffered from unregulated growing pains, as different networks found it difficult to communicate with each other. This untenable situation prompted the International Standards Organization (ISO) to develop an architecture, known as the Open System Interconnection (OSI) Reference Model. This model defines data communications standards that will allow different networks to interconnect. [Ref. 11:pp. 3-9 - 3-10]

The OSI Reference Model is a seven-layer architectural structure, with each layer having a distinct function. Table I is an illustration of the layered structure, with each layer's specific functions defined. The concept of the layering can be confusing, but the premise behind it is simply to provide industry manufacturers with a frame of reference by which they can build their systems independently, with certain proprietary bells and whistles, while conforming to OSI standards to provide interconnection capabilities with other systems. [Ref. 9:pp. 15 - 18]

TABLE I.
OSI Reference Model: SEVEN LAYERS AND FUNCTIONS

LAYERS	FUNCTIONS
APPLICATIONS	Communications between processes.
PRESENTATION	Formating and displaying of data.
SESSION	Coordination and administration of process data.
TRANSPORTATION	Reliable end-to-end transfer of data.
NETWORK	Routing and switching of data packets.
DATA LINK	Reliable data packet transfer.
PHYSICAL	Bit-stream transmission

3. GOSIP

The Federal Information Processing Standard (FIPS) 146 is more commonly know as the Government OSI Profile (GOSIP). It was established to provide vendors with a common set of data communication protocols so that independently-developed systems, produced under GOSIP, can interconnect. As of August 1990, GOSIP was designated as the official network reference model for all US government agencies. It is felt that by establishing GOSIP as the standard protocol suite, the government, and DoD specifically, will lead the way in pushing telecommunications toward international network interconnectivity, with an added dividend of fair and open competition between vendors [Ref. 11:p. 3-1]. This DoD-wide push for industry acceptance was given a "shot in the arm" when, late in 1990, the Navy issued a Request For Proposal

(RFP) to the tune of $75 million for the first GOSIP products and services [Ref. 12:pp. 2 and 6].

The earliest versions of GOSIP will be dealing with the many and varied network architectures currently fielded, by the use of a "gateway" between networks. A gateway is a networking term used to describe a device (or merely software) that is used to link dissimilar or heterogeneous networks at the "network layer" of the OSI Reference Model. Its next major objective, as relevant to the DMS, is the transition from the Simple Mail Transfer Protocol (SMTP), currently being used on the DDN, to the X.400-based Message Handling System (MHS). [Ref. 13:pp. C-11 - C-13 and C-B-30]

4. X.400/X.500 Protocols

CCITT has defined the X.400 protocol primarily as a Message Handling System (MHS). A MHS is used for transmitting electronic messages through communication systems, end-to-end, from the originator to the reader. The MHS is comprised of User Agents (UAs) and Message Transfer Agents (MTAs). A UA will compose a message at the originating end of the network, and another UA at the receiving end will accept it. Between these UAs will be one or more MTAs that will be responsible for the transfer of the message from one UA to the other. Within the DMS structure, this UA (originator) to UA (receiver) relationship will push the message delivery function past the "line of demarkation" currently in place in the "baseline" AUTODIN system. [Ref. 13:p. C-D-8]

The CCITT X.500 standard defines a directory service which will provide a user-friendly naming and name-to-address mapping functionality [Ref. 12:p. C-D-9]. Simplistically, this means that if a DMS system user would like to send a message to their college professors, Dr. Suh and Dr. Boger, the originating UA merely accesses the X.500 directory and addresses this salutation "TO: Dr. Suh and Dr. Boger", the directory will then fill in the actual network address and send it on its way.

This MHS promises to provide data security, message store-and-forward functions, access to worldwide directories of users via the X.500 directory services, and international network connectivity under the auspices of the GOSIP protocols [Ref. 14: pp 48, 60 and 63]. These protocols are not without their faults as they require a very large "pipe" with fast data rates to push a message, wrapped in an X.400 envelope, through the system. This tremendous amount of data "overhead" is currently one of the major restricting factors to the full implementation of the DMS to all users, namely the Naval at-sea subscribers [Ref.6].

B. BITS ARCHITECTURE

The DMS requirement for base-level connectivity compelled each branch of the DoD to develop ISDN/GOSIP upgrades for all their facilities. For the Department of the Navy (DON), the responsibility was delegated to the Commander, Naval Computers and Telecommunications Command (NCTC) for systems concept development, testing and installation [Ref. 5:p. 110]. From the initial planning came the BITS program, under the aegis of the Telephone Modernization Plan (TMP). The TMP was a key element of the Navy Data Communications Control Architecture (NDCCA) which, in 1988, separated Naval data communications into three sub-architectures, of which the base-level (BITS) was one [Ref. 11:pp. 3-7 - 3-9]. The underlying motivation for NDCCA was that, although most base-level telephone systems were adequate, they lacked standardization and were prone to costly failures. The goal was to both modernize and institute international standards in these new BITS systems, thereby taking advantage of ISDN innovations and meeting DoD-directed GOSIP requirements.

1. BITS Objective

The principle objective of the BITS architecture was to provide base-level integrated network management with worldwide interoperability and connectivity. The BITS system quickly became locked into the phased implementation planning of the DMS architecture since DMS is one of the services available through ISDN modernization. Other BITS objectives included:

* Service availability upon demand.
* Network integrity -- as measured by the system's ability to send and receive without introducing errors above an acceptable level.
* System reliability -- by the use of redundant and modular systems. This reliability will also be facilitated by the implementation of GOSIP standards.

* Serviceability -- also provided through modular and redundant design.

The successful fulfillment of the BITS objectives will allow each base-level DMS/BITS user access to a standardized and transparent network that meets all DoD GOSIP requirements, while providing ISDN services integrating voice, messaging, data, imaging and video. [Ref. 13:pp. C-27 - C-30]

2. Planning Phases

In December 1986, the Chief of Naval Operations (CNO) directed the Naval Data Automation Command (NAVDAC) to develop a procedure that could be used as a standard throughout the Navy for BITS implementation. This CNO tasking resulted in the BITS Requirements Identification and Planning Program. This central planning effort was instituted to provide for standardization and projected cost savings by virtue of their market buying leverage. [Ref. 13:p. C-3]

Under NAVDAC's guidance, each base would develop a customized Base Communications Plan (BCP) which would identify and account for interbuilding and interactivity communications, all the way down to the waterfront. Once completed, the BCP will then be turned over to the NCTC commercial buying facility which will then design a BITS Modernization Plan. This modernization plan will then be developed into a Request For Proposals (RFPs) to solicit contract bids from the private sector. The overall BITS planning and development process will pass through the following phases: [Ref. 13:pp. C-4 - C-6]

* Phase I (baseline): Each base identifies a BITS point of contact who coordinates all efforts in the development of the initial Life Cycle Management (LCM) documents. This is the first step in any major DoD acquisition program.

* Phase II: Each base develops a BCP with the assistance of NAVDAC under the direction of the base commanding officer.

* Phase III: Technical specifications are drawn to meet all DoD requirements with guidance from OPNAVINST 2800.3.

* Phase IV: The contracting officer releases the RFP and the contract is awarded.

* Phase V: BITS is installed and tested.

It is forecasted that the majority of the Naval bases will have completed the initial BITS installation sometime after 1996 which will meet DMS phase I mandates; however, it is not expected that this will mean total ISDN conversion. ISDN technologies will be implemented as they become available and will be used as the basis for intrabase data transport among DMS processing equipment and ADP equipment, and will provide interbase (off base) connectivity. As ISDN matures, the Navy plans on its implementation to meet the needs of DMS's Phase III high data rate requirements by the year 2008. [Ref. 13:p. C-66]

Although BITS is a Navy program, it is also required to interface with DoD programs such as the DMS, SDNS and finally the DIN. The DMS program requires joint DoD programs to monitor its worldwide progress and to insure total interoperability. There must be close ties between the DoN-level BITS and the DoD-level DMS, especially when dealing with the X.400 MHS and X.500 Directory Service phase-in.

3. Network Security

As networks have evolved over the past ten years, so have their security problems. Nowhere is the problem of network security more critical than in a DoD communication system. The protection of military messages (data), classified or unclassified, is of the utmost concern for both the DMS and BITS designers. The protection of a network goes well beyond mere data security as the physical integrity of the cabling and equipment loom at the forefront of any DoD security officer's planning.

As a culmination of the combined efforts of private industry, academia and the DoD, the National Computer Security Center (NCSC) has established a specific set of computer system security evaluation criteria in a publication known as "the orange book", so named for the color of its cover. The criteria were intended to be used as an assessment tool for the evaluation of security attributes of any computer/communication system, and has recently become the standard by which security requirements and accreditation have been dictated. As Table II illustrates, the NSCS security criteria are organized into four divisions ranging from A to D, with A being the most secure division [Ref. 15:pp. 260 - 263]. Each division is further segmented into classes, and it is by these class categories that most systems are evaluated.

TABLE II.
NSCS "ORANGE BOOK" SECURITY CLASSIFICATIONS

Division D:	Minimal Protection
Class D:	Minimal Protection
Division C:	Discretionary Protection
Class C1:	Discretionary Security
Class C2:	Controlled Access
Division B:	Mandatory Protection
Class B1:	Labeled Security
Class B2:	Structured Protection
Class B3:	Security Domains
Division A:	Verified Protection
Class A1:	Verified Design
Beyond Class A1	

Guided by the NSCS evaluation criteria, DoN has drawn up specific security requirements for all their new computer and communications systems [Ref. 13:p. C-51]:

* Protection of unclassified yet sensitive information.
* Data aggregation and inference control, and protection of ship movement information.
* Changes in operational environment/scenario.
* Separation of classified and unclassified data.
* Sufficient network controls to meet NSCS accreditation.
* All unclassified networks will meet at least NSCS Class C2 level requirements.
* All classified networks will meet at least NSCS Class B2 level requirements.
* All gateways will meet at least the NSCS Class B3 level requirements.

The target security architecture for the BITS system is similar in design to the National Security Agency's (NSA) proposed SDNS. SDNS is the DoD messaging network scheduled to replace DDN.

> The SDNS will use NSA-provided, high-grade cryptographic algorithms for data encryption and traffic key generation to assure confidentiality of communications. State-of-the-art key management techniques will be used to minimize the burden associated with generation, distribution, accounting, and control of classified key in physical form. [Ref. 13:p. C-55]

The BITS network will be designed around cryptographic protection via concepts known as end-to-end encryption (E^3) and BLACKER. For example, E^3 security is similar to the encryption methods that protect current messages being transmitted from ship-to-shore. If the encrypted message was intercepted by some unauthorized source it would be very difficult to decipher in a timely fashion. The BLACKER program is being developed to support multilevel security systems, specifically for networks such as DMS and BITS. [Ref. 13:pp. C-51 - C-56]

4. BITS Architecture

The foundation of the BITS architecture is based on several components such as an ISDN-compatible backbone cable plant, an ISDN switching complex and network gateways. These will be used as a Navy-wide standard upgrade to allow a uniform migration toward the BITS Target Architecture by 1994.

The BITS Target Architecture, as illustrated in Figure 6, will be configured in such a way that all base elements, including ships that are pier-side, will be interconnected to an ISDN switching complex and cable plant [Ref. 13:p. C-30]. From the switching complex, the BITS network will interface with the DoD long-haul communications system (currently DDN and AUTOVON). The switching, monitoring and billing of the entire system will be controlled by a Network Management Center (NMC) which will soon be replacing TCCs as the primary communications element at each base.

The base switch complex will be the key to the BITS transition due to the mix of private switches and equipment currently in use on many bases. This switching center will be the location on base where all services will be integrated and distributed for either intrabase (on base) or interbase (off base) connectivity. To date, the technology critical to achieving a low-cost, efficient integrated switch is limited and, therefore, remains as a stumbling block for BITS planners. [Ref. 13:p. C-34]

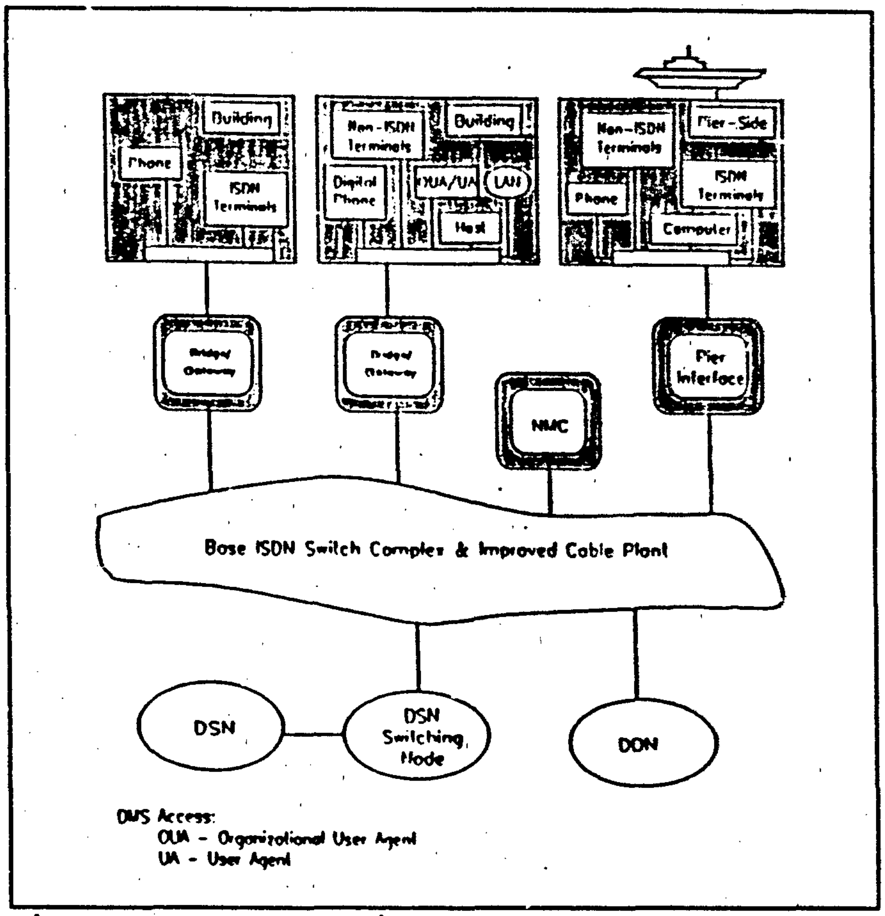

Figure 6. BITS Architecture

The transmission media options that are being considered to provide the base backbone cable plant are the currently installed copper twisted-pair wiring, a total base retrofit with fiber-optic cabling or a combination of the two. These media will be required to meet international ISDN standards and will be connected to all users to provide the base-wide and DoD-wide network services.

Pier-side interconnection between a shore-based system and a ship at the pier is unique, in that currently telephone service is provided by the base system while messaging (data) is not handled via an intrabase exchange. The fact that ships at sea will be using their own means for the transmission of both voice and messages further complicates the situation, as one communication system is required for ships in port to interface with BITS and another is required for those at sea. The difference in bandwidth requirements alone is critical to both the DMS and BITS implementation. In the interim, current Naval messaging systems will retain most of the responsibility for message delivery to ships either at sea or in port. The target for a fully operational ISDN pier-side connection will be to provide connectivity to the DMS via the BITS with sufficient bandwidth for both voice and data services by the year 2001 (DMS Phase III). [Ref. 13:p. C-31]

The Network Management Center (NMC) will be the center of the BITS system as it attempts to meet the needs of a diverse group of base users. The interface of the base network to the pier-side alone is like providing flexible service capacity to several floating cities whose operating schedules make their arrival and departure totally unpredictable. This large traffic variation will be managed through the NMC automated management resources and automated communications switches.

C. CONCLUSION

As integrated services become available through BITS implementation, the control and management of these services within each base will become more and more complex. The requirement for the maintenance of the base's portion of the DMS X.400 MHS and X.500 directory, combined with a full range of BITS support functions, will require a fully-staffed and automated NMC. Currently, there is no NMC-equivalent on most bases, with the only facilities even close in functionality being the Naval Telecommunication Centers (NTCCs) which provide AUTODIN connectivity to the base subscribers. Phone services are provided by a "mixed-bag" of Private Branch Exchange (PBX) equipment and wire-line services, which are normally managed and maintained by local telephone companies or telecommunications equipment vendors. It seems that the cost savings derived from the reduction of manning and antiquated equipment at base NTCCs, as envisioned by DMS planners, will be partially absorbed by the BITS requirements for NMC staffing and network equipment.

IV. AUTOMATED SHIPBOARD MESSAGING: AN EVOLUTION

In the previous chapter, it was explained that one of the most difficult aspects concerning both the DMS and BITS planners was the shipboard interface. While in port, ships might be able to link directly into the intended base network (BITS). But, when they get underway, there remains a transmission capacity problem that cannot quickly be dismissed. This chapter will concentrate on the various systems that are currently being developed to bridge the gap between the manually-intensive shipboard messaging systems currently in use and the systems meeting the degree of automation required to satisfy DMS architectural demands.

A. CURRENT SHIPBOARD MESSAGING SYSTEMS

At present, there are several methods used to process messages onboard ships, ranging from pen-and-ink message drafting to computer-assisted processing and routing systems. Most ships are using two procedures for messaging: a slow and labor-intensive system while in port and a rudimentary computerized system while at sea. The determination as to whether a ship is to have an elaborate computerized messaging system is based on mission requirements and cost. With the advent of inexpensive and highly-efficient PCs and "user friendly" word processing software, the gap between the "have's" and "have not's" in automated message processing has narrowed.

1. In Port Messaging

The vast majority of the fleet still uses pen-and-ink message drafting while in port. These drafts are routed through the ship's chain-of-command until they reach the person with message releasing authority, who is usually the commanding officer. By the time the message has been passed through this gauntlet, known as "the chop-chain", the draft is nearly unintelligible due to the line-outs and rewrites that clutter the page.

A releasable message will now be passed to the ship's Radioman, who will retype it on a standardized DoD form known as a "DD-173", with a special Optical Character Readable (OCR) type setting. Special processing codes will be assigned, and the message will be routed for final release. This labor-intensive process usually goes through several iterations due to typing or formatting errors before the message leaves the ship. Unfortunately, the message is not yet in the communication system because it must now be hand-delivered to the local communication center (NTCC). It is at the NTCC that the message will be input into the messaging system via an optical scanner. Usually there are errors introduced into the system during the scanning process, and these, if not caught initially, will slow the system downstream, as an operator will have to manually reprocess the message before it reaches its destination. Once it arrives at the destination NTCC, it will be processed and hand-carried to its intended addressee.

As desktop computers began to appear in the fleet during the mid-to-late 80s, the Marine Corps began development of message generation software known as Message Text Format (MTF) Editor. The MTF Editor is an easy-to-use message preparation software package that allows a message drafter to create, format and transmit United States Message Text Format (USMTF) formatted messages. The MTF Editor is designed to run on an IBM compatible PC. With special devices such as a paper tape punch or an OCR "daisy-wheel" printer, it can significantly reduce the degree of manual processing that was required by the old system. [Ref. 5:p. 47]

The most recent release of MTF Editor includes a "floppy" diskette read-and-write capability. This function was developed to meet the DMS Phase I requirement for diskette message delivery and receipt at local NTCCs. By delivering messages to the NTCC via a diskette, error-prone optical scanners will quickly become a thing of the past. This message automation capability is very cost efficient because it does not require a dedicated computer system to run it.

An interesting linkage has developed between the BITS and DMS systems as a result of the MTF Editor's "next generation" which is planning a modem or gateway interface that will allow messages to be sent to and received from the

NTCC electronically, and thereby eliminating the hand-delivery required in the present system [Ref. 16]. This electronic delivery of messages is an added bonus and was not in the original DMS or BITS planning.

2. At-Sea Messaging

Ships at sea are connected to the AUTODIN via several Navy-operated communications stations, known as NAVCAMS (see Chapter II). This connection is established by the Naval Computer Processing and Routing System (NAVCOMPARS). NAVCOMPARS routes messages between the shore-based AUTODIN and at-sea subscribers equipped with the Naval Modular Automated Communications Subsystem (NAVMACS) via HF message broadcasts (known as a Full Period Termination) and Fleet Satellite Broadcast (FSB) (satellite message transmission for ship at sea). The NAVCOMPARS has automated several functions that allow efficient delivery and receipt of fleet messages. Among the automated functions are: [Ref. 17:pp. 66 - 67]

* Maintaining a real time locator of fleet users.
* Formatting, screening, and distributing messages for both local and remote subscribers.
* Providing termination (receipt) of ship-to-shore messaging circuits.
* Housing the primary interface with the NAVMACS afloat satellite messaging system, known as the Common User Digital Information Exchange System (CUDIX).

The satellite-based linkage for the ship-to-shore messaging is provided by NAVMACS/CUDIXS systems. This computerized communications equipment was developed in 1975 to take advantage of the first fleet communication satellites in orbit. The CUDIXS receives its input from the NAVCOMPARS and rekeys (retransmits) all messages addressed to the fleet at-sea users. The NAVMACS is a family of shipboard systems ranging from the antiquated V(1) variant to the relatively powerful V(5A). Today, over 90% of the fleet has NAVMACS installed, with the goal of Navy-wide coverage by the end of 1992.

NAVMACS was designed to automate at-sea shipboard messaging, and to its credit, most communicators cannot imagine being without it. However, NAVMACS is slow and expensive compared to today's modern computers. NAVMACS planners have been upgrading as many ships as possible with later variants as they become available; unfortunately, these will not meet the fleet automation needs according to the DMS requirements.

The latest NAVMACS variant, V(5A), is a shipboard networked messaging system, with its computerized foundation being two UNISYS-built AN/UYK-44 (nicknamed "YUK-44") computers. The AN/UYK-44 is based on 1975 computer technology and, due to its highprice, is limited to such high-value ships as aircraft carriers and large amphibious ships. Unfortunately, only the NAVMACS V(5A) is operational during normal inport periods (the other NAVMACS variants only operate in port for a short period before and after getting underway) and must operate with all of its radio transmission and receiving equipment. This procedure is very cost intensive due to the extra manning requirements, and environmentally questionable because of the electromagnetic radiation that is inherent in radio transmission. Radiomen manning the "Radio-Shack" on these ships would be more willing to power-down their communications gear if there were a system that could more efficiently handle their message requirements. Unfortunately, the V(5A) is not designed for a pier-side network interface as required by the BITS architecture, but under the Copernicus architecture (discussed later in this chapter) there is help coming. [Ref. 18]

B. HOW DO WE GET THERE FROM HERE?

Designers for contemporary shipboard communication system are working on LANs and the new generations of communication suites to meet the demands of messaging subscribers at-sea, and to assure interoperability with the DMS system.

1. Shipboard LAN: SAFENET II

One of the major programs that the Navy has been working on to integrate shipboard communication services is the SAFENET II system. The SAFENET II is the second in the series of shipboard network technologies using fiber optics. In an attempt to save time and money by the use of industry-developed technologies, its design is based on the American National Standard Institute (ANSI) standard known as Fiber Distributed Data Interface (FDDI).

The FDDI network standard was chosen because of its transmission bandwidth capacity, reliability and cost of technology. It is also the standard of choice by BITS network designers because FDDI provides redundancy, via dual fiber optic rings, and security, since it is not easy to tap into a fiber optic cable without disrupting the transmission bit-stream [Ref. 19:p. 189].

Without getting into an overly complex study of network technologies, the following will provide an overview of the basic concept behind FDDI. An FDDI-based network uses a token-passing dual ring architecture. The token is a unique series of bits circulating around the network. A node (user) wishing to transmit on the network must wait until it captures the token before transmitting. Once the token is captured, the node can start transmitting the message. The token is released back at the end of the transmission. The message travels around the network until it returns back to the originating node. As the message travels around the ring, the intended addressee of the message will receive it and pass it on its way. This accomplishes two things: first, the fact that the token returned to the originator ensures that the ring is intact, and secondly, it provides acknowledgement to the originator. The dual-ring architecture, as depicted in Figure 7, provides the redundancy required in any vital shipboard communication system [Ref. 20:p. 16]. If a node in the ring were to go off-line or the ring were to be severed, the backup ring would allow the rerouting of the message. All of these features are transparent to the network user. The FDDI system is designed to operate at transmission speeds of 100 MBPS. [Ref. 19:pp. 187-193]

Specifically, SAFENET II is ideally suited for the DMS/BITS in-port ship-to-pier, and at-sea ship-to-shore communication interfaces, because it conforms to the OSI standards and avoids the ad hoc retrofitting prevalent in many messaging systems. Along with the benefits associated with the OSI (or GOSIP) protocols, come the detriments. That is, not all GOSIP standards have been clearly defined; and, though private industry is gearing up to provide OSI products, there is very little "on the shelf" at this time.

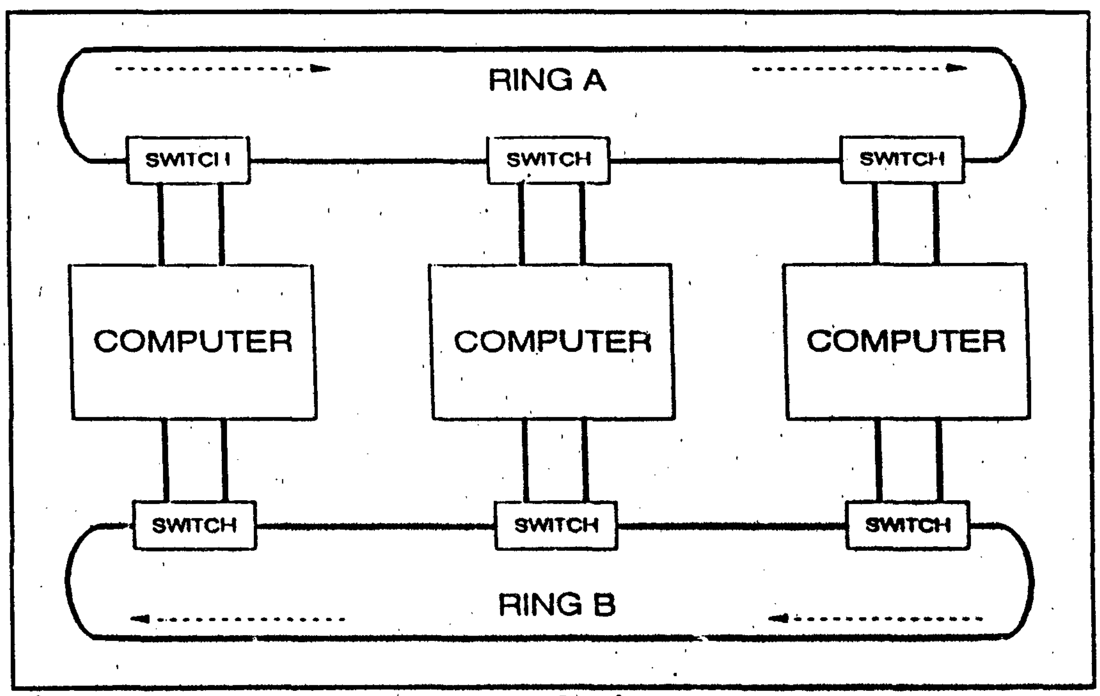

Figure 7. FDDI/SAFENET II Dual-Ring LAN

To date, only a prototype of SAFENET exists, as developers at the Naval Oceans System Command (NOSC) attempt to work out the "bugs" and design a simple and cost effective method to install it in the fleet. The present plan of action is to try to sell the Navy on wiring SAFENET directly into new construction ships and merely retrofitting a selected number of newer ships. This plan is prudent insofaras DMS planning documents are not calling for a true shipboard interface until the year 2001. [Ref. 20:p. 15]

2. The Future: Copernicus

In 1543, Copernicus put forth that the sun, and not earth, was the center of the universe. His vision inspired the Navy to christen its new communication architecture in his name. The essence of the Copernicus architecture, as it applies to the shipboard environment, is to bring multiple communication services together into one system. [Ref. 21]

Currently, there is tremendous competition for the limited space in the ship's Radio Shack which is a result of the independent equipment that supports a score of tactical and strategic communications systems. Copernicus will strive to eliminate the need for customized pieces of equipment, the only mission of which is to control but one or two circuits. To accomplish this, the Navy must abandon the way it has developed communications systems in the past, which has resulted in delays from five to fifteen years (e.g., NAVMACS).

> The rate of change in technology is already accelerating before our eyes. The downside is programmatic; the generation length for a microcomputer is now less than the average tour length of Navy men and women and one-third the length of the average acquisition cycle. [Ref. 21:p. 86]

In the spring of 1990, the CNO authorized the migration of NAVMACS functionality from the current AN/UYK series computer systems to commercially-available PCs under the Copernicus architecture [Ref. 22]. This decision was based on the fact that the NAVMACS program, though adequate for the present time, lacked the flexibility to expand to meet future shipboard communication needs.

Table III outlines projected cost savings resulting from the replacement of NAVMACS systems with the Navy Standard Desktop Tactical Computer 2 (DTC-2). It is assumed that all ships including those not currently having the latest variant of the AN/UYK computer are to be upgraded [Refs. 18 and 22]. The DTC-2 used in this comparison is a SUN 4/110 workstation equipped with a 300MB hard disk, color monitor, Tempest certified high-speed printer, system software and Motorola 88000 processor [Ref. 22].

The potential for cost savings is obvious, but what is even more significant is that, with the use of the continually evolving PC in the system, NAVMACS can quickly extend itself to facilitate both at-sea and in port messaging. An added benefit derived from the use of PCs is the fact that they are modular and easy to upgrade. The main criticism is that the standard "garden variety" PC may not be rugged enough for

TABLE III
NAVMACS MIGRATION COMPARISON

NAVMACS VARIANT	SHIP NUMBERS	UYK-44 UPGRADE ($)Million	DT-2 CONVERSION ($)Million
V1	93	17.67	3.72
V2	324	61.56	12.96
V3	74	14.06	2.96
V5	35	N/A	1.4
V5A	47	N/A	1.88
	SUBTOTAL	99.29	22.92
	DIFFERENCE	$ 76,370,000.00	

Desk Top 2 (DT-2) Mod. version @ $ 40,000. ea.
AN/UYK-44 @ $ 190,000. ea.

full-time message processing. Therefore certain components must be hardened so as not to break down under heavy use. For the most part, these critiques have been answered by the mere fact that PCs have been at sea for over ten years and have performed adequately thus far.

Over the past few years, designers at the Space and Naval Warfare Systems (SPAWARS) Command have been working on ways to integrate PCs onto ships. These efforts were provided with extra emphasis recently because of the emergent DMS requirements. In an attempt to develop emulation software that would allow the current NAVMACS system to act like a PC and simultaneously link into a SAFENET-like LAN, SPAWARS has unwittingly laid the foundation for Copernicus communication architecture. This new system has formed its name as an amalgamation of the English alphabet, and will be known, at least for the interim, as MNFEP or the Modernized Naval Front End Processor. [Ref. 23]

The MNFEP program is the epitome of the Copernicus vision, as it will consolidate and subsume all of the special tactical circuits that each ship must monitor (i.e., OTCIXS, TADIXCS, JOTS, FSB, etc.). The circuit that is most important (at least to this thesis) is the FSB (Fleet Satellite "message" Broadcast). Currently, the FSB is transmitted by CUDIXS on shore and received by NAVMACS at sea. Now MNFEP will perform all functions previously accomplished by NAVMACS and more [Ref. 23]. The front end of this system will receive from the various pieces of communications equipment each tactical circuit which will, in turn, be processed by two DTC-2 computers. The processing will direct each tactical circuit toward its appropriate location via the ship's LAN (SAFENET II interface). [Ref. 24]

Each circuit had previously required its own system of equipment to support it, but now only the software within the MNFEP will define the previous system, and NAVMACS is no different. Within MNFEP will exist what will be known as NAVMACS II and, instead of having over 30 pieces of NAVMACS specific components, it will share less than 15 with all the other tactical circuits. Of these modern components, there will be two DTC-2 computers, an optical as well as a magnetic disk storage device, two high-speed shielded printers and a LAN transceiver [Ref. 24].

The designing concept behind MNFEP is that software must be modular and evolutionary, in that, as each new version becomes available, it need only be input into the computer as opposed to the old way of redesigning the entire system. The modularity ground rule also applies to the system as a whole as designers must keep in mind the lessons learned from the old, rigid NAVMACS system which was difficult to expand and conform to changing requirements.

Unfortunately, MNFEP and NAVMACS II are in their infancy, and most information regarding specific capabilities is not yet available. The one thing that is apparent, however, is that this program is being pushed through the acquisition system, and a prototype is being planned for late 1991, with the first battle group installation and Operational Test and Evaluation (OPT&E) to be conducted in mid-1992 [Ref. 24].

One of the major pluses for this Copernicus-sponsored project is the fact that the main component of the MNFEP is the DTC-2 computer which is being installed on every deploying ship since the beginning of the Persian Gulf crisis in late 1990. By late 1996, it is expected that the entire fleet will have an MNFEP system installed. [Ref. 23]

C. CONCLUSION

Mentioned earlier in this chapter was the fact that there is a transmission capacity problem that must be overcome before the X.400-based DMS system can be extended to shipboard at-sea users. The problem remains as funding in the area of satellite transmissions in the range of Extremely High Frequency (EHF) has slowed to a trickle. It is felt that recent events in the Middle East have shown how vital high-capacity transmission capability is, and that this reality will provide the impetus to the search for a larger "pipe" for at-sea users. The onslaught of computer technology has created tremendous opportunity for the fleet. In vital areas such as communications, where previous procedures have left us with much to be desired, automation will soon be the rule and not the exception.

V. CONCLUSION: FUTURE EFFECTS OF DMS ON THE NAVY

As the DoD, and the Navy specifically, rushes toward a potential panacea of performance boosting and cost savings through the embrace of message system automation via the DMS and BITS programs, it is important to stop and reflect on what the potential collateral effects might be.

A. SURVIVABILITY

Being able to achieve high system survivability from severe damage, whether it be caused by battle at sea or natural disaster ashore, is a critical requirement for any DoD-wide communication system. For the Navy, the past has proven that the militarized AN/UYK-44 computer has performed admirably with an outstanding record for maintainability. A SPAWARS designer once quipped that a ship could take a hit from a 16-inch round and keep communicating. But at what cost?

In the past, the preferred way of designing communication systems was to develop each piece of equipment from the ground up, component-by-component, and build it to meet militarized specifications to ensure high-reliability. But, would that prevent battle damage or provide protection from fire or flooding? No, probably not. The next designing plan was to physically separate vital and redundant components (that were highly militarized, of course!) in different compartments which would ensure survivability by the sheer numbers of back-ups. Again, at what cost? [Ref. 25:pp 226-237]

A Navy example of the service-wide costs that have been incurred are manifested when the NAVMACS program is examined. The bottom-line result is a slow and laborious acquisition cycle that takes years to field a communications system. This has resulted in a system that is so heavily platform-specific in its design that it is neither transplantable nor easily reconfigured to meet changing requirements. The fact remains that computer and network technologies have become so powerful, so reliable, so fast, and so inexpensive that the survivability considerations spelled out above are easily achieved at relatively low costs and in record time.

B. LOGISTICS CONSIDERATIONS

In DoD acquisition cycles, one of the potential downfalls for any major program can occur in the area known as Integrated Logistical Support (ILS). This is euphemistically known as the "catch-all" in program management. ILS tends to collect leftover odds-and-ends, system documentation, training guidelines, manning requirements and spare-parts. These program elements, though vital, are normally considered to be low priority items until the programs are about to be fielded. Unfortunately, by then, much of the development money is gone or has been taken away.

The result of this kind of program management is that the system users often receive equipment they have no idea what to do with. This worst-case situation is exemplified by the recent flood of computing devices that suddenly arrived in the fleet during the mid-80s.

When the Desk Top Tactical Computer (DTC-1) first hit the fleet, the happy recipients were overjoyed to get these great computing machines. Trouble began later when there were no standard operating procedures, training programs, spare parts or "deck-plate" level expertise to ease these PCs into the daily functions of the command. Many man-hours were wasted as data files were lost due to operator errors or system crashes. The only plausible answer for this disaster is that the Navy was not prepared to purchase these systems and install them in the fleet in such a short period of time.

Now, standard operating procedures have been established, training is available and, most importantly, security requirements are being addressed at all levels throughout the Navy. The question now is "Is it enough?" as the DoD embarks on a wholesale automation of systems that was previously performed at such rudimentary levels as pen-and-ink message drafting.

1. Manning

In mid-1990, Vice Admiral J.O. Tuttle, Director, Space and Electronic Warfare, the CNO's man in charge of all naval C^3 development, directed that the first of many interdisciplinary mergers would take place between the Naval Data Automation Command (NAVDAC) and the Naval

Telecommunications Command (NAVTELCOMM). This new entity is now known as the Naval Computers and Telecommunications Command (NCTC) and was established to ensure that required modernization in Naval telecommunications was institutionalized from the top to the bottom. If the cost savings conceived by DMS and BITS planners were to be realized, not only did the Navy have to update its equipment but also its personnel. NCTC, by its position at the top of both the Naval communications and computers disciplines, was the perfect position to organize this transformation. Since that first merger, several lower level commands have followed suit, which has resulted in a little confusion as well as tremendous Naval communications opportunities. [Ref. 26:p. 2]

The implications of the NCTC merger were felt throughout the Navy, from Washington, DC to the Naval Postgraduate School in Monterey, California. This merging policy decision turned out to be a logistical support program of massive proportions as service school training commands gear-up to cross-train Radioman (RM) as Data Processing Technicians (DP) and vice versa. On the other end of the personnel spectrum, two officers' education programs blended into the new sub-specialty defined as Information Systems Specialist, which was born from the previous Telecommunications and Computer Systems Management fields. [Ref. 26:pp. 58-60 and 82]

Navy's path toward a complete merger of computers and communication has just begun and there remain many questions to be answered. Of the most significant impediments to a complete functional merger is the fact that there are varying degrees of professional pride and colloquial prejudices within each group, which could create resistance to this mandated change. Adding to the confusion is the fact that not all of the Navy will require these interdisciplinary skills right away. The reality of the situation is that ships at sea will continue to need different telecommunication skills than will the communicators ashore, and as long as sailors rotate from ship-to-shore periodically, their functional skill base must continue to remain very broad.

2. Training

To bridge the gap among formal service school training, sub-specialty graduate education and the rest of the fleet, a Navy-wide computer training and awareness program must be instituted. The underpinnings of any successful change is acceptance, and that can be fostered when the stigma of computerized "black magic" and "mystery" is dispelled by bottom-to-top training.

Formal training is required for all computer users as dictated by Navy regulation. As more and more people become aware of their usefulness, computers will become commonplace in the Navy. The kinds of professional training that will be required transcends anything that has gone before it, as the

Navy (and the DoD) is now attempting not only to march to the forefront of telecommunications technology but also to actually lead it.

The skills required to meet future technical needs will take a considerable amount of sophisticated training, and to be truly effective, will require a cadre of intelligent individuals to form a foundation. Until then, those that are receiving the initial professional training must guard against the pitfalls of computer ignorance and misuse, as novice computer users "hack" their way through operating systems and data files, destroying hard work and equipment along the way.

C. SECURITY

Security awareness is the thread that binds manning and training requirements with respect to ILS programs. As computer usage continues to increase, it will become an unstoppable part of DMS subscriber's lives. In the future both physical and informational security will become all that more important. As discussed earlier in this thesis, the DoD is spelling out exactly what is expected from industry in terms of built-in or trusted computer security systems. Unfortunately, these types of hardware and software security restraints are in their infancy and both BITS and the DMS are heavily dependent on the rapid maturity. As a result of the lack of transparent or involuntary security restrictions, we must rely on self-imposed protection to prevent the possibility of accidental or planned insecurities. This level of security can be accomplished by the linking of properly skilled, able-bodied personnel and relentless vigilance.

D. LOOSE ENDS

In conclusion, it is obvious that there is a lot of work ahead for everyone, from the DMS planners, attempting to maintain funding levels and a unity of vision among services, to Naval Radioman personnel, who will be seeing not only their rating overhauled but also must face the brunt of the momentum that has built up behind the demand for automation in the Navy.

This evolutionary telecommunication process has quickly become time critical, and any slowdown by the key programs (i.e., DMS backbone, BITS pier-side interface, an effective ship-shore transmission capability, etc.) will result in considerable costs to the system as a whole. This slowdown will require redundant communications systems that are capable of providing services at both levels of technology, old and new.

Protocol changeovers such as X.400, ISDN and GOSIP will require increased capabilities in computing sophistication, critical technology maturity and transmission bandwidth usage. These key areas will be the deciding factor as to whether "The Impact of the Defense Message System on the United States Surface Navy" is a mere bump in the night or a collision at sea.

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