NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

CASHLESS SHIPS:
A FEASIBILITY STUDY

by

Carey M. Manhertz

September, 1997

Thesis Advisor:	Suresh Sridhar
Associate Reader:	Rex Buddenberg

Approved for public release; distribution is unlimited.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE September 1997	3. REPORT TYPE AND DATES COVERED Master's Thesis

4. TITLE AND SUBTITLE CASHLESS SHIPS: A FEASIBILITY STUDY

5. FUNDING NUMBERS

6. AUTHOR(S) Carey M. Manhertz

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/ MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
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.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

The advent of mechanisms for facilitating electronic commerce has triggered widespread interest in several fields. However, research in electronic commerce to include Smart Card Technology has mainly focused on land-based transactions. This research investigates the role of Information Technology in facilitating electronic commerce at sea, aboard U.S. Navy ships. It determines the feasibility of replacing the current cash shipboard architecture with a cashless network providing real time accounting and banking applications. This research verifies the feasibility of cashless network systems aboard ships with cashless mechanisms. The motivation for this research is to provide and ensure monetary freedom to sailors at sea. This research evaluates the efficiency of cash processes using Commercial off the Shelf technologies. It also identifies workload demands through automated networks, and verifies seamless integration with cashless processes available commercially. A review is conducted of the existing shipboard cash systems. Then, the motivation for electronic commerce on ships is discussed. Two active prototype solutions are investigated. And finally, some of the lessons learned based on the experiences of these prototypes are summarized with a recommendation for the future.

14. SUBJECT TERMS
Electronic Commerce, Ships, Navy, Smart Cards, Banking

15. NUMBER OF PAGES
64

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18 298-102

Approved for public release; distribution is unlimited

CASHLESS SHIPS: A FEASIBILITY STUDY

Carey M. Manhertz
Lieutenant Commander, United States Navy
B.S., United States Naval Academy, 1987

Submitted in partial fulfillment of the
requirements for the degree of

**MASTER OF SCIENCE IN
INFORMATION TECHNOLOGY MANAGEMENT**

from the

**NAVAL POSTGRADUATE SCHOOL
September 1997**

Author: _____
Carey M. Manhertz

Approved by: _____
Suresh Sridhar, Thesis Advisor

_____
Rex Buddenberg, Associate Advisor

_____
Reuben Harris, Chairman
Department of Systems Management

ABSTRACT

The advent of mechanisms for facilitating electronic commerce has triggered widespread interest in several fields. However, research in electronic commerce to include Smart Card Technology has mainly focused on land-based transactions. This research investigates the role of Information Technology in facilitating electronic commerce at sea, aboard U.S. Navy ships. It determines the feasibility of replacing the current cash shipboard architecture with a cashless network providing real time accounting and banking applications. This research verifies the feasibility of cashless network systems aboard ships with cashless mechanisms. The motivation for this research to provide and ensure monetary freedom to sailors at sea. This research evaluates the efficiency of cash processes using Commercial off the Shelf technologies. It also identifies workload demands through automated networks, and verifies seamless integration with cashless processes available commercially. A review is conducted of the existing shipboard cash systems. Then, the motivation for electronic commerce on ships is discussed. Two active prototype solutions are investigated. And finally, some of the lessons learned based on the experiences of these prototypes are summarized with a recommendation for the future.

TABLE OF CONTENTS

ACKNOWLEDGEMENT

The author gratefully acknowledges the support for travel in part under the Smart Ship Project and by the Department of Systems Management, Naval Postgraduate School. The author also thanks Bill Olsen, Kevin Lynch and other members of the Smart Ship Project; Jim Stansfield, Research Fellow of Logistics Management Institute; and Helen Greene, ATMs-At-Sea program Manager, for their help and encouragement.

I. INTRODUCTION

A. AREA OF RESEARCH

The purpose of this research is to evaluate the functionality of Smart Card Technology in cashless networks as an alternative to shipboard cash handling functions. The goal is to evaluate the prototype system aboard the USS Yorktown. Through design, operational, and economical analyses, this thesis will determine the feasibility of replacing the current architecture with a cashless network.

B. OBJECTIVE

The objective of this research is to determine the feasibility of replacing the current cash shipboard architecture with a cashless network providing real time accounting and banking applications. This thesis will address the hardware and software implications and maintenance, security training requirements.

Some of the questions this research will answer include:

- What is a Cashless Network? What are the advantages and disadvantages?
- What are the hardware and software requirements for establishing a cashless network?
- What protocols are used and how do they function?
- What is the current network configuration afloat to support this new architecture?
- What impact will a cashless system have on the current configuration?
- What are the costs and benefits of upgrading the existing architecture?
- What network control and security measures must be implemented to ensure authorized access and use of the network?
- How will these controls be verified and tested?
- What documentation will be necessary to support implementation of the Cashless Network? (Training, maintenance, troubleshooting, network control and security measures, network policies)

- What back-up and recovery systems will be required to support the Cashless System?
- What skills will be necessary to implement the system? What tools will be required?
- What maintenance skills will be required to maintain the system? What is the impact in terms of staff and equipment?
- What existing shipboard functions can be eliminated?
- Will maintenance personnel require special skills? How much will training cost?

C. DISCUSSION

Commercial transactions usually involve several players such as buyers, sellers and intermediaries (typically, banks). Although such transactions are common on land, they can also occur in air (e.g., aboard an airline) or on sea (e.g., aboard a ship). Prior research in the area of electronic commerce has mainly focused on land-based transactions. This thesis investigates the role of information technology facilitating electronic commerce at sea, aboard U.S. Navy ships.

Naval platforms of varying types all operate using cash handling processes. These processes are concentrated within Disbursing operations, Retail store operations, Open market operations, Galley meal sale operations, Wardroom Mess payment functions, Morale Welfare and Recreation fund transactions and Automated Transfer Machine (ATM) functions. Cash processes require significant time for any custodian, store manager or disbursing personnel to manage on a daily basis.

Consider the daily method of double counting of thousands of dollars in change from vending machine sales. Then, wrapping and packaging each coin, and double counting it again before submission to the Disbursing Office (finance center). Then consider double counting between $5000.00 and $10,000.00 worth of daily Ship Store or retail outlet sales of cash and coin for submission and credit to each store's fund account in the finance center. Meanwhile at the end of the day the various petty cash custodians report to the finance center to double count and unload their petty cash all at the end of

the day. If Disbursing is closed for some unforeseen reason, where is all that cash being held? Additionally, the finance centers are open for check cashing about two hours per day. Countless hours are also spent reconciling debit vouchers, bounced checks resulting from cash exchanges. On a typical workday cash collection agents and finance personnel consume roughly 4.3 hours per operator. Imagine why historic problems with cash handling functions have not gone away. Fraud and theft, stowage and security are some underlying problems involving any cash handling function. Figure 1. Depicts the typical flow of payroll cash aboard ships with ATMs [Ref. 15].

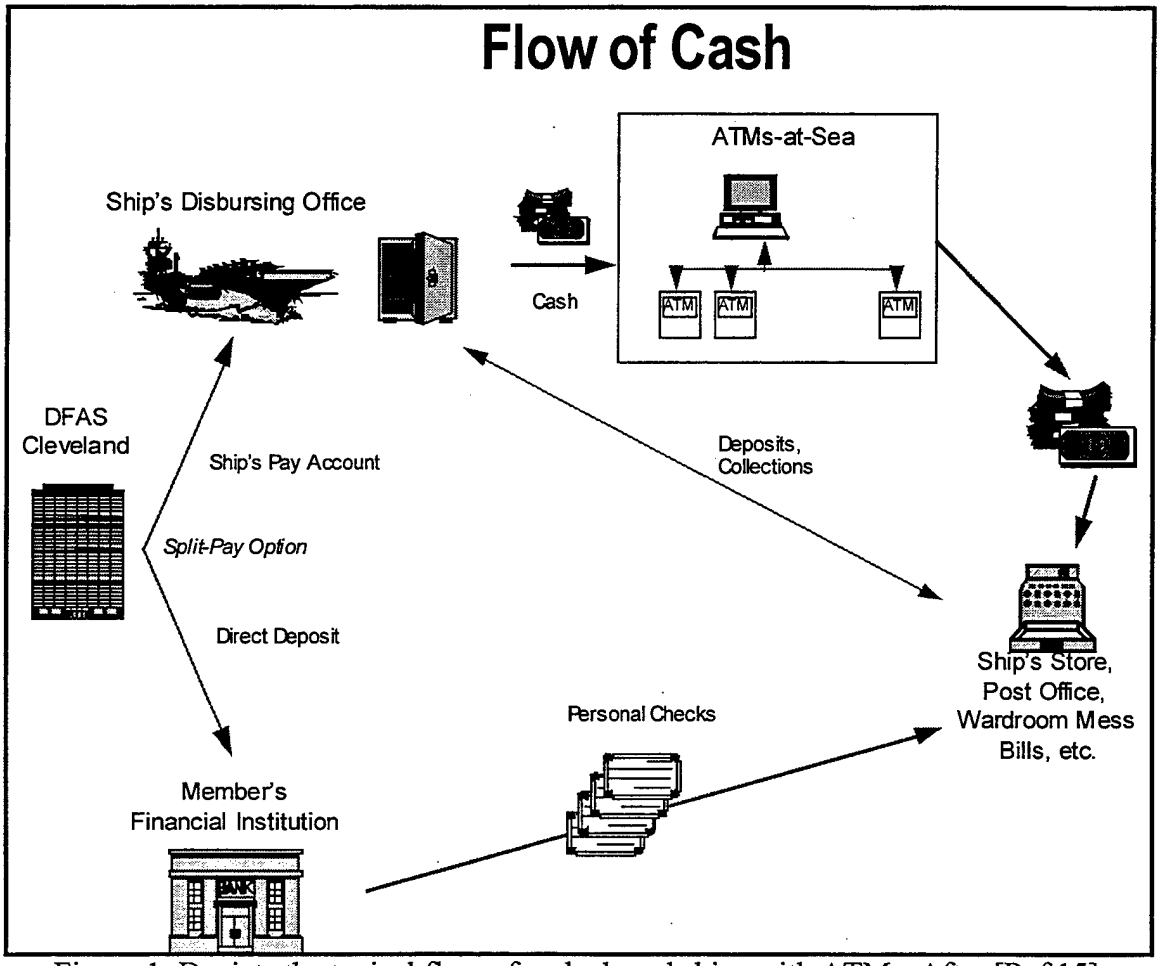


Figure 1. Depicts the typical flow of cash aboard ships with ATMs. After [Ref.15]

* There are 163 ships with ATMs [Ref. 15]. At the lowest level, a CG and DDG carry one ATM and a Carrier would utilize up to six. The other ships operate without automated cash distribution systems.

The cash flow begins with pay. Payroll is determined and accounted for by the Defense accounting and Finance Center (DFAS). It is distributed to ships via AUTODIN, Streamlined Automated Logistics Transmission System (SALTS) or electronically over landline to member institution accounts as direct deposits [Ref. 15]. The member's ship account comprises a portion of his pay and is held in account to be withdrawn by ATM machine or paid by Disbursing Office as cash. This Split Pay option provides sailors cash availability afloat, in their local pay account, in addition to normal check writing. The local pay account is maintained through the ATMs-at-Sea system. To buy something in the Ships Store or pay a mess bill in the Wardroom; for example, service members who have a local pay account can use the ATM to withdraw the necessary cash. On average less than 50% of service members opt for Split Pay, and 98% of ship's company have Direct Deposit [Ref. 13]. Service members who do not have a local pay account or whose local pay account are low on funds must write personal checks drawn on their commercial bank or credit union. The cash and checks from these transactions are consumed and accounted for first in the Ships Store, Post Office, Wardroom, etc., and second in the Disbursing Office.

If the current business practices continue, several consequences include: wasted manpower and personnel efficiency, continuous loss of space requirements due to security limitations, continued levels of fraud and theft aboard shipboard units, and finally, violation of law. Under the Debt Collection Improvement Act signed by President Clinton on April 26, 1996, any newly eligible recipient of a federal government payment, benefit or salary must be paid electronically. By January 1, 1999, all federal payments - wage, salary, retirement, vendor, expense reimbursement and benefit-payments must be made electronically [Ref.19]. As our electronic world continues to evolve, so must our local shipboard payment systems and wide area systems. This thesis will diagnose the Navy's shipboard local area to wide area cash-flow network intricacies and highlight some initiatives that may forge integrated and interoperable solutions.

D. METHODOLOGY

The methodology used in this research is outlined as follows:

- Conduct a literature search of books, magazine articles, CD-ROM systems, and other library information resources.
- Conduct a thorough review of Security protocols, hardware requirements, system management requirements, compatibility issues, and standards.
- Conduct a review of the current cash handling system. Review cashless system documentation and examine the physical and software components that comprise the system.
- Examine Internet working capabilities of the current system and document all hardware and software requirements.
- Conduct a visit to the USS Yorktown to observe operation and discuss network management issues, maintenance issues, maintenance equipment requirements, implementation and maintenance costs, and lessons learned.
- Identify all potential hardware, software, and protocol compatibility issues.
- Prepare a cost/ benefit analysis for the system and its components.

E. SCOPE

The scope of this research includes: (1) a review of Smartcard architectures, (2) a review of linking network systems to afloat units (3) and a cost/ benefit analysis of implementing the Cashless Network, and (4) a recommendation for implementing the new architecture for afloat units. The formal definition of the research problem is to maximize performance of cash handling processes while minimizing cost of cash processes on Fleet units. The underlying requirements of this problem include:

- Verify the feasibility of cashless network systems aboard ships.
- Maximize the efficiency of cash processes using Commercial off the Shelf technologies.
- Reduce workload through automated networks.
- Provide a common operating cash environment.
- Provide seamless integration with cashless processes available commercially.
- Increase security while increasing availability of consumer goods.

- Reduce the amount of cash carried on ships.
- Provide and ensure monetary freedom to sailors at sea.

This research assesses the problem in four sections:

- First, assessment of the existing cash processes, describing its cash processes and the functionality of the existing systems.
- Second, evaluation of commercial technology for open and closed system alternatives.
- Third, evaluation of these alternatives as demonstrated in two shipboard prototypes.
- And finally, proposal of a best-fit solution based on existing shipboard infrastructure and needs, trends of technology, and cost to the government.

II. EXISTING SHIPBOARD CASH SYSTEMS

A. RETAIL OPERATIONS

The Retail or Ship Store division manages a number of cash processes to include: coin-operated vending machines, snack machines, dollar bill changers and safes. Cash is counted, collected, rolled and wrapped by hand with the use of dollar bill counters, coin rollers and wrapping machines. Even then, these devices do not improve the time sink associated with current Navy cash collection procedures. Navy guidelines direct Ships Stores to collect daily and not leaving more than $50.00 in any retail outlet overnight, not more than $400.00 in any dollar changer overnight and to collect vending or snack machines if sales per vending machine exceed $150.00 per day [Ref.16]. Additionally, cash collection agents and disbursing personnel are required to verify cash by actual cash count usually by a double-count method. These rules under the existing system help improve accountability while preventing loss, theft or break-in. However, they make the cash collection process man-hour intensive and restrict patrons to a coin operated environment.

The physical locations of these cash processes are various. They are not centralized and are located in common areas (near berthing and dining facilities), benefiting crewmembers by positioning retail outlets like vending machines with common areas. The vending and snack machines' physical attributes are also significant. They are independent structures whose integrating device is a coin/cash accepting machine that interacts with the machine's computer logic board to dispense a soda or snack item with correct change. The integrating medium is having coins or cash to operate. Changing the integrating medium and device to one capable interacting with an existing ATM machine, Retail store or in the commercial financial network would initiate transition to a wide area open, cashless environment and not just a local area closed shipboard system.

The Ship Store Division manages its purchasing documents, inventories, vendor information and ledger details with its Resale Operation Management software package. This package allows store managers to order and receive status information with

networked vendors and Defense Finance and Accounting Service (DFAS) through the SALTS. This system provides connectivity between the ship and conus via the IMMARSAT Satellite Phone System. Accounting information is downloaded and re-addressed to appropriate government entities. This SALTS system does provide a means (via modem) for transmitting financial data but not cash, mainly because the system is not set up for digital units of currency.

B. DISBURSING OPERATIONS

The Disbursing Office is the mainstay of all cash operations. Underway, it virtually controls the flow of money aboard ship. They perform services to include: check cashing, paycheck calculation, reconciliation and distribution, load and fill ATMs, maintain safekeeping deposits for the crew, pay and reconcile travel claims, exchange foreign currency (overseas), pay special bonuses, provide counseling, payroll auditing, allotment services and administer the ATMs-At-Sea program. Navy Comptroller Manual directs each disbursing office agent to balance at the end of each day and the Disbursing Officer to balance at least weekly, after each payday and at the end of the month. These directives improve accountability but do not save time when counting cash. Carriers carry a deployment payroll up to 10 million dollars each. The volume of the ATMs-at-Sea ship's pay account system averages about 10,000 transactions per month aboard a carrier. Check cashing for a carrier during a six-month deployment can total as much as $6,000 to $13,000 in a single day. A Disbursing Office may receive as much as $70,000 in bad checks during in a six-month deployment period. Under current guidelines, each check cashed must be reproduced front and back (normally microfiche) and retained in the Disbursing Officer's files. Checks must be bundled and taken or mailed to the bank -- further adding to the cash process time sink [Ref.15].

C. THE AUTOMATED TELLER

ATMs-At-Sea program has been available since Aug. of 1988 to Oct. of 1993. ATMs- At-Sea II phase development and initiatives are planned from October of 1993 to May of 1998. ATMs provide a debit-card payment solution at the Post Office and Ship

Store. Payments are made available through members local Split Pay account. Each ship issues ATM cards with secure PINs to crewmembers. These ATM cards may have duplicate numbers from one ship to another, but each ship has a unique encrypted key, or identification number, on the cards issued by that ship. Pay is available after 0001 on payday. The system provides monthly statements to its members [Ref.15]. However, its use is supported by less than 50% of crewmembers primarily due to lack of interest in Split Pay and the restricted use of the card itself [Ref. 15]. What is left to discover is verifying an institutional saving with debit cards with 50% participation. A majority of crewmembers interviewed suggest that they prefer using personal checks or cash. The current check cashing policies in the store, Post Office and in the Disbursing Office makes all of a sailor's assets available when shopping and is not limited when using a debit card. Monetary freedom seems to be the deciding factor for customer satisfaction and should thereby become the driving factor in open or closed system design.

NAVSUP has used this design strategy with their Commercial Banking Afloat program as a prototype project within their existing ATMs-at-Sea program. The basic objective of the project is to work toward standard banking system protocols and procedures wherever possible in creating a more open system. Table 1, on the next page, identifies current ATM system application as well as future considerations.

System Capability	Phase I		Phase II
	ATMs-at-Sea II	CBA Prototype	CBA Prototype
Debit Terminal Transactions (From Local Accounts Only)	✓		
ATM Debit Transaction from Local Account	✓		✓
Local Account Reporting Mechanism	✓		✓
Local Account End-of-Day Settlement	✓		✓
Post Office and Ships Store End-of-Day Settlement	✓		✓
ATMDebit Transaction From Commercial Bank/Credit Union Account		✓	✓
Remote Debit Transaction End-of-Day Settlement		✓	✓
Electronically Move Funds Withdrawn from Commercial Account to Local ATM Account			✓
Debit Terminal Transactions - Modified Procedures (From Local Accounts Only)			✓
Year 2000 Compliance			✓

Table 1. System Capabilities for Phases I and II. From [Ref.15]

* The ATM program does not provide access to wide area commerce. Personal debit cards or credit cards can only be used on Prototype shipboard ATMs.

Table 1 also demonstrates the limited features of the current ATM system and its planned migration with expanded features under phase II. The ATM system is the only networked cash distribution system aboard Navy ships. A single computer on a 10 Base-T network manages the ATMs. Figure 2, on the next page, illustrates this topology.

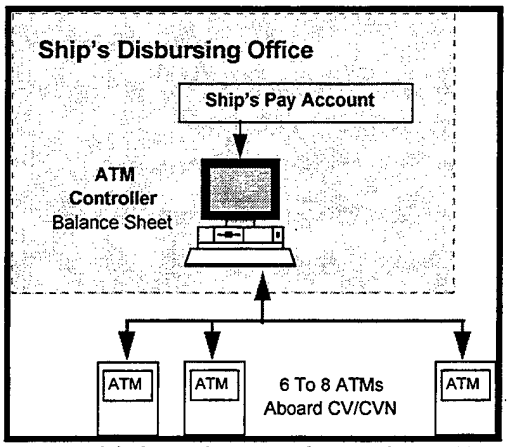


Figure 2. Current shipboard network topology. From [Ref. 15]

D. GALLEY OPERATIONS

The Galley Operations do not generally worry about cash processes or petty cash funds underway. When visitors ride, visitor's meals are paid with cash or check, if approved in Disbursing. Officers subsist from the galley or general mess and must pay a messbill with cash or check at the end of the month. Manual records are maintained for each officer or visitor's meal and updated in the Food Service Management (FSM) database where it is summarized and reported by mail each month. The Wardroom Mess Treasurer and Galley Cash Collection Agent collect bills, reconcile outstanding bills or bounced checks, and redeem their reimbursement voucher with cash or checks [Ref. 14]. The treasurer and agent positions are standard on all ships and can become tedious when considering handling and accounting for cash on a daily basis apart from their primary duties.

E. POSTAL OPERATIONS

Postal Operations may involve the sale of stamps through stamp vending machines, in addition to selling stamps; metered postage, and money orders at the ship's Post Office. At the end of the day, the custodian of postal effects (COPE) redeems the money order and metered postage cash for an ex-cash remittance check from the Disbursing Officer. A separate check for each will be made payable to the appropriate U.S.P.S. source. Stamp sales cash collected is maintained until approximately 25% of the

total fixed credit is on hand and an ex-cash remittance is made payable to the appropriate U.S.P.S. Postmaster along with a stamp requisition. All stamp, postage meter, and money order sales remittances are credited to U.S.P.S. sources.

F. SUPPLY OPERATIONS

Open market operations aboard ships involve contract purchases less $2,500.00 dollars. Imprest fund or petty cash is sometimes used to settle some of these purchases [Ref.12]. However, this method of procurement is seldom utilized aboard ships. The IMPAC credit card (by VISA) used for purchases under $2,500.00 alleviates the procedural problems associated with the Imprest Fund procurement method. This credit card provides another card-based solution to a shipboard cash environment.

G. MAGNITUDE OF THE PROBLEM

The elimination of cash processes aboard ship represents a significant relief of overhead with respect to efficiency and manpower utilization. Figure 3 shows calculated manpower expenditures for various cash processes for staffing levels on a single Cruiser platform. Savings for the Fleet would be considerable. The Post Office, Disbursing Office and Ship Store Division would directly benefit from reduced overhead and man-hour windfalls. Opportunity for manpower reductions will also be available. Figure 4 displays the processing costs per transaction. Electronic systems are cheaper to operate [Ref. 10]. The costs per transaction shown here include all those incurred by the commercial commerce market: banks, retailers, and others performing links in the transaction chain -- thus, driving an electronic solution [Ref. 10]. The shipboard commerce environment, as mentioned, is mostly a closed environment.

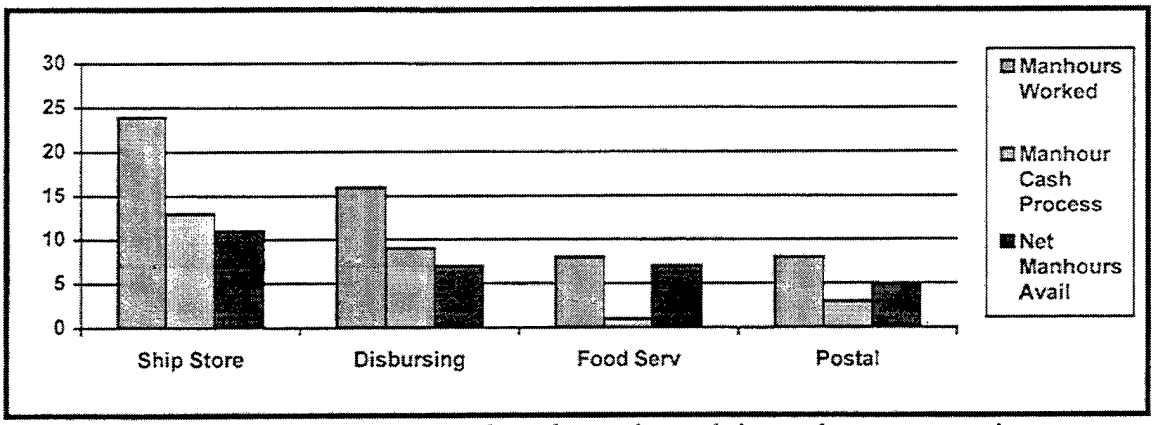


Figure 3. Demonstrates man-hour losses by activity cash system per day.

*. Man-hour totals for Ship Store is based on 3 personnel (on Cruiser platform) [Ref. 9]. Although Postal operations is part of the Ship Store Division, its money order sales and cash out procedures add significantly to the total man-hour assessment for cash operations only. Disbursing Office man-hour totals represent a 2-person operation. Food Service Operations represents 1 collection agent. Assumes no Imprest fund on board. Net man-hours available represents hours available for other duties aside from cash handling.

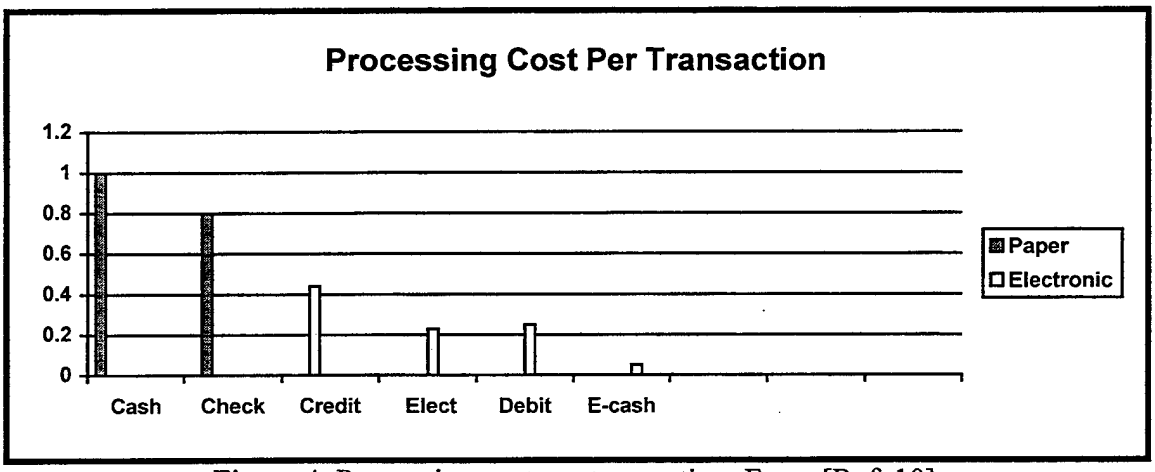


Figure 4. Processing cost per transaction. From [Ref. 10]

* This graph shows horizontally: cash, check, credit card, Electronic Bill payment, Debit card and E-cash. Units are in dollars.

III. COMMERCIAL TECHNOLOGIES

A. WHAT IS NEEDED?

A cashless network alternative can relieve most of these problems by providing a network architecture that guarantees security, privacy, accessibility and most importantly providing monetary freedom in cash payment system applications. This architecture can be based or combined in several forms to include Digital cash operations, Smartcard operations, Creditcard or Debitcard processes. Their technologies may eliminate the need for or augment automated tellers aboard ship. Their implementation will certainly reduce the manning requirements for Ships Servicemen and Disbursing personnel as well as collateral responsibilities carried out of hide. Potential benefits [Ref. 15] are:

- Provide service members aboard ship access to their bank or credit union checking and savings accounts to withdraw funds and make balance inquiries.
- Reduces volume of bad checks or eliminate the need for check cashing.
- Reduces overall amount of cash required aboard ship.
- Reduces requirement for Split Pay Option.
- Provide the ability to electronically move funds withdrawn from a commercial bank or credit union to the local pay account for safekeeping.
- Possesses the potential to significantly reduce workload for the Disbursing Office, particularly for such things as special pays, bonuses, cash handling, and check cashing.
- Reduce the workload of Cash Collection Agents, Vending Machine Operators, Recordskeepers, Postal Operators and Ship Store Operators, Galley Operators and the Wardroom Treasurer.

- Provide a cost-effective solution that does not drive up current operational costs.

These benefits will only be realized upon transformation of the medium and integrating devices within the ship's closed system and later as part of an open wide area network [Ref. 15].

B. DEFINING THE MEDIUM DEFINES THE ARCHITECTURE

For a cashless environment to exist there must be a medium to replace cash and maintain the integrity of shipboard commerce as well as Disbursing functions. Three technologies are available by different companies to challenge and expand the existing form of commerce. They include digital currency, stored value cards like smart cards, or debit cards and credit cards. These cards and currency must satisfy a general framework to be accepted in a closed system and eventually in a wide system as a replacement for cash. This framework is an evolution in itself. For our shipboard, closed system, a major constraint for acceptance will be the integrating devices. A system that can both effectively operate with vending, snack and postal machines and shipboard ATMs will be the system chosen.

C. IDEAL REQUIREMENTS OF THE MEDIUM

There is much more to developing a cashless system than merely being able to pass units of currency between a consumer and a vendor. This system would be based on a mutually accepted protocol that maintained a strict adherence to most of these key elements. A discussion of the required elements [Ref 11] follows to include:

1. Independence (physical)
2. Security
3. Untraceability
4. Off-Line Payment
5. Transferability
6. Divisibility
7. Infinite Duration
8. Trust (Acceptability)
9. Simple
10. Unit-of-Value freedom

1. Element - Independence

The use of digital cash or stored value and the security of the protocol would not be dependent on any physical location. The protocol would be a standard that is acceptable in every cash operating institution. The protocol must allow the transfer of funds independent of the presence of a network, the type of systems involved, type of delivery method or even the need for a computer system. The system must support all forms of distribution to ever become widely accepted [Ref 11].

2. Element - Security

Simply put, the cash instrument must not be able to be copied or reproduced. Authenticity and non-repudiation are primary requirements. Confidentiality would be a secondary requirement. The protocol must provide the highest level of encryption to ensure that a transaction between two parties can not be intercepted and the transaction copied or altered in any way [Ref. 7]. This level of security will be the basis for which the users of the system will base their trust for the system.

3. Element - Untraceability

This element will more than likely prove to be the most talked about or controversial element. This element of the protocol would provide an assurance above encryption of transactional privacy on multiple levels [Ref. 6]. It is this feature of being totally untraceable that will provide for great opportunities as significant challenges. This level of anonymity would allow that a transaction would remain invisible both to the parties involved as well as the mere existence of the transaction [Ref 11]. Currently, the Federal Bureau of Investigations is petitioning Congress for eavesdropping rights within electronic commerce processes within the Internet. Secondly, the Federal Government rations the level of encryption available to facilitate their eavesdropping ability. Therefore, this piece of the puzzle will be long debated and probably never settled.

4. Element - Off-Line Payment

The protocol must allow for the free passing of value from one party to another without need for a system connection. This would provide unrestricted availability. This

portable payment concept would allow for access to the currency without concern or need for a computer system. So, if you have a money card or and account number you can draw money at a bank, business or networked personal computer.

5. Element - Transferability

The obvious need is for functional value to be able to be passed between two parties. The most important need of this protocol would be that there would be no need for a third party to act as a registered merchant or a certificate authority for a transaction to take place. Two parties are able to complete a transaction with confidence that it is authentic and untampered without the need of a third party. For example, just as a husband can physically exchange cash with his wife and realize that he is receiving genuine currency. The digital currency must have the same level of transferability.

6. Element - Divisibility

The unit of cash must be able to be split or divided into smaller units. Given a certain amount of cash it should be able to be broken down into smaller units to be used for small-value transactions. Digital correct change must be available.

7. Element - Infinite Duration

The protocol must support the concept that a digital cash instrument (i.e., a token) or Smartcard unit will not expire. Once a token is generated it is good until it is either lost or destroyed [Ref 11]. This element will allow an individual to store quantities of the digital cash for long periods of time without losing the value.

8. Element - Trust

The trust of the system or protocol will be the basis for its wide acceptability. Acceptability is element that will allow the use of this digital cash or stored value card apart from some small-restricted setting. The trust and recognition of the issuer are as big a part of the protocol as any other element. For the system to be effective, it must be accepted anywhere that a given party wants to conduct a transaction.

9. Element - Simple

The overall system must be simple. The ease of use both in spending and receiving will again lead to the expanded use by the masses. There should be no assumed level of knowledge of the system; simply the desire to conduct a transaction that eventually leads to a successful transfer of value between two parties.

10. Element - Unit-of-Value Freedom

The protocol would provide the unit as its own form of currency, independent of political affiliations and with it's value determined by the market. It would effectively compete with other governmental currencies on the open market. This element is the one true difference between digital cash and stored value and the current electronic fund's transfers we know today [Ref 11].

There are various types of cards or electronic media that act as a medium of money. Their definitions must be understood when trying to differentiate between them. I will describe the benefits and weaknesses of three types of digital money and what they can provide ships afloat following a description of the varying types:

- Stored Value Card: A machine-readable card capable of executing debit transactions such as credit cards or debit cards. These cards decrement expenditures towards a checking account or prepaid limit (prepayment card). Value can be reloaded or expire depending on account status. These cards can have either magnetic stripes or IC chips. These cards are like phonecards or metrocards.

- Smartcards or Integrated-Circuit Card (ICC) or microcircuit card contains one or more embedded integrated circuits offer the same capabilities but include Memory Card functions and a microcontroller, so that the card is capable of making decisions. Some decisions include authentication, account inquiries, or inventory status. These IC Cards can interface with a point-of-sale terminal

(POS), an ATM machine, or a card reader integrated into a phone, a computer, a vending machine, or any other appliance.

- Memory Card is similar to an IC card that can store information, but lacks a calculating capability that a CPU chip can provide.

- Electronic Wallet can be an IC Card or a digital unit of currency or e-cash that can execute a variety of financial transactions and identification functions to include debit, credit or prepayment card functions.

- Ecash is a network medium of currency used to facilitate electronic commerce over the Internet within closed market networks. IC Cards are capable of expanding this closed network to multiple applications [Ref. 8].

Ecash is designed for secure payments from any personal computer to any other workstation, over email or Internet. Ecash has the privacy of paper cash, while achieving the high security required for electronic network environments exclusively through innovations in public key cryptography [Ref. 1].

Ecash flows to its destination over the Internet (or any other computer network). The open architecture of the Internet requires security measures to be taken against attempts by unfriendly third parties to intercept the digital money [Ref. 1]. Ecash provides the highest security possible by applying public key digital signature techniques to include blind signatures and digital stamping. Additional security features of ecash include the protection of ecash withdrawals from your account with a password that is only known to the user -- not even the bank [Ref. 1].

A unique feature of ecash is payer anonymity. When paying with ecash, the identity of the payer is not revealed automatically. This way the payer stays in control of information about himself. During a payment a payer can of course identify himself, but only when he chooses to. Ecash offers one-sided anonymity; when clearing a transaction, the bank identifies the payee [Ref. 1].

"Ecash works on all major platforms (MS Windows, Macintosh and UNIX). The graphic user interface works with a small comprehensive status window displaying the amount of money in cash. A text mode version is available for people without a graphical operating system. If an on-line ecash accepting shop requires payment, depending on user settings, the client will handle the transaction completely by itself, or prompt the user for authorization [Ref. 1]."

Ecash is the digital equivalent of cash. You can withdraw digital coins from your Internet bank account and store them on your hard disk. Whenever you want to make a payment, you use these coins. The payment is fast and anonymous, and the payer can always prove that he made a certain payment. In some environments, there may be a need for additional security to prevent other users from accessing your ecash. Smart cards can be used to store your ecash allowing you to carry your ecash with you. Currently, smartcards are accessible with few ATM networks.

Requirements for ecash include access to the Internet, the software operating environment-the ecash network, and integrating devices to support the smart card medium within your local network. The Internet provides domestic and international commerce (depending on the businesses accepting ecash) and wide area availability.

As an ideal medium, Ecash must first be widely accepted (element 8) and operate freely across markets (element 10) before it can replace cash aboard ships. It can, however, benefit the ship by bringing electronic commerce via the Internet to sailors or officers at sea. Only a few terminals would be required to facilitate use to shipboard users. Crewmembers can purchase digital tokens with their credit cards on-line or have them available through their bank to begin debit account transactions electronically. This capability will provide a unique option for crewmembers to shop through the Internet and get merchandise shipped home. Also, it may possibly reduce some "hardship" situations. The biggest problem with this medium for ships is having an uninterrupted period of access to the Internet to facilitate shopping.

The electronic wallet or IC Card, on the other hand, quickly seems to be the revolutionary medium of currency ready to tackle not only commercial markets, but also make a flexible fit within the shipboard environment because of its advantages over cash

and magnetic stripe cards. First, it is lighter, reduces space and is convenient to carry. Second, it can not only act as currency but can carry 10-100 times as much information and hold it more robustly and securely than current magnetic stripe cards (Magnetic Stripe cards can be read and written with equipment available in most hobby shops) [Ref. 10]. Third, it provides a form of mutual authentication between the interface, the bank and the user that can reduce fraud or misuse. Its operating environment can be limited to the ship or expanded to an evolving wide area network.

As an ideal medium, it does not meet elements 8 and 10. Wide acceptability (element 8) is solely dependent on its expansion with in the world market. The unit of value freedom (element 10) is also dependent on its use and market value between currencies of different countries. Specifically, just as the US dollar competes economically among other currencies, so also will the electronic unit of cash represented on the smart card. The smart card remains a viable option within these constraints because multiple currencies can be maintained simultaneously on a single card. Additionally, it is already accepted in similar forms internationally.

In a shipboard environment, it is extremely difficult to meet all of these elements. Even if the medium met these elements, there are several implicating factors that would still have to be addressed.

D. LEGAL IMPLICATIONS

Chris Sandberg [Ref. 18] in his article, "Legal Issues in the world of Digital Cash," addresses several areas of concern when considering implementation and acceptance of electronic media.

> Digital cash can take numerous forms, from "smart cards" (plastic credit card-like but with an embedded computer chip), to cash-like electronic certificates issued by banks or other entities, to proprietary systems like Cybercash or Digicash that are completely net-based. Several legal issues come up regardless of the specific form the digital cash takes, and a number of those issues remain unanswered. These include privacy, security, and consumer protection.

Privacy

One drawback to many current forms of electronic payment (such as bank credit cards) is that they leave a clear and persistent trail of records. That record trail can be used by many parties other than those involved in the actual transactions, ranging from law enforcement personnel to marketers to litigants in civil suits. An advantage claimed for digital cash is that it can be much more private than traditional paper or credit-based exchanges. The providers of "ecash", for example, claim that "The underlying ecash protocol protects the privacy of the customer, so that banks cannot create a list of descriptions of amounts of purchases made by payers." If this level of confidentiality can be preserved, digital cash presents both great opportunities and significant challenges. It would allow consumers to shop without leaving information about themselves that can be sold to (or stolen by) third parties for their own purposes (such as compiling mailing lists and sending junk mail to people who repeatedly buy a certain product or service). At the same time, the lack of a record trail can make it easier for money to be "laundered" through the Internet, and for individuals engaged in illegal activities to evade the research efforts of law enforcement. Given the experience with law enforcement's reaction to digital voice communications (the 1994 Federal law that requires all new telephone equipment to provide easy, analog entry for law enforcement wiretaps), it seems unlikely that the criminal justice system will not take an interest in the potential for abuses of a digital cash system, and look for ways to ensure records of digital case transactions.

Security

While various forms of cryptography have gotten most of the attention as means of providing security for digital cash, WebTech, Inc. raises another view of the security issue, in their "Internet Banking and Security" white paper. They suggest as an analogy, using an armored van to transport cash from one branch bank location to another, but then leaving the cash in the middle of the back lobby. Cryptography provides the armored car for the data transmission portion of the electronic transaction, but additional software and operational security are needed to be sure the digital cash is safe at the conclusion of the transaction.

Legal issues that arise in this area include the portability of cryptographic software (since current Federal laws restrict the export of sophisticated encryption software, using good security in connection with international transactions is problematic), the access to private cryptographic keys (such as in the Administration's Clipper Chip proposal), and the ability to use existing computer fraud and computer crime statutes to prosecute

violations of security systems that protect not the computer but digital cash passing through the computer.

Consumer Protection Issues

The Electronic Funds Transfer Act ("EFTA") provides most of the consumer protections presently in place for electronic fund use. "Regulation E" of the board of governors of the Federal Reserve System implements the EFTA, and controls electronic signature issues for consumer debit transactions. Regulation E covers banks and their customers for electronic transfers in and out of consumer accounts; these include ATM cards and point of sale transactions. Under Regulation E, consumers have significant protection from unauthorized electronic funds transfers. The bank, which issued the card to the consumer, has the burden of proving that a transaction which a consumer says was unauthorized was in fact authorized by the consumer. Generally, a consumer's failure to carefully protect the authorization process does not make the bank's case. For example, just because a consumer wrote his access code on the back of his ATM card does not prove that any transactions made with that card were authorized.

Regulation E doesn't just apply to banks; any "financial institution" that issues an access device and agrees with the consumer to provide an electronic funds transfer service can be covered. While the common cards in use today are the ATM-style magnetic-coded cards, the Federal Reserve has recognized the emergence of new technologies such as smart cards.

Still unanswered is how these regulations can and should be adapted to wholly net-based digital cash models. One vehicle would be to expand the definition of "access device" to cover software tools and automatically generated security protocols. This coverage will be particularly important as non-bank entities develop on the Internet. The First Bank of Internet ("FBOI") is advertising on-line as providing "transaction processing services for Internet electronic commerce" through a Visa ATM card-based digital cash system. At the very end of the two-page announcement of its services, FBOI notes that it is not a lending institution or a chartered bank. Similar issues arise outside the consumer-shopping context as well. Requests for bank-to-bank wholesale transfers of funds, for example, can be electronically signed under the Uniform Commercial Code. As some forms of digital cash become commercially negotiable, they may fall under the UCC's Article 4A provisions for digital signatures, which are quite different from the provisions of Regulation E.

Government Actions

Federal government consideration of the issues surrounding digital cash is scattered among a few agencies, including the Office of Technology Assessment and the Treasury Department. States are beginning to realize they also need to address the emerging digital cash issues. The Minnesota Department of Commerce issued a Public Notice on August 25 that it is seeking information to help draw up rules relating to electronic funds transfer terminals. The State of Utah has passed the first state-level digital signature law. Utah's law sets up a new category of intermediaries between buyers and sellers, known as Certificate Authorities. These cybernotaries will check the identity of a digital signature user and will be liable for making a bad identification, thus moving some of the risk of digital cash away from sellers and financial institutions. In turn, users will have to be more careful with their private encryption key, and can be held liable for forgeries.

Privately-Issued Digital Cash

Some thinkers in the digital cash arena advocate creating private digital cash - that is, funds which are not tied to the value set by any political institution. Under this approach, the units of value would not be in dollars, yen, marks, or any other government-backed currency. Instead, new financial backers such as merchants on the Internet, Internet service providers, content providers, and service companies, would create their own units of value and back them with their own assets. Consumer would probably use the private cash initially to make purchases within a controlled environment (such as in an on-line shopping mall), but the private digital cash could spread generally if users accept it. No federal law prevents individuals from creating their own currency, but privately issued digital cash would not technically be legal tender for debts. Brand name recognition and trust are liable to be key elements of any such system, since acceptance of private digital cash would be voluntary on the part of the seller or creditor [Ref. 18]

E. COMPATIBILITY

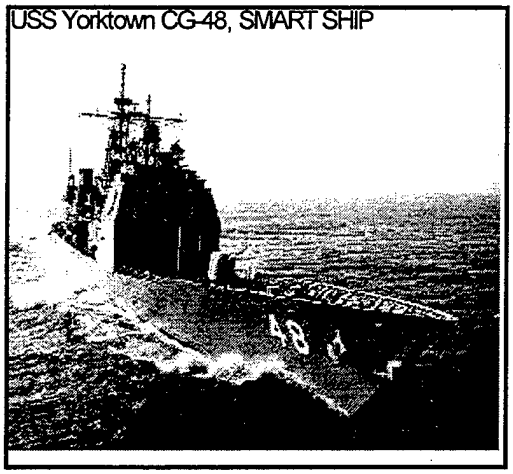
When determining the form of medium to be contracted, the ideal medium should be compatible with open systems interfaces. These interfaces include cash registers, vending, machines, ATM machines, Verifone card readers, Point of Sale (POS) readers and other commercial interfaces. The industry specific protocols include ISO 9992 which covers Financial Transaction cards, ISO 10202 which defines the security architecture of financial transaction systems using IC cards and finally EMV protocol which are IC cards

specifications for payment systems developed by Europay International SA, Mastercard International Inc., and Visa International Association [Ref. 10]. These protocols become important for three reasons: 1) the Navy needs interoperability with the rest of the financial world (banks, credit card companies and businesses), 2) the Navy should not be inventing any of this, but simply adapting to a standard environment and 3) when planning a shift from a closed financial network system to an open wide area network payment system. The purchase and implementation of integrating devices using these protocols can be performed in series. Therefore, as the US credit system converts to an IC card based system, maintenance agreements should outline the conversion or support necessary to facilitate migration to these protocols.

IV. PROTOTYPE SOLUTIONS

A. THE USS YORKTOWN CASHLESS PROTOTYPE

1. Background


USS Yorktown CG-48, SMART SHIP

The SMART SHIP Project (SSP) Team began in December 1995 in response to the Chief of Naval Operation's (CNO) review of the 1995 Summer NRAC study that focused on reduced manning. The study concluded that major reductions in manning could be achieved by design in new construction ships, however, there were gains to be made in existing operational ships through insertion of technology as well as challenging culture, tradition and current procedures [Ref. 4]. Commander Naval Sea Systems Command responded to the CNO's desire to focus on existing operational ships. The goal of the team is to generate an action plan, understanding that the studies had been done and reduced manning initiatives need to be proven at sea. Other goals include reducing workload, improving mission readiness and maintaining safety [Ref. 4].

Commander Naval Surface Force Atlantic (COMNAVSURFLANT) nominated USS YORKTOWN, a Pascagoula, Mississippi based, Ticonderoga Class cruiser as the SMART SHIP (shown above) on which to focus ideas that lend themselves to the team's mission [Ref. 4]: "Develop, evaluate, and select solutions to demonstrate that reductions in the crew's workload for a surface combatant can be achieved. Solutions will involve the application of available technology, changes to personnel and manpower policies, and changes to any other policies or procedures which drive shipboard manpower requirements. Implement these solutions using a pilot program on an operational ship and evaluate the ship's ability to maintain readiness and accomplish its mission. Identify specific billets which can ultimately be eliminated." As part of this mission, the USS

Yorktown would undergo implementation testing on a closed system cashless network with the goals of reducing manpower and operations.

2. Shifting to Cashless Services

A closed system cashless network will eliminate cash handling billets such as the ship's servicemen, and the postal clerk. The postal clerk sells stamps, money orders and handles outgoing parcel funding. Likewise the Disbursing Officer, Ships Store Operator, Vending Machine Petty Officer and other operators likewise all deal daily with cash handling. A debit card would eliminate the need for cash. Debit cards would be installed in place of coin integrating devices in vending machines, Ships Store, and the Post Office. Debit card readers would have to be installed in all of these areas. Debit cards could be used at vending machines, galley, and the Ships Store. The Disbursing Office would handle a limited amount of cash (supporting overseas exchange and members not on Direct deposit) and it would eliminate long check cashing lines. Stamps or money orders could be also dispensed from ATM machines with the new technologies. The Under Secretary of Defense has approved funding for the MARC card. It is an IC card being used as a "Smart ID" card [Ref. 4]. The Smart Ship Project proposed adding the cashless ship capability to its functionality [Ref. 4].

The USS Yorktown cashless prototype began in 1 July 1996 but the pilot was launched on 12 November 1996 and implemented on 22 Nov 1996 by American Express (AMEX). AMEX provided a closed-system, cashless payment solution designed for a single card issuer in the disbursing office. The pilot utilized the ships' ATMs at Sea card and added the IC chip technology to the card making it usable from an ATM standpoint and for independent debit card readers. The cashless initiative involves reducing labor and overhead associated with cash processes throughout the ship. The Smart Ship Project in association with the Commanding Officer tested this goal by removing two Supply department personnel in support of this prototype. All shipboard members participated in the prototype. Without detailed requirements of the existing shipboard systems, American Express, the prototype resource, began tailoring their proprietary software in meeting the functionality and inspection requirements of the existing cash processes. Their efforts

were constrained by time and deployment schedule but resulted in a working prototype that is ripe with future considerations for system improvement, cost savings, manpower reductions and reduced overhead.

The system is comprised several parts. The card was a smart card with a purse application to handle debits and credits. It also contained a magnetic stripe on the back for ATMs At Sea I functions. The card was used in the store, dining facilities and vending machines. Its value was loaded onto the card via a cash to card machine. The card provided a maximum spending value and spending limit per transaction to increase security during the prototype. The card's software manager was capable of producing hot lists of lost or stolen cards and it also provided PIN protection. Transactions were collected via transport cards for the POS terminals, Hewlett Packard Palm Top readers for the vending machines and later using a transport device, the Gemplus GMX 2000. This collection process updated a centralized card transaction software management system off-line. Customers of the system loaded their personal cash onto the smart card through a cash to card machine. Stored value was then available to use in vending machines, Ship Store, Post Office, Wardroom or Galley.

3. System Achievements

After conducting interviews with retail, disbursing, postal and food service personnel, Figure 5 depicts the saved man-hours achieved when compared with Figure 3 (taken prior to the cashless implementation). During a month, 780 man-hours are consumed handling cash. With smart cards, it takes less than 330 hours per month based on the type of transport system utilized and the frequency of collection (Retail operators collected every two to three days with this system for 30 minutes per session). Man-hour consumption was reduced by approximately 60%. The derived saved man-hour consumption total of 450 is equivalent to the man-hour consumption of two personnel per month. A manpower survey audit was conducted and the following findings [Ref. 17] were reported about the cashless system:

- Eliminates the need for a change fund.

- Eliminates the need for a change machine.
- Eliminates the need for daily cash collections.
- Saves money normally spent on operating supplies such as coin wrappers, coin machines, coin sorters, spare parts for vending machines, etc..
- Eliminates the possibility of overages/ underages in the Ships Store and Post Office.
- Reduces the time spent collecting /depositing cash.

The assessment did not validate the elimination of further billets because of the significance of primary functions. During the prototype, two crewmember positions were removed. Further reductions Fleet-wide could result in the elimination, or shift (outsourcing, privatization or civil service) of at least 52 billets within the Ships Servicemen and Disbursing Clerk ratings for an estimated savings of $2,000,000 annually. This is derived by implementing a smart card system on ships with similar cash processes and does not consider billet lifecycle costs. Further research in this area is required.

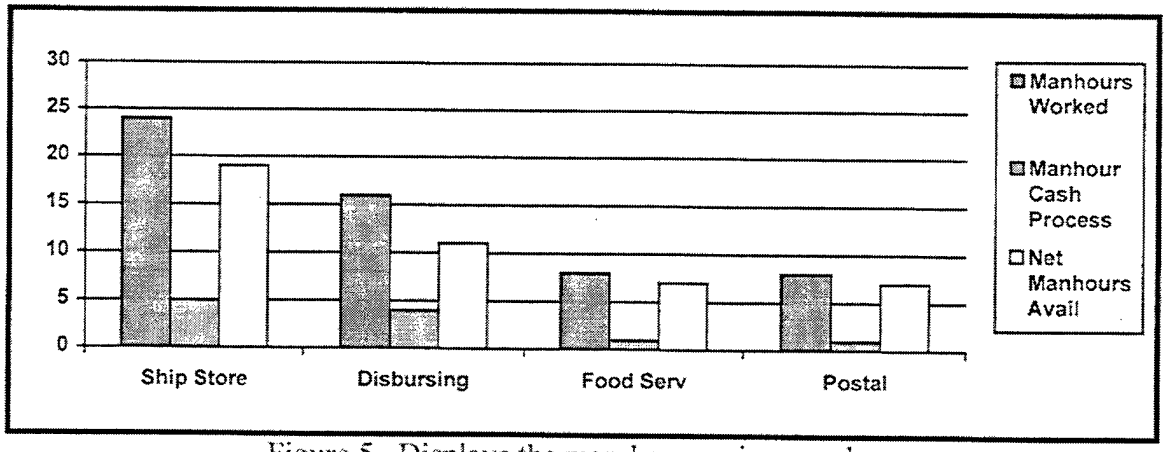


Figure 5. Displays the man-hour saving per day.

* Man-hour total for Ship Store is based on 3 personnel (on Cruiser platform) [Ref. 9]. Although Postal operations is part of the Ship Store Division, its money order sales and cash out procedures add significantly to the total man-hour assessment for cash operations. Disbursing Office man-hour totals represent a 2-person operation. Food Service Operations represents 1 collection agent. Assumes no Imprest fund on board. Net man-hours available represents hours available for other duties aside from cash handling.

The exact price-tag of the prototype system could not be determined for proprietary reasons. However, taking the derived saved man-hour consumption total of 450 and adding the assumed man-hour saving derived from the two personnel eliminated prior to the prototype, then multiplying an average wage constant of $12.00 per hour, yields a break-even point for annual implementation and maintenance costs or $133,920.00. If the procured system plus maintenance projections' cost greater than $134K annually, there will be no benefit to the government. Ideally one would expect the initial system to cost less than $134K with annual maintenance costs less than 10% annually.

4. Customer Feedback

This prototype produced mixed reviews depending if you were the customer, the operator or the auditor. In a voluntary survey, the crew response rate in surveys was 58% [Ref. 13]. Eighty percent of the customers felt it was easy to use and enjoyed not carrying or handling cash [Ref.13]. They commented on slow transaction times when using the card in vending machines. They indicated a sense of expanded freedom in an operational environment simply because they did not have to carry around cash. Some wanted the capability to purchase more than one soda per transaction. Others wanted their spending limits increased so they did not have to reload their cards too often. Spending limits for the prototype were requested to be $100.00 but could be set as high as the Commanding Officer would designate. Officers found it cumbersome to use because they were accustomed to paying for their meals on a monthly basis with a check and not a daily basis with a card. Crew acceptance level should be a major concern but not a major factor when considering manpower reduction coupled with operational efficiency.

The operators do not want the prototype to end or go away. Some have stated, "Sir, we don't want to go back to counting cash anymore." They liked the fact that they did not have to wrap and count coins any more. Vending Machine reliability has improved. During deployment operations, there were several instances where individual training, existing operating procedures could not eliminate errors or overages in balancing. Fault tolerance levels and procedures may play an important role in future

design considerations. The cash to card machine when balanced by the operators reflected more physical cash than represented on the card meaning that collection process and/or the central management software was losing transactions. Operators did not use the correct steps when uploading transactions to the central management software causing system errors indicating a less than clear understanding of procedures. Flash memory had to be expanded in collection devices to handle the number of transactions. Most of these errors are correctable and can be attributed to the quick implementation due to operation tempo, lack of adequate training and inadequate system requirement availability to facilitate merger of the shipboard cash requirements or norms and the fixed, off-line payment mechanisms.

For auditors or managers, the system presents change from old system procedures, methods and balancing schemes to new procedures based on smart card technology. For example, cash is collected from retail outlets on a daily basis. The management software calculates daily cash transactions from 0001 to 2400 also on a daily basis. So what should be the problem balancing at the end of the month? Under the old system, the cash is collected and the stores are inventoried at the end of the month. Since smart card management software transactions end at midnight, it may appear as if there is unaccounted for sales after financial closeout at the end of the month due to continued vending machine sales through 2400. There simply needs to be re-training, or a software update to allow balance features to bring post balance business to the beginning of the next business day. This example may not appear to be very significant, but to an auditor used to the old system, this may appear to be a system flaw or an accountability problem on the part of the Sales Officer. As with software implementation, through continued dialogue and user interaction, a clear definition of system requirements will be identified and a more reliable system for all parties will be enjoyed.

The management also had mixed reviews. The Sales Officer commented that his personnel were taking up to 15 minutes per card to reissue a lost card. He also commented that this became significant when issuing visitor's cards in foreign ports, so visitors could shop at the store or buy a soda. He attributed the problems to personnel training with the system.

5. System Limitations

The cash to card machine did not operate perfectly. Normally, in vending machine operations, besides delivering or accepting too much or too little change, slugs or foreign coins can be a problem for collection agents. Smart cards, on the other hand, do not share these problems. They do share with their cash counterparts similar errors with the Bill Acceptors in the cash to card machines. Wrinkled or older soiled notes can become stuck in these devices necessitating operator intervention. During the prototype this error caused cash not to be credited on the chip. The custodian resolved it by inserting another bill from the hopper back through the Bill Acceptor.

Management of administration functions was slow to react to customer needs. This reaction suggested a lack of adequate training prior to implementation or lack "user friendliness" of the smart card management software. New processes like of issuing cards, reassigning PIN numbers, and error reconciliation created new jobs within the Retail division, but considerably less than the old system. With vending machines or store accounts, reconciliation processes such as refunds or loss of coins could take several hours depending on the time of loss and the availability of the custodian. Smart cards reduce the time for reconciliation but the observed time during this prototype was approximately an average of 20 minutes per customer.

The smart cards were not compatible with the existing shipboard ATM (Version I) machine. Split Pay option personal could use the magnetic stripe feature for debits but account to chip functions will require hardware upgrades for the ATM machine.

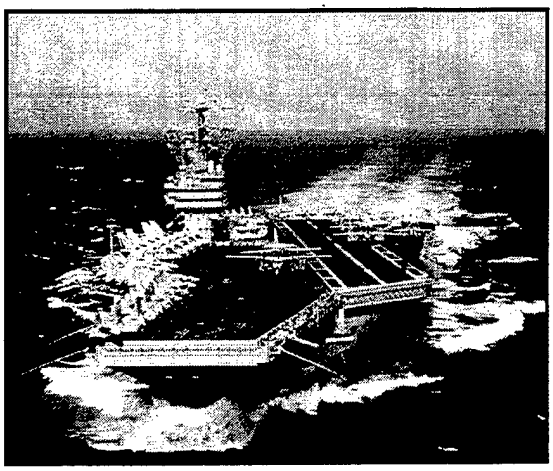
A cumulative spending limit must be defined and introduced with any disposable cash, or chip, application because users can have up to 100% of their prepaid assets withdrawn if stolen. The USS Yorktown imposed a $10.00 cumulative spending limit to set a maximum loss level if stolen or lost. This limit signals an authentication process, where card carriers must verify their PINs before making transactions again. This limitation restricts monetary freedom when compared to using cash or coins but provides additional security in a cashless environment.

During the collection process, it was discovered that collection agents needed more transport cards for downloading transactions than were available. Ship Store transactions (over 1000 per day) required up to 15 cards to download all data. The amount and order of transport cards became an issue for the software administrator. This inefficiency was solved with the implementation of the GMX 2000 transport system that had the capacity of holding all transactions in a single session.

In sum, the system does relieve operational overhead at an expense that is satisfactory to the government. The system adequately provides a closed system for cash management and distribution. Detailed user requirements, definition of business rules and the personnel training plans must be incorporated in future implementations. This will result in an improved product and increased acceptance by the customer.

B. COMMERCIAL BANKING AFLOAT PROTOTYPE

1. USS Theodore Roosevelt (CVN 71)



The ATMs-At-Sea program sponsored by Naval Supply Systems Command (NAVSUP) began in 1982 and was provided by NCR Corporation [Ref. 15]. It has helped distribute cash to available crewmembers, but has been severely limited in its scope and application. Their continued evolution through application development of wide area open-systems networking, make the future more promising and possibly cashless [Ref. 15]. The USS Theodore Roosevelt (CVN 71), shown on the left, is the first ship to operate the CBA prototype system. Since a background of the CBA prototype has already been mentioned, what is left is a technical overview of the system.

The objective of the CBA system is to provide one 2.4 Kbps channel from the C-band Challenge Athena system through a government-provided Timeplex Multiplexer to the Armed Forces Financial Network (AFFN) Frame Relay Switching Node in Rochelle Park, NJ [Ref. 15]. This will allow shipboard personnel to access their commercial checking and savings accounts via Automated Teller Machines (ATMs) aboard ship and conduct commercial banking withdrawal and balance inquiry transactions while deployed.

The CBA system has been connected to the Armed Forces Financial Network (AFFN) using USS Theodore Roosevelt's Challenge Athena, a commercial high-data-rate satellite communications transponder. Figure 6 depicts an overview of the basic architecture for the prototype implementation of commercial banking afloat [Ref. 15]. Pay information is sent to the ships and banks from DFAS using CBA or electronically by SALTS, modem or Department of Defense AUTODIN messaging system. The ATMs provides banking services to the crew and updates shipboard Split Pay accounts or

member banking accounts. Transactions are processed within the ATM computer server and transmitted via Challenge Athena to ashore Gateway Earth Station. The Gateway Earth Station located in Holmdel, NJ, relays the communications signal via the Challenge Athena T1 trunk to the Naval Computer and Telecommunications Area Master Station Atlantic (NCTAMS LANT) for signal encryption/decryption, patching, and processing [Ref. 15]. The signal then will be routed through a shore Multiplexer and a Frame Relay Device (FRAD) at NCTAMS LANT and relayed over a frame relay circuit (commercial landline) to the to the AFFN network switch at the Electronic Data Systems Corporation (EDS) facility in Rochelle Park, NJ, for further routing via AFFN to the appropriate commercial bank or credit union [Ref. 15].

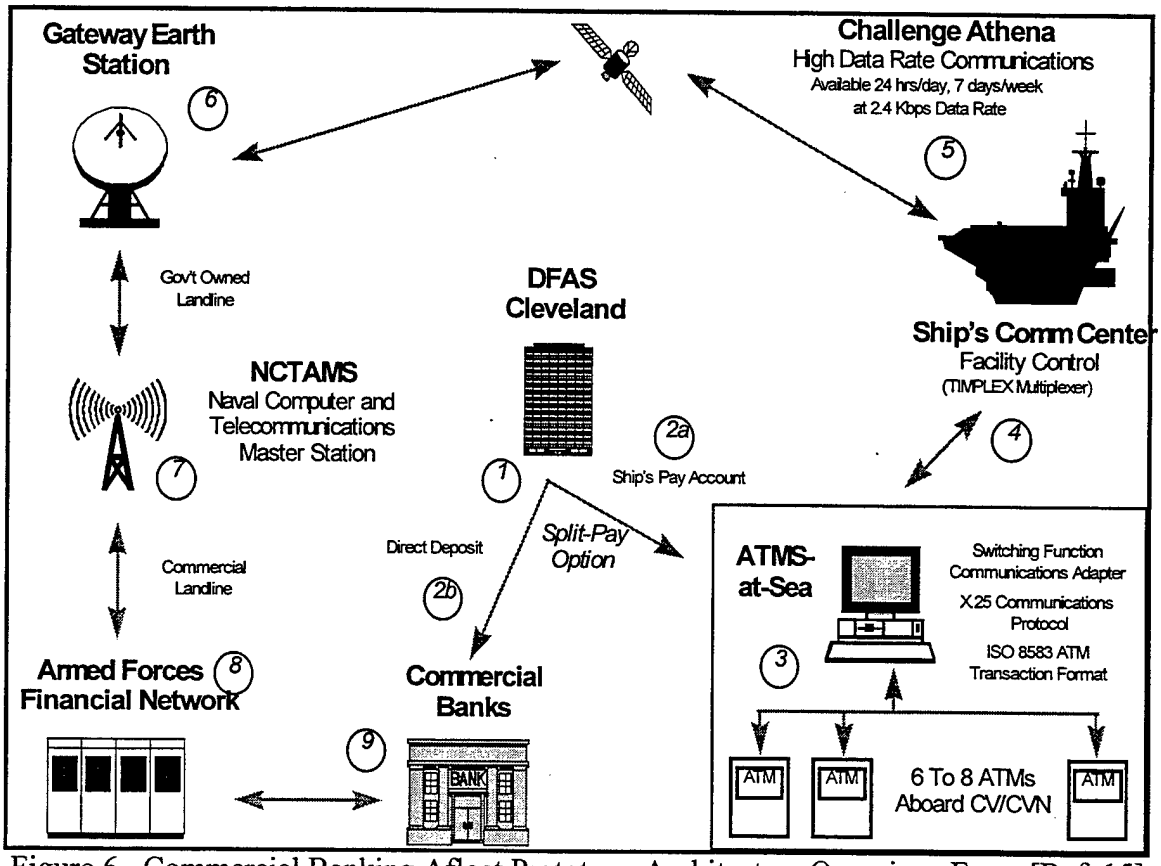


Figure 6. Commercial Banking Afloat Prototype Architecture Overview. From [Ref. 15]

The basic communications requirement for the CBA prototype is a 2.4 Kbps data line, using the X.25 communications protocol and the ISO 8583 ATM financial

transaction message format. The designed availability is 24 hours a day, 7 days a week [Ref. 14].

2. Shipboard Communications Architecture

During underway operations, Challenge Athena provides a full-time 2.4 Kbps satellite communications circuit for CBA ATM operations. The ATMs, connected to a processor/controller located in the Disbursing Office, is connected via phone line to the Timeplex TDM Multiplexer in the ship's Radio Technical Control Room [Ref. 15]. Signal encryption/decryption, patching, and processing takes place in Technical Control, and the signal is patched to a satellite communications modem in the Radio Frequency Suite and transmitted via the Challenge Athena C-Band antenna [Ref. 15]. As stated, the data rate of Challenge Athena to shore is T1. CBA is using only a portion of that pipe at 2.4kbps since Challenge Athena is very full with various circuits. Although CBA capabilities can go up to 56kbps or higher, the implementation team is only using the minimum in order to minimize operational prioritization within the pipe. System security is achieved through Personal Identification Number (PIN) encryption. Hardware devices already available in the ATMs aboard ship perform this process [Ref. 15]. These devices use the Data Encryption Standard (DES) required by the financial network. Additionally, the Challenge Athena communications stream is bulk encrypted through a KG-194 utilized on board USS Theodore Roosevelt before it leaves the ship, and bulk decrypted as it arrives at the (NCTAMS LANT). [Ref. 15]

Figure 7 describes the shipboard communications architecture to support commercial banking afloat and depicts circuit strategy and layout.

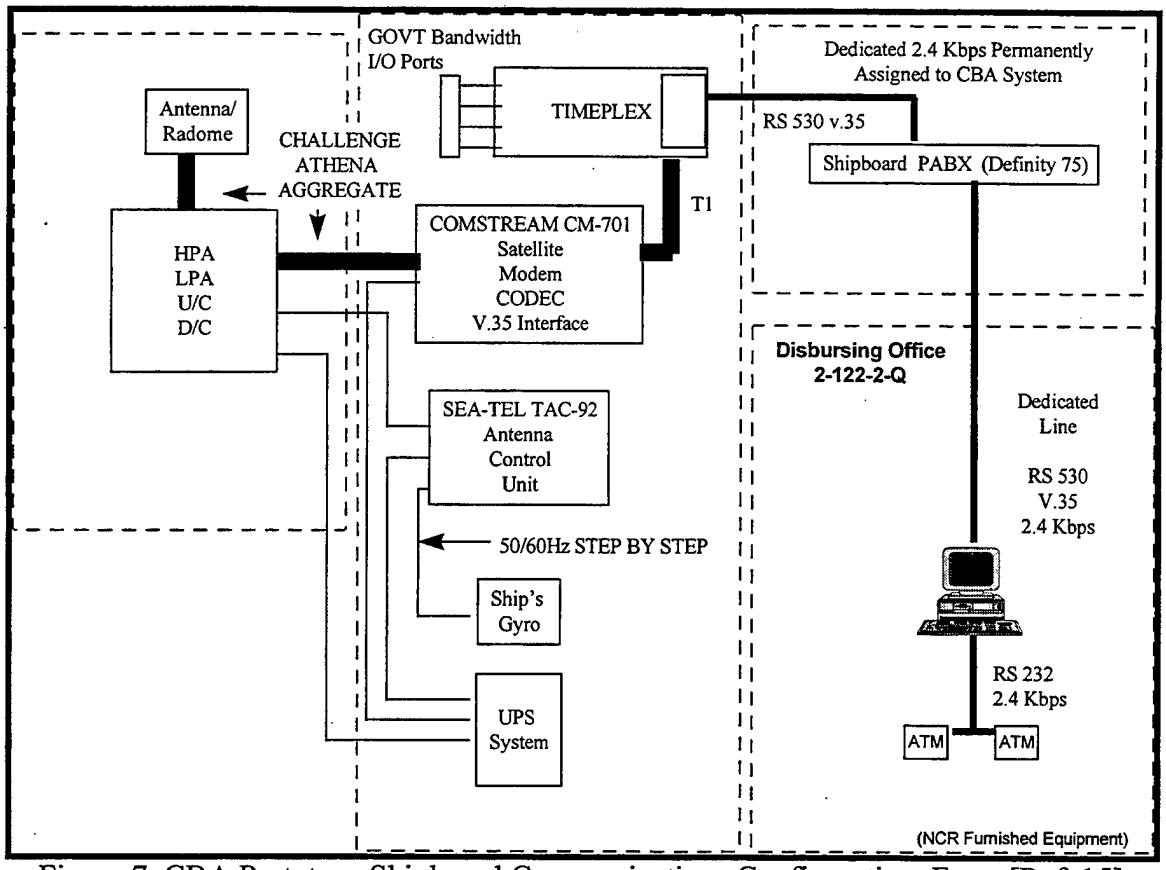


Figure 7. CBA Prototype Shipboard Communications Configuration. From [Ref. 15]

3. Communications Architecture Ashore

Figure 8 describes the ashore communications architecture to support commercial banking afloat and depicts equipment locations and circuit strategy.

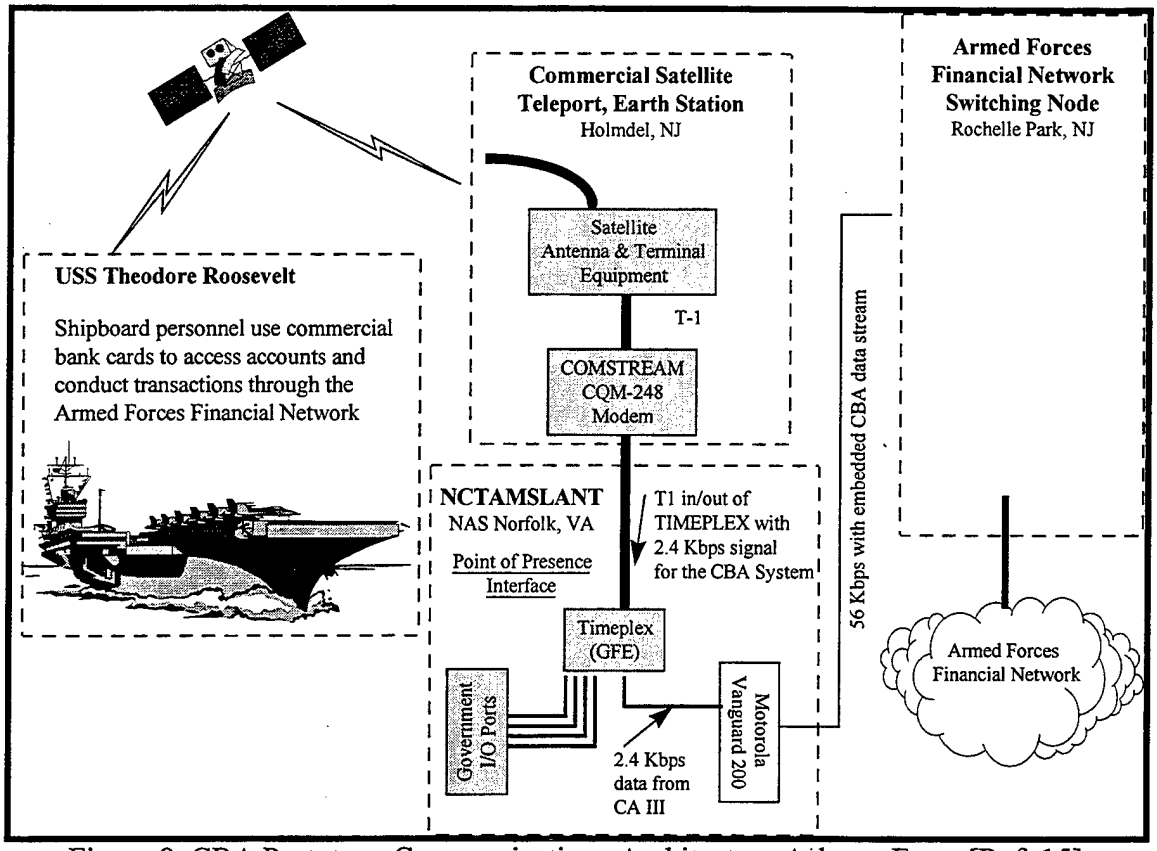


Figure 8. CBA Prototype Communications Architecture Ashore. From [Ref. 15]

4. Financial Network Operations

A financial network connects the commercial banks and credit unions that belong to the network. It provides data communication between the network central switch and member financial institutions. The network also establishes operating rules and regulations to manage such things as network transactions and the use of network logos [Ref. 15]. It provides transaction settlement services and defines and facilitates methods of adjustment for erroneous transactions or violations of the network's rules and regulations. EDS provides central switching services for the AFFN financial network [Ref. 15].

A gateway interface is required to send an ATM transaction to a commercial bank or credit union that belongs to a different financial network [Ref.15]. A gateway interface provides data communication from the ATM system termination to the gateway location. It identifies the network and transaction routing based on the ISO prefix of the ATM card account number in the transaction message [Ref. 15]. It reformats the

transaction to the message formats required by the various financial networks. It then provides data communication to the appropriate financial network central switch. The gateway interface also provides for an audit trail and settlement reporting of all transactions [Ref. 15].

5. Sponsorship into Commercial ATM Networks

The participating financial institution members own commercial ATM networks, either directly or indirectly. Many networks require that participants be an insured financial institution to ensure the financial integrity and collectability of each transaction. Other organizations must be sponsored (i.e., guaranteed) by an insured financial institution. EDS can provide this sponsorship for AFFN [Ref.15]. AFFN is the only financial network with an exception to this policy that allows military organizations to join the network as an acquiring participant, military member and participate directly (i.e., accepting ATM transactions into the network) [Ref.15]. CBA operations are limited to commercial banks and credit unions that are members of AFFN network. After tests, proof of concept, and further review, the Navy can apply for membership in other financial networks [Ref.15].

6. Customer Feedback

In general, the crew of the Theodore Roosevelt were pleased with the operation and the availability of the CBA ATMs [Ref.13]. The crew began to depend on the availability of the CBA machines. Two of six machines were installed on the Roosevelt. Since the Prototype tested only two machines, large lines formed during periods of maintenance or troubleshooting of each machine. A sign of immediate crew acceptance, the CBA program has now become a significant quality of life issue on the Roosevelt. During port visits sailors would debit large amounts of cash to change foreign currency ashore instead of using their cards. Other ships visiting the same port with the Roosevelt mirrored this action. The other ship crewmembers would come on board to use the CBA machines increasing the amount of cash drawn.

Disbursing personnel have reported an increase of cancellations of crewmembers Split Pay accounts. These actions suggest that crewmember prefer to use or have access

to all of their money and not just a portion of it. With CBA, all of their bank account funds are available. There was no significant change in manpower for the check cashing lines since the position remained open facilitating those crewmembers not taking advantage of the CBA machines.

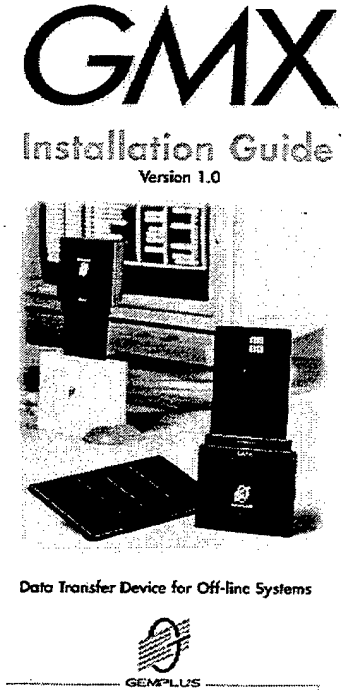
Managers were impressed by the overall reliability of the system. Transaction speeds were remarked as fast as pushing the buttons. And the system remained up for 98% of the time. There was a short down period when entering the Indian Ocean.

A review of survey results indicated that 95% of the crew's banks were members of the AFFN financial network [Ref.13]. Over 81% of the crew possessed debit card from their banks, and over 70% crewmembers said that they would use the CBA system for their banking requirements [Ref.13].

V. CONCLUSION

A. RECOMMENDATION

GMX 2000, [Ref. 2]



The best-fit solution for both large and small afloat platforms is a closed-system, based on smart card technology, linked with the CBA ATM. This approach combines the efforts of technologies observed in two prototypes. The Smart Ship, USS Yorktown, prototype provided a smart card based solution. Again, this solution method involved linking all smart card integrating devices in each cash handling point with a transport system. The smart card itself can be a prepaid smart card or electronic wallet that can be linked to the existing ATMs-At-Sea platform. Crewmembers can buy services and sodas and pay messbills in a cashless environment. Visitors would be able to receive visitor's cards permitting them to load up personal funds to the cards. Cards would then be used in the Ship Store, vending machines, messline or Post Office to buy merchandise. Although user requirements and business rules were not addressed to the fullest extent, what quickly became evident was the reduction of workload and the ease of operation with the sailors interacting with the cash mechanisms. This closed system solution provided a common sense approach to a difficult problem.

Considering the locations of stores, the finance center, vending machines and ATMs, there are not to many places on ships where these machines can be installed. The Yorktown solution provided a transportable integrating device reader permitting collection agents to collect from machines without having to open vending machine doors or requiring a network connection capability [Ref. 3]. The GMX 2000 reader made by Gemplus (shown above left) enables speedy transport mechanism from each machine or store. Since units are paid for in advance, a closed system of virtual money replaced all

the cash mechanisms of the ship. The monetary units were managed by a single software package, CMS manager, in the retail store division office [Ref. 3].

The ATMs would have to be upgraded to perform and meet certain cashless operating environment objectives. The transactions that the ATM machine would have to perform include account to chip loading and chip to account loading. This process would ensure that sailors would have their money back in their bank account or Split Pay account when they transfer from the ship. The card itself would be a property of the ship and could then be turned in for re-issue when a sailor departs. The advance of using this technology lies within its security. If the card is lost or stolen new cards can be reissued to members to accurate account balances since it is a closed system. The smart card administrator would have to be able to track account to chip debit transactions to load the card for individual management. The smart chip will be the only managed stored value process available on the card. The Split Pay Account can still be available using the magnetic stripe but would not be managed by the CMS manager or even necessary in the new environment.

The ATM would also provide commercial banking services. Cards from AFFN member institutions (totaling 200 banks) would be accepted in CBA machines. Crewmembers would be able to make account inquiries, withdraw cash required for liberty, or load their smart cards.

B. LIMITATIONS OF THE SYSTEM

The limitations of both systems have been covered but for the reliability and the availability of the local area to wide area communications network. This represents the most difficult problem to solve when thinking in terms of balancing shipboard operational or administrative requirements with existing communications infrastructure and commercial technological advances. If the Navy continues to plan to run the Internet to its ships, then financial applications should be set up use this architecture.

There are several piping schemes that provide high data rate capabilities in support of a closed area to wide area solution. Challenge Athena provides large afloat platforms with T1 (1.544 Mbps) connectivity ashore. However, smaller platforms require

alternative piping schemes to achieve wide area connectivity primarily due size constraints. Some of these alternatives are described below.

1. Automated Digital Network Systems

ADNS "autonomous subsystems"(AS) provides routing schemes that will merge existing shipboard communications infrastructure to provide a reliable pipe for small afloat ships via larger Battle group components. By "piggybacking," smaller ships would benefit from larger ship communication platforms. With ADNS, we can snap in any link into it such as UHF, SHF, EHF, IMMARSAT A, IMMARSAT B, or various orbital satellites. Financial data packets would be relayed from shore to the carrier and then to the smallboy [Ref. 5]. Figure 9 illustrates the ADNS piping structure.

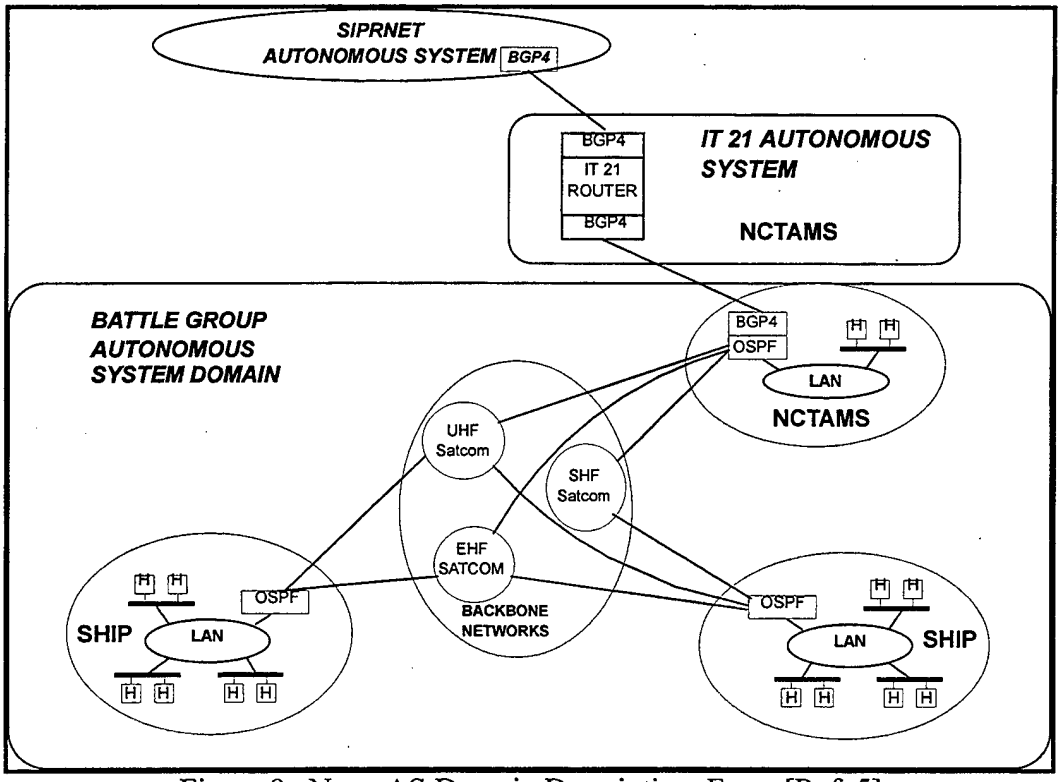


Figure 9. Navy AS Domain Description. From [Ref. 5]

A typical example of multiple battle groups connected at one NCTAMS is shown in Figure 9. Each battle group AS has a separate border router connected to the NCTAMS local area network (LAN) [Ref. 5]. These battle group AS border routers can talk to each

other or to the "IT 21" (Information Technology for the twenty-first century) router for SIPRNET connections. The SIPRNET connections represent the classified telecommunications backbone. For cashless purposes, the NIPRNET (unclassified) autonomous system would be utilized. All traffic between AS's must go through the NCTAMS LAN [Ref. 5]. From NCTAMS, the financial packet would follow the same routing to AFFN as depicted back in Figures 6 and 8. The reason for not having one large AS for all ships is to reduce the net management overhead [Ref. 5]. Each AS would have separate channels such as one DAMA channel each reducing bottlenecking [Ref. 5]. Figure 10 is another representation of a battle group sharing the ADNS communications infrastructure but with one drawback.

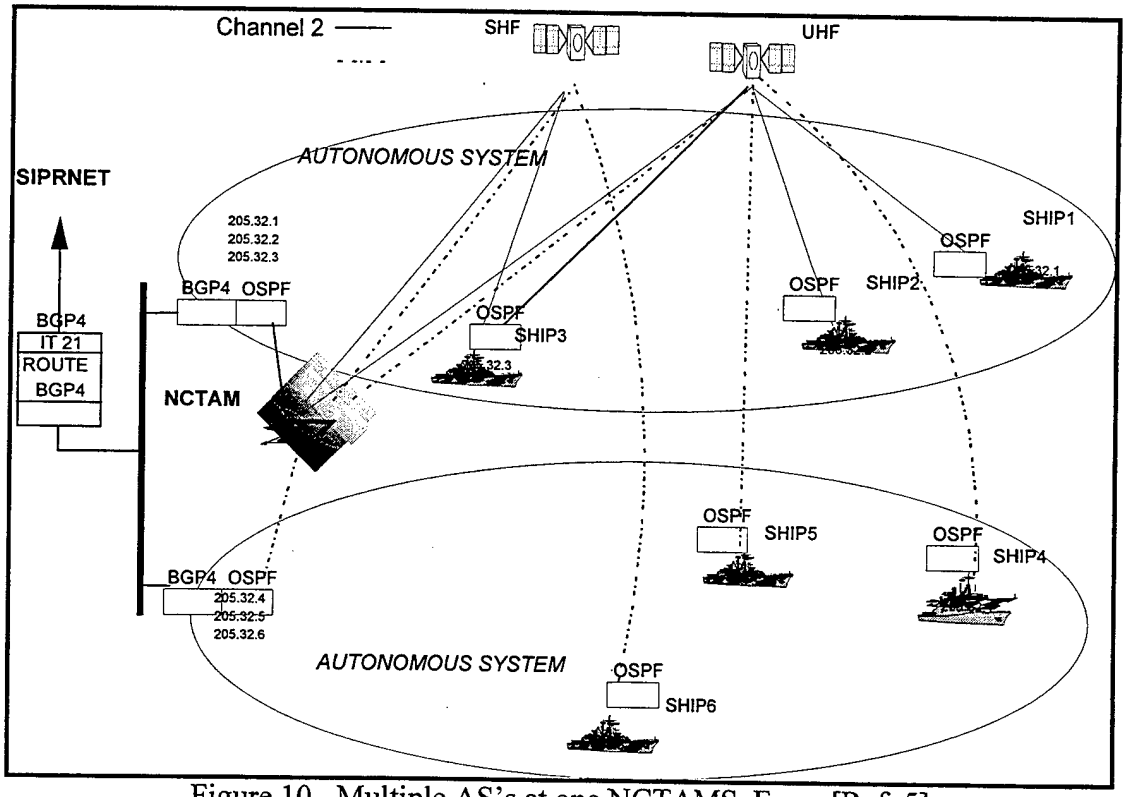


Figure 10. Multiple AS's at one NCTAMS. From [Ref. 5]

The above approach worked well in the past when only large deck ships had a single (e.g., SHF) link to an NCTAMS [Ref. 5]. It has problems when many small deck ships are included in the AS and have multiple links to more then one NCTAMS [Ref. 5]. This problem occurs when ships transition between NCTAMS or when not all links are

available at one NCTAMS. Also all ships in an AS may not transition at the same time and still need connectivity within their battle group [Ref. 5].

The approach for ADNS as an integrating system is sound and its implementation appears feasible. However, it remains under review for the future and is a moving target at this time. Further research is necessary.

2. Deployable Smartlink System

Smartlink is a ship board communication system using existing commercial C-band satellites to provide high data rate connectivity from ship to shore or anywhere [Ref. 2]. The deployable aspect operates on the premise that non-dedicated shipboard space is not lost but can be utilized for deployment whenever necessary. Smartlink could therefore be available to all ships by fitting wherever necessary [Ref. 2].

This C-band communication system overcomes the size limitations of Challenge Athena for smaller ships by its unique low windload antenna technique developed by Malibu Research. This technique causes a reduction in sail factor [Ref. 2]. The antenna system has the following advertised characteristics [Ref. 2]:

- Minimal reaction to high winds
- Portability
- 10 foot diameter antenna
- low radar cross-section

The antenna system provides the following minimal capabilities [Ref. 2]:

- 1.544Mbps full-duplex ATM(frame relay) connectivity across satellite link
- 1.544Mbps full-duplex ATM to another ship via a AN/WSC-3 radio
- Multiple trunk lines (up to 24) to the voice PBX
- Up to four videoconferencing interfaces
- Full firewalling of all data (IP) communications.
- MPEG1/MPEG2 video communications using external storage and decoding equipment.

Elements of this system provide a great fit for smaller ships in support a cashless wide area network. Further research is required concerning additional shipboard application support, operational requirements and user interfaces.

3. IMMARSAT B

IMMARSAT B is the second phase implementation of an existing shipboard telecommunications (IMMARSAT A). It deployment schedule is a moving target at this time. The cost of usage per minute will remain high at roughly $5.70 per minute. The existing system suffers from low data rates as well as areas of blackout. The price, data rate and coverage problems tend to limit its consideration for a cashless network.

Figure 11 depicts a concept of a potential cashless architecture.

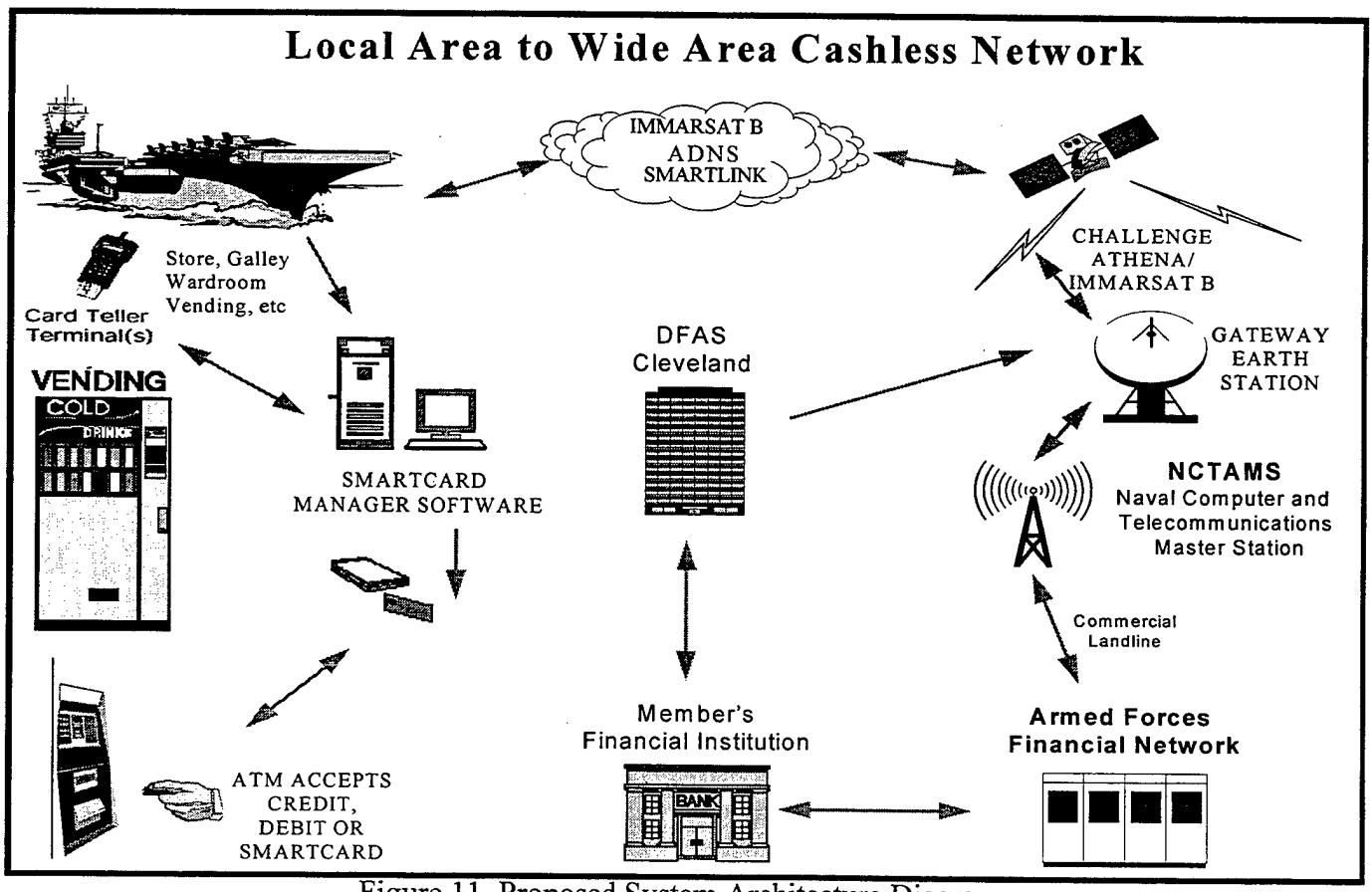


Figure 11. Proposed System Architecture Diagram.

With respect to reliability and availability, any cashless network using any wide area pipe would be subject to shipboard electromagnetic communications restrictions. These restrictions would limit network availability for command directed outages. For hardware failures in fixed or mobile satellite systems such as Challenge Athena or Smartlink respectively, the wide area network would be down until repaired.

With one exception, for an ADNS environment, there exists redundancy with different communications equipment making the wide area network more available and reliable but still subject to electromagnetic restrictions.

A cashless environment is feasible but to a certain extent. Disbursing Officers must continue to retain cash for emergency foreign exchanges (currency or dealer's bills), and for personnel not on Direct deposit. The network solution as observed through CBA and the Smart Ship Prototype represents a "common sense" approach for cashless services to exist. And thereby, reduce workload, personnel and improve efficiency.

LIST OF REFERENCES

1. Author Unknown. *About Ecash.* http://www.digicash.com/ecash/about.html

2. Author Unknown. *Deployable Smartlink System.* MRA P597-01. Malibu Research Associates. 16 May 1997.

3. Author Unknown, *SmartCity® Electronic Money System (EMS)*, System Overview, Product Technologies Inc., 1996.

4. Author Unknown. *Smart Ship Project Overview.* http://www.dt.navy.mil/smartship/whatgoes.html#Cashless_Services

5. Casey, Roger," *ADNS Autonomous System Implementation*," Working Paper, NRaD Code D8205, 23 December 1996.

6. Chaum, David. "Security without identification: card computers to make big brother obsolete," http://www.digicash.com/publish/bigbro.html

7. Chaum, David. "Online Cash Checks", Advances in Cryptology. *Eurocrypt'89*, pp. 288-293. http://www.digicash.com/publish/online.html

8. Fancher, Carol H. " In Your Pocket Smartcards," Electronic Payments, *IEEE SPECTRUM*, February 1997.

9. Heline, L., *Demographic Data*, DMDC West, DOD Center, Monterey Bay, 8 April 1997.

10. Maat, Mike Ter. "The economics of E-cash," *IEEE SPECTRUM*, February 1997, p. 68-73.

11. Matonis, Jon W., "Digital Cash and Monetary Freedom."April 1995. http://www.publitronix.com/digital_cash/home.html

12. Naval Supply Systems Command, *Afloat Supply Procedures*, NAVSUP Publication 485, Revision 2, 15 November 1989.

13. Naval Supply Systems Command, Commercial Bank Afloat Crew Survey Results, NAVSUP (05) Working Draft, November 1996.

14. Naval Supply Systems Command, *Food Service Management, General Messes,* NAVSUP Publication 486, Volume I, Revision 3, 1 February 1994.

15. Naval Supply Systems Command, *Commercial Banking Afloat Prototype: Expanding the ATMs-at-Sea Program To Include Afloat Access To Commercial Banks and Credit Unions*," NAVSUP (05) Working Paper, 10 March 1997.

16. Naval Supply Systems Command, *Ships Store Afloat*, NAVSUP Publication 487, 1 February 1994.

17. Naval Manpower Analysis Center, *Implementation Proposal Assessment, CNSL IP 007: Shifting to Cashless Services*, 29 March 1997.

18. Sandberg, Chris. (1996). *Legal Issues in the world of Digital Cash.* Http://www.info-nation.com/cashlaw.html.

19. Singletary, M., Electronic World: Unchecked Problem?, *Washington Post*, 4 March 1997, C-6.

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center 2
   8725 John J. Kingman Rd., STE 0944
   Ft. Belvior, Virginia, 22060-6218
2. Dudley Knox Library 2
   Naval Postgraduate School
   411 Dyer Rd.
   Monterey, California 93943-5101
3. S. Sridhar, Code SM/Sr 3
   Naval Postgraduate School
   Monterey, California 93943-5101
4. R. Buddenberg, Code SM/Bu 2
   Naval Postgraduate School
   Monterey, California 93943-5101
5. RADM G. Huchting, PEO SC AP 1
   2531 Jefferson Davis Highway
   Arlington, Virginia 22242-5160
6. CAPT. G. Glover, SSP 1
   2531 Jefferson Davis Highway
   Arlington, Virginia 22242-5160