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MBA PROFESSIONAL REPORT

The Development of a Business Case Analysis for the Acquisition of the Agile Rapid Global Combat Support System used for the United States Marine Corps' Ground Equipment

**By: David L. Jupiter
Lisa J. Reuter**

December 2006

**Advisors: Raymond Franck
Daniel Nussbaum**

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**THE DEVELOPMENT OF A BUSINESS CASE ANALYSIS FOR THE
ACQUISITION OF THE AGILE RAPID GLOBAL COMBAT SUPPORT
SYSTEM USED FOR THE UNITED STATES MARINE CORPS' GROUND
EQUIPMENT**

David L. Jupiter, Captain, United States Marine Corps
The College of William and Mary, 2000
Lisa J. Reuter, Captain, United States Marine Corps
Valparaiso University, 2000

Submitted in partial fulfillment of the requirements for the degree of

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December 2006**

Authors:

David L. Jupiter

Lisa J. Reuter

Approved by:

Dr. Raymond Franck, Co-Advisor

Dr. Daniel Nussbaum, Co-Advisor

Robert N. Beck, Dean
Graduate School of Business and Public Policy

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ACQUISITION OF THE AGILE RAPID GLOBAL COMBAT
SUPPORT SYSTEM USED FOR THE UNITED STATES MARINE
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ABSTRACT

Agile Rapid Global Combat Support (ARGCS) system is a new Automatic Test System being developed through the Department of Defense's Advanced Concept Technology Demonstration program. This business case analyzes ARGCS' benefits for the Marine Corps as an option to replace their current Automated Test Systems for ground equipment. The business case analyzes the Marine Corps' current systems, specifically the Marine Corps' Third Echelon Test Set, and quantifies the relevant differences between these systems and the Agile Rapid Global Combat Support System.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACTD- Advanced Concept Technical Demonstration
ADSR- ARGCS Distance Support and Response
APS- Application Program Set
ARGCS- Agile Rapid Global Combat Support
ATE-Automated Test Equipment
ATML- Automated Test Markup Language
ATS-Automated Test System
BCA- Business Case Analysis
CCA- Circuit Card Assemblies
CTI- Common Test Interface
DOD- Department of Defense
ESTS- Electronic Systems Test Set
FY- Fiscal Year
GPETE- General Purpose Electronic Test Equipment
I level- Intermediate Level
JDSR- Joint Distance Support & Response
LCC- Life Cycle Cost
LRU- Line Replaceable Unit
LXI- Local Area Network Extension for Instrumentation
MOS- Military Occupational Specialty
MRTE- Multiple Run Time Environment
MTBF- Mean Time Between Failures
NFF- No Fault Found
O-to-D- Operational to Depot
O&S- Operations and Support
PQDR- Product Quality Deficiency Report
R&D- Research and Development
RDT&E- Research, Development, Testing, and Evaluation

RIP- Repairable Issue Point
RTML- Recursive Textual Markup Language
SAIF- Stand Alone Instrument Fixture
SECREP- Secondary Repairable
SME- Subject Matter Expert
SRU- Shop Repairable Unit
TAD- Temporary Additional Duty
TETS- Third Echelon Test Set
TPS- Test Program Set
TTR- Time to Repair
UUT- Unit Under Test
USMC- United States Marine Corps
V- Version

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EXECUTIVE SUMMARY

Agile Rapid Global Combat Support (ARGCS) system is a new Automatic Test System being developed through the Department of Defense's Advanced Concept Technology Demonstration program. This business case analyzes ARGCS' benefits for the Marine Corps as an option to replace their current Automated Test Systems for ground equipment. The business case analyzes the Marine Corps' current systems, specifically the Marine Corps' Third Echelon Test Set, and quantifies the relevant differences between these systems and the Agile Rapid Global Combat Support System.

"In developing new weapons or systems, logistic considerations should be balanced with performance characteristics to reduce rather than increase logistic requirements whenever possible." (United States Marine Corps 1997) Additionally, the Marine Corps should "pursue standardization to ease the problems of interoperability and increase the efficiency of the logistics systems." (United States Marine Corps 1997) In compliance with this doctrine, the Third Echelon Test System (TETS) was developed and fielded in 2000. TETS has lead the way to establish common test equipment within the Marine Corps; however, the DoD is currently pursuing to advance the TETS technology with ARGCS.

Agile Rapid Global Combat Support (ARGCS) is an Advanced Concept Technology Demonstration (ACTD). ARGCS is a compilation of different technologies that are developed or nearly developed, and when used together, intends to enhance the performance and jointness of ATE throughout the military. The different technologies that compose ARGCS are currently mature or are nearly mature; however, ARGCS as a system is still under development. This business case will describe the various technologies that make up ARGCS.

After collecting the available data and analyzing this information given the ARGCS projections this study is able to present its findings; however, there are limitations to these results given the restraints that there are no cost projections on the ARGCS system nor does the Marine Corps collect data on many areas that ARGCS

claims to improve. This study's findings center around the analysis done in the three capabilities areas: knowledge management, organizational level tester and commonality. Each area displays benefits offered by various ARGCS technologies.

The capabilities represented in ARGCS technologies show potential to improve the status quo for maintenance in Marine Corps ground equipment and throughout the military. Further research and increased data collection will help refine this analysis.

It is recommended that a future study examine the potential of a decreasing the logistic footprint for both non-deployed and deployed units.

I. INTRODUCTION

This Business Case Analysis (BCA) will scrutinize the option of utilizing Agile Rapid Global Combat Support (ARGCS) or portions of its associated technology in conjunction with the Marine Corps future acquisitions of the next generation of Automated Test Equipment (ATE) for ground equipment. This BCA will discuss the status quo for the Marine Corps. It will also describe in detail what ARGCS will offer as new concept as well as in terms of technology. It will then provide an analysis of a possible move from the Marine Corps current system to ARGCS. It will also highlight the aspects of ARSCS that offer the most return on investment given the Marine Corps' planned acquisition of next generation ATE. This BCA will provide a comprehensive look of the utility of ARGCS for Marine Corps ground equipment.

ARGCS aims to use a single ATE to test multiple pieces of hardware. Currently, the Marine Corps uses TETS for this function. TETS is used to test and diagnose electrical, electro-mechanical, electro-optical, and radio frequency modules for a variety of Marine Corps weapons systems. This business case will describe how TETS serves as an integral part the Secondary Repairable (SECREP) cycle within the Marine Corps' maintenance and supply system. Additionally, the paper will describe the current technologies that TETS uses just as the JDSR (Joint Distance Source and Response) capability which provides is an Advanced Concept Technology Demonstration (ACTD) that provides the experience and oversight of subject matter expert to using unit. However, the DoD is currently researching the next generation of ATE which will function in a joint environment.

ARGCS is a compilation of different technologies that are developed or nearly developed, and when used together, intends to enhance the performance and jointness of ATE throughout the military. The different technologies that compose ARGCS are currently mature or are nearly mature; however, ARGCS as a system is still under development. This business case will describe the various technologies that make up ARGCS. The first demonstration of an ARGCS system will occur within the Marine

Corps is scheduled for February 2007. Prior to this demonstration, this business case will provide a baseline for analysis between TETS and ARGCS.

TETS will serve as the benchmark which ARGCS will be measured against. In order to compare TETS with ARGCS this paper will examine the capabilities that the ARGCS technologies would provide and measure the differences between those technologies and what TETS currently provides and quantify those differences. The capabilities that this paper will focus on are the Reasoner, an Organizational Level Tester and a Common Test Interface. Sensitivity analysis will be used to examine the assumptions made about the anticipated results from the ARGCS demonstrations. The limitations of this case are due to a lack of data concerning added capabilities that ARGCS will provide. The demonstration will provide opportunities for further research using the new data based on our current analysis.

II. DESCRIPTION OF THIRD ECHELON TEST SET

A. OVERVIEW

In developing new weapons or systems, logistic considerations should be balanced with performance characteristics to reduce rather than increase logistic requirements whenever possible. (United States Marine Corps 1997) Additionally, the Marine Corps should pursue standardization to ease the problems of interoperability and increase the efficiency of the logistics systems. (United States Marine Corps 1997) In compliance with this doctrine, the Third Echelon Test System was developed and fielded in 2000.

B. DESCRIPTION

TETS is a modular and portable automated test set. It is used to test and diagnose electronic, electro-mechanical, electro-optical, and radio frequency modules for a variety of Marine Corps' weapons' systems. TETS has universal test ports that interface with interchangeable Application Program Sets (APS). This interface provides TETS the ability to functionally test many Marine Corps' weapons' systems' modules. Because TETS' test ports are universal, TETS can be easily reconfigured with alternate TSPs that interface with different Units Under Test (UUT). Most UUTs within the Marine Corps are Secondary Repairables (SECREPS).

C. SECONDARY REPARABLE MAINTENANCE CYCLE

Currently TETS' most significant role in the operating forces exists within the intermediate maintenance activity. TETS serves as an integral part of SECREPs' cycle within the Marine Corps' maintenance and supply system. SECREPS are removable components that can be fixed within the maintenance cycle and then reissued to the user. These parts can be continuously recycled, which is comparable to consumable parts that can not be fixed once they are broken. The Repairable Issue Point (RIP), located within the intermediate level supply activity, maintains the rotating stock of SECREPs. This stock allows for faster response time to the user because an operational SECREP can be pulled off the shelf and issued on the spot.

In order to initiate the maintenance/ supply system, the user or maintainer must first identify a defect within the weapon system. This defect can be identified internally to the weapons system (eg; a fault light) or externally (eg; diagnostic test). The part is removed and an operational SECREP is requested from the RIP. The defective SECREP is submitted into the maintenance cycle. SECREPs are only authorized to be fixed at the intermediate maintenance level or higher. The SECREP is refurbished at the intermediate maintenance activity and then sent to restock the RIP, ready for reissue. TETS's role in this cycle is to identify and diagnose the defects of the SECREPS. The end user needs only to identify that the SECREP is broken. However, the maintainers at the intermediate level must identify specifically which components within the SECREP are broken. Hence, TETS is integral at the intermediate maintenance level.

D. FUNCTIONS

TETS' primary function is to detect or verify and isolate faults within the SECREP. TETS mimics the weapons system that the SECREP derived from which allows the SECREP to function as if it were in its parent weapons system. This makes possible to decipher how subcomponents interact with each other.

TETS can also function as stand-alone General Purpose Electronic Test Equipment (GPETE). TETS contains a digital multimeter, counter/timer, functional generator(s), digitizer and other test assets that are available manually as individual instruments. Additional commercial off the self software can be purchased in order to view the test on the monitor. (United States Marine Corps 2000)

E. OPERABILITY

The TETS operator connects TETS to the SECREP via the TSP and initiates the test program. The execution of the test is controlled by the computer. The system determines which stimuli, power sources and settings are necessary to test the UUT. Stimuli are sent to the UUT and subsequently the UUT responds. The TSPs have pre-programmed test limits and establish parameters for signal amplitude, pulse width, etc. These test limits serve as the benchmark criteria for which the results received from the UUT are measured. This provides TETS the ability to test to factory specifications. The

results, which list errors and faults, are displayed on the monitor. The TETS operator decipheres the results and determines what corrective action to take in order to repair the SECREP.

Currently TETS has JDSR (Joint Distance Source and Response) capability. This is an Advanced Concept Technology Demonstration (ACTD) that provides “near-real-time, reliable, accurate tele-maintenance for forward deployed forces using a collaborative knowledge center and tool suite, with reach-back capability.” (Department of Defense 2004) The fleet support personnel for TETS are located in Albany, Georgia. Albany manages the TETS program and serve as the Subject Matter Experts (SME) for TETS support. In order to manage the TETS program, data is collected remotely by the fleet support personnel, via the internet, from individual TETS throughout the Marine Corps. If a trend or problem is identified then the fleet support personnel update the software for the APS and push it out to the operating units via the internet. If a unit has a specific problem then they can contact the SME for support. The SMEs have the capability to remotely “look in” any individual TETS system in order to assist the operator. Additionally, each TETS maintains a fault history database. The fleet support personnel collect the individual fault history databases and maintain a master database for the fleet.

F. VARIANTS

There are three variants of TETS.

1. AN/USM-657(V)1 Basic:

This is the basic instrument configuration. It contains the core TETS hardware and software. It has the capability to screen analog, digital and hybrid Line Replacement Units (LRUs), Secondary Reparable Units (SECREPs) and Circuit Card Assemblies (CCAs). It consists of the following primary components: the primary instrument chasis, secondary instrument chasis, power distribution unit, the instrument controller or laptop, the receiver and the stand alone instrument fixture (SAIF). (United States Marine Corps 2000)

2. AN/USM-657(V)2 RF:

This is the radio frequency variant which consists of the core TETS AN/USM-657 (V)1 with additional hardware and software that add radio frequency testing capabilities to test radio frequency LRUs, SRUs and CCAs. (United States Marine Corps 2000)

3. AN/USM-657(V)3 EO:

This is the electronic/ optical variant which consists of the core TEST AN/USM-657 (V)1 with additional electro-optical test equipment installed that add electro-optical testing capabilities to the core system and has the capability to test electro-optical LRUs, SRUs and CCAs. (United States Marine Corps 2006)

G. DEPLOYABILITY

One of the important characteristics of TETS for the Marine Corps is that it is rugged and small enough to be transported in a HMMWV. This capability is keeping with the highly deployable nature of the Marine Corps and allows it to operate far forward. TETS has been deployed in Iraq and has been particularly successful at intermediate level maintenance activities.

H. SELF-MAINTENANCE

TETS can self-diagnose errors and problems. If a component breaks, then a fault light will come on. The component is first sent to the calibration lab within the intermediate maintenance unit for recalibration. If it can not be recalibrated then it is sent to the manufacturer for repair. If a reoccurring problem or deficiency exists with within TETS a Product Quality Deficiency Report (PQDR) is initiated. "The primary goals of the [PQDR] program are to maximize mission and operational effectiveness, prevent recurring deficiencies, and improve user satisfaction with Marine Corps materiel." (Unites States Marine Corps 1993) If a consistent problem is found within TETS then it is reported through the Marine Corps; PQDR program.

When TETS is not available (or if it were to break down) then Marines must resort to identifying defects within SECREPS using the traditional method. This is a tedious process which often involves individually testing circuits. It is especially

cumbersome because Marine Corps equipment is rapidly becoming more digitized and complex. Identifying defects by hand significantly increases the chance for human error and slows down the repair process.

I. OVERALL

Although TETS provides significant advancements to the Marine Corps maintenance capabilities, there is significant opportunity for improvement. For example, the laptop component of TETS is old, does not have a lot of memory and it is not interchangeable therefore TETS runs very slowly. Additionally, TETS is vulnerable to human error at both the user level and the fleet support level. The maintainer receives the results from TETS, but must determine which repair actions to take. This could potentially lead to mistaken use of repair parts and a waste of the maintainer's time. At the fleet support level, personnel must manually identify trends across the Marine Corps. This process is prone to error and inaccuracies. In order fill some of these gaps and take advantage of some of the new technologies since 2000, TETS II will be fielded throughout the Marine Corps. While TETS II is an improvement to the current TETS, gaps will still remain. Currently, the OSD is assessing ARGCS potential to further advance diagnostic and testing capabilities.

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III. DESCRIPTION OF AGILE RAPID GLOBAL COMBAT SUPPORT

A. OVERVIEW

Agile Rapid Global Combat Support (ARGCS) is an Advanced Concept Technology Demonstration (ACTD). ACTDs are Department of Defense (DoD) Research and Development (R&D) programs aimed at demonstrating the utility of mature technologies to the services in order to fulfill their needs. ACTDs concentrate on mature or nearly mature technologies in order to limit the funding necessary for development phase of a program. ACTDs hope to demonstrate the ability of existing technology to meet the needs of the services.

The services have a need for new Automated Test Equipment (ATE). ATE are diagnostic tools used to identify problems in hardware and help correct those problems. Many of the services' ATE are antiquated, unreliable, and far too numerous. Many are so old that the services have difficulty finding replacement parts. The result from each of the test equipment varies greatly depending on who is running the test. Compounding this problem is that nearly every single piece of equipment requires its own specialized ATE. This is very costly and makes training more difficult. The Department of Defense (DoD) is also promoting programs that facilitate jointness and reduce redundancy. ARGCS potentially provides solutions to these problems.

B. CAPABILITIES

ARGCS uses various technologies to implement its overarching goals. This paper discusses these technologies later in this section and throughout this paper. The overarching goals that ARGCS hopes to address are a learning system that improves as it gains more experience, a common test interface (CTI) that will allow the same tester to be used for all hardware and across services, and synthetic instrumentation which will make testers smaller and more versatile.

1. Knowledge Management

Many of the current testers in DoD require a lot of human input. The individual operating the ATE must have a lot of experience before he can operate the tester efficiently. The operator must be able to interpret results based not only on his knowledge of the tester, but also on his experience with the hardware being tested. ARGCS attempts to utilize knowledge management in a manner that will allow reasoning by the ATE. Each individual tester will reach into a global database and use the trends for each type of equipment as well as the particular piece of equipment that an operator is testing. These trends will reduce the operator interpretation necessary for efficient and correct diagnoses.

2. Commonality

CTI will allow the services to test multiple pieces of hardware on a single tester. Currently there are hundreds of different testers, for hundreds of different pieces of hardware. Each of the testers is expensive to build and require their own specialized training for operation and maintenance. CTI, in conjunction with some of the other ARGCS technologies which will be discuss later, will eventually allow all hardware to use the same tester. This will reduce training requirements, and the number of testers required. It will also provide savings by reducing the number and types of parts that are in the supply system. The system will not have to supply replacement parts for all of the various testers.

3. Organizational Level Tester

One other technology that RGCS offers is the Organizational Level Tester. This technology will provide the operational units, the lowest level in the maintenance cycle, with some of the functionality of an ATE. With an Organizational Level Tester, units will have the ability to check hardware for no fault prior to sending the hardware up to intermediate level maintenance facilities. This will reduce the workload of maintenance operations, decrease the downtime of equipment, and increase readiness.

4. Instrumentation

ARGCS involves various technologies that will increase the productivity and efficiency of the instrumentation in ATE. Smaller instrumentation will allow for greater capabilities without increasing the size of the ATE. The technologies will also provide a greater flexibility for the ATE, which fits in with cross compatibility concept behind the CTI.

C. TECHNOLOGIES

Most of the ARGCS technologies fall within the categories discussed above. There are other key technologies included in the ARGCS concept as well. This case will review each of the ARGCS technologies and group them by category.

1. Knowledge Management

The reasoner function of ARGCS technology consists mainly from the Net Centric Diagnostics that ARGCS will incorporate and the Automated Test Mark up Language. This technology will provide reach back capabilities as well as the knowledge management network. The reach back capability will be used for real time or near real time access to subject matter experts who will guide mechanics through diagnostics and repair. Net Centric Diagnostics will also provide access to manual and other training material. The data accumulated through the network will provide the reasoning capability (described earlier) that will allow the ATE to provide better results as time goes on. Automated Test Mark up Language is a subset of eXtensible Mark up Language (XML). XMLs provide a platform for the exchange of logistics data collected by the various ARGCS ATEs. The Automated Test Mark up Language standard will enable the various levels of maintenance to pass the information collected which is the basis for the reasoning technology.

2. Commonality

The ability for ARGCS to test multiple sets of hardware is to help the military attain greater efficiencies. CTI refers to the plug and socket for a tester and its hardware, but it is not enough that the two fit together. When traveling overseas, an individual can buy an adapter so their plugs can fit in foreign sockets, but if they do not use a

transformer as well, they may blow a fuse. The other ARGCS technologies that perform this transformer function are the Joint Service Tester Family and the Multiple Run Time Environments (MRTE). The Joint Service Tester Family will be an intermediary between the current testers in the military and a truly one tester for all system. The Joint Service Tester Family will run on standardized architecture and use common test hardware and software in order to eventually transition the armed services to a unified tester. MRTE provides a platform for multiple versions of software, written for multiple platforms, using various programming languages, to all run in the same environment. MRTE will allow the various Test Program Sets (TPS) to run on the same tester. TPSs are the software that tells the ATE how to test a particular piece of equipment.

3. Instrumentation

Most ARGCS technologies involve instrumentation. These technologies include Synthetic Instrumentation, Local Area Network Extensions For Instrumentation (LXI), Bus Emulation Technology, and Digital and Analog instrumentation. Synthetic instrumentation uses software to augment the hardware necessary to conduct a test. This allows synthetic instrumentation to perform a myriad of measurements using only elements of natural instrumentation. The relationship between synthetic instrumentation and natural instrumentation is similar to the relationship between a synthetic keyboard and the multitude of musical instruments the keyboard replicates. Synthetic instrumentation will allow ATE to perform numerous tests for many different pieces of equipment and still maintain the compactness and durability that is necessary in our expeditionary armed services. LXI allows the ATE to utilize a great amount of instrumentation. An open architecture will allow all instrumentation to build to the ARGCS standards so that they will all be able to communicate with ARGCS. Bus Emulation Technology will use software and hardware to duplicate the same data buses used by the various services, thereby making ARGCS more universal. Digital and Analog Instrumentation will create accepted instrumentation across services. Currently the services do not use the same testers or instrumentation even though many of test

functions are common across services. Universality in instrumentation is key to a common ATE across hardware and across services, these technologies moves the services ATE in that direction. (Ackerman 2006)

D. OVERALL

All of these technologies have the goal of increasing the efficiency of the services' maintenance programs. Some of these technologies already exist in current Marine Corps ATE and others will provide greater capabilities, responsiveness, and cost savings in the Marine Corps Logistics Cycle. This paper will be used to analyze the benefits of these technologies, to the Marine Corps, and whether or not they are a worthwhile investment.

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IV. METHODOLOGY

A. OVERVIEW

As discussed in the previous chapter, ARGCS can provide four capabilities. These capabilities are knowledge management, tester at the organizational level, commonality and synthetic instrumentation. This chapter will describe the methodology for quantifying the differences of these capabilities between TETS and ARGCS.

B. KNOWLEDGE MANAGEMENT

Knowledge management is a collection of processes that govern the creation, dissemination and the use of knowledge. It provides a process of creating value from the organization's intangible assets by acquiring, capturing, sharing, managing and using knowledge within the organization. Information technology provides a forum to promote maximum utility of the organization's knowledge management efforts. ARGCS lays the information technology groundwork in order to use knowledge management in regards organizational learning. As described in the previous sections TETS has knowledge management capabilities through Joint Distance Support and Response (JDSR). JDSR will provide the Commander In Chief's (CINC's)/Services with four integrated functions: remote collaboration, information/ knowledge sharing, remote platform diagnostics and maintenance mentoring. (Department of Defense 2005)

ARGCS offers additional knowledge management capabilities through the reasoner technology. ARGCS' reasoner technology provides an organizational learning capability by capturing the test results from all ARGCS across the Marine Corps. The reasoner uses this data to identify trends and then pushes the information back down to the individual unit. This will allow for faster and more accurate diagnoses.

In order to measure the relevant differences between ARGCS and TETS this study will look at capabilities that either TETS or ARGCS provides beyond the other. In this case, the relevant capability is the reasoner technology from ARGCS. A learning curve analysis will be used to quantify the benefit. The baseline will consist of the current misdiagnosis rate that TETS produces. This will provide the rate which TETS

gives results which are subject to interpretation. ARGCS reasoner capability will improve the misdiagnoses rate over time. The speed at which this rate improves will be captured in a learning curve.

The term misdiagnosis rate for TETS needs to be defined. TETS does not necessarily provide incorrect results at the conclusion of a diagnosis; however, the results are often really broad. The TETS results often do not specify which exact part is broken; rather it will indicate that a section within the SECREP that contains the problem. The Marine uses these results to guide him/ her to the area of the problem and based upon experience determines which exact part to replace. The first maintenance action taken by the Marine may or may not repair the SECREP. Therefore; TETS does not necessarily misdiagnose the problem within the SECREP; however, the results are often broad enough that the course of action to repair the item is not clear.

The lower misdiagnoses rate will reduce the total number of maintenance actions performed in the maintenance cycle. This reduction will provide cost savings. The average cost of a maintenance action would be used to determine the cost savings.

C. COMMONALITY

Reducing the variety of existing ATE will standardize and simplify the maintenance efforts across the Marine Corps. Currently most end items have a unique ATE associated with them and as the equipment across the Marine Corps ages, so does its associated ATE. The costs associated with maintaining each of the aging ATEs are significant. Technology commonality for the diagnostic and testing needs across the Marine Corps can reduce operations and support costs, reduce the footprint and minimize the logistics requirements. Implementation of technology commonality for the Marine Corps' ATE has potential to provide significant savings. These savings will occur in technical publications, total spares required, footprint, training, reduced obsolescence, calibration, annual maintenance savings cost and operations and support costs. The section will describe the methodology for analyzing the cost savings in these areas.

1. Spare ATE Required

In order to maintain a level of readiness the Marine Corps must have on hand spares units of end items. The number of spares is a factor of the total number of end items in use across the Marine Corps. If ARGCS reduces the total quantity of ATE then the spares will be reduced by the same factor.

2. Technical Publications

Technical publications accompany end products at procurement. They include details concerning the technical specifications, operating instructions and guidance. Commonality will minimize the need for an extensive publications library due to the reduced variety of ATE across the Marine Corps. In order to quantify the savings in technical publications a baseline will be established using the current total cost for technical pubs across the Marine Corps. Then subtract the expected cost of ARGCS technical publications.

$$\textit{Tech pubs savings} = \textit{Current Cost} - \textit{ARGCS pubs cost}$$

Maintainers often require a hard copy of a technical publication while working on a piece of equipment; therefore, significant savings from electronic publications is not anticipated.

3. Operations and Support Costs

Current costs for maintaining ATE in the Marine Corps are high because of the vast number of antiquated testers that required parts that difficult to obtain or are no longer in production. Standardized ATE across the Marine Corps will provide savings because it allows for economies of sales for manufacturers and simplifies and reduces the burden on the supply system. The current O&S costs will be reduced by a factor as determined from the demonstration.

4. Footprint

Minimizing the embarkation requirements across the Marine Corps eases the ability for units to deploy and allows for greater flexibility. ARGCS will reduce the quantity of ATE needed across the Marine Corps thus, the footprint of deployed units will decrease. In order to quantify if ARGCS will reduce the maintenance footprint in the

Marine Corps, the baseline will be established from the current embarkation space requirements for a deployed maintenance unit. The majority of this space is composed of the variety of maintenance vans a unit must deploy with.

5. Training

It is not anticipated that a large savings will occur due to training costs; however, it is anticipated that there will be qualitative benefits. Each maintenance Military Operational Specialty (MOS) in the Marine Corps train at different school. These schools teach the Marines diagnostic skills and repair skills. A large majority of the training is learning how to repair the equipment and a smaller portion is learning how to diagnose the defects. Therefore, cost savings derived from training on a common ATE will not be relevant.

D. ORGANIZATIONAL LEVEL TESTER

An organizational tester pushes diagnostic and testing capabilities down to the organizational level. The Marine Corps maintenance activities consist of three levels: organizational, intermediate and depot. The organizational level corresponds with the operational unit and this is where most of the maintenance activities originate. Currently, the organizational level units have crude means of identifying defects when the equipment breaks. For example, many weapons systems contain indicators which identify that there is fault within the system. Based upon this information, the operator pulls the component from the system and submits it into the maintenance cycle. However, often the component pulled is not the cause of the defect. This is a false pull. The pulled component enters the maintenance cycle although it is not defective. Currently, this cannot be identified until the intermediate level. False pulls waste resources by overtaxing the supply system and increasing work load at the intermediate activity and also reduces operational readiness.

ARGCS offers an organizational tester which provides the user the ability to test components at their level. This will allow the organizational level the ability to address the problematic issue, rather than wasting time and effort on components which are not broken. At the intermediate level, the work load will reduce because less false pulls will be entered into the system.

This will be measured through the no fault found rate at the intermediate level. The no fault found rate will show the potential impact that an operational level tester can bring to the maintenance system.

If the no fault found (NFF) rate can be reduced, then the number of SECREPS can also be reduced. The amount of SECREPS can be reduced by the no fault found rate. If the no fault found rate is reduced to zero then the number of SECREPS can be reduced by the same amount. Because less SECREPS are in the maintenance process then a higher percentage of those in the system are available for use.

$$\text{Saving from Organizational Level Tester} = \text{total cost of SECREPS} * \text{NFF rate}$$

There are also reductions in the maintenance costs of those SECREPS. With an organizational level tester the NFF SECREPS will not enter the maintenance cycle. If the cost of a maintenance action on a false is equal to the average cost of a maintenance action, then the maintenance costs for SECREPS will be reduced by the quantity of false pulls times the average cost of a maintenance action.

E. INSTRUMENTATION

The capability provided through instrumentation technologies are necessary in order for the other capabilities to exist. Commonality and the organizational tester require synthetic instrumentation, bus emulation, LXI, and digital an analog instrumentation, or else one tester would not be able to the instrumentation required to test such varied equipment. The instrumentation on its own will not show measurable benefits, however the instrumentation capability is required in order for the other capabilities to produce their benefits. This makes the instrumentation technologies enabling technologies rather than capabilities that should be measured on their own.

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V. ANALYSIS

A. OVERVIEW

Capabilities were broken down into four groupings: knowledge management, organizational testing, commonality and instrumentation. This chapter uses the data collected and the methodologies discussed in order to quantify the benefits from the ARGCS capabilities.

B. KNOWLEDGE MANAGEMENT

A learning curve illustrates the effect of the reasoner capabilities and its associated technologies on the misdiagnosis rate. The learning curve of 85%, 90% and 95% were used in this analysis. These cover the range of reasonable learning curves for automated process which typically have higher learning curves or lower rates of learning.

The maintenance actions performed per year was extrapolated from the estimated number of SECREP maintenance actions that a MEU performs per year. It is estimated that a MEU performs 500 SECREP maintenance actions for an infantry battalion and a service support group in one year. The Marine Corps has about 27 infantry battalions; therefore the estimated number of maintenance actions that the Marine Corps performs per year is 13,500. Sensitivity analysis was conducted on this number.

As seen in Appendix A, the expected time to field ARGCS is 2 years. Therefore, the maintenance actions per year was doubled for number of units for learning curve analysis.

The first unit cost represents the current misdiagnosis rate. The model uses 15% as a current misdiagnosis rate. The Marine Corps doesn't track this information, so this number is a representative figure until better data is collected.

The standard formula for unit learning curve analysis is $Y_x = T_1 * X^b$

Where Y represents the misdiagnosis rate which is on the y axis. T_1 is first unit misdiagnosis rate which is the curve that intercepts the y axis. X is the number of

maintenance actions which is displayed in the x axis. The variable b is the natural log of the slope of the learning curve divided by the natural log 2 or $\ln(\text{slope}) / \ln(2)$.

Annual Maintenance Actions	SECREP	Transition Period SECREP Maintenance Actions (2 Years)	85%	90%	95%
5000		10000	1.73%	3.70%	7.59%
7000		14000	1.60%	3.51%	7.40%
9000		18000	1.51%	3.38%	7.26%
11000		22000	1.44%	3.28%	7.16%
13000		26000	1.38%	3.20%	7.07%
15000		30000	1.34%	3.13%	6.99%

Table 1. Misdiagnosis rate after Transition Period

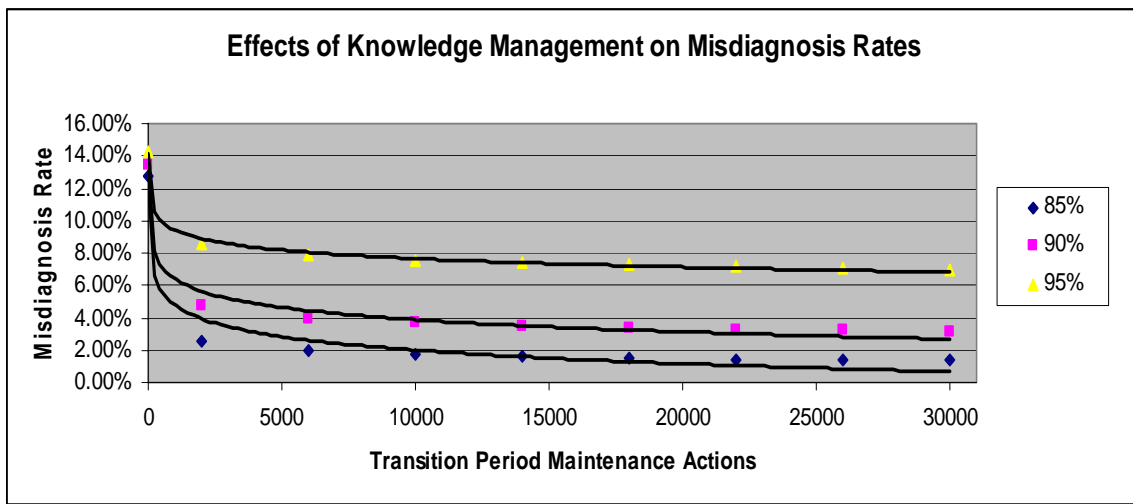


Figure 1. Effects of Knowledge Management on Misdiagnosis Rate

The results of the analysis shows that the lower the learning curve the greater the effect on the misdiagnosis rate. These results are not representative of actual results that may be seen as a benefit of ARGCS because data on current misdiagnosis rate are not collected and the rate of learning due to ARGCS has not yet been determined.

C. COMMONALITY

1. Spare ATE Required

Standardizing the ATE throughout the Marine Corps is expected to reduce the

overall number of ATE in the military and specifically, for this analysis, Marine Corps ground equipment. In addition, this commonality will reduce the redundancy of spares that is currently needed.

The 2006 procurement budget for the Marine Corps indicates that a readiness of 450+ ATE systems are needed. (See Appendix B) If the current readiness level is 80% then this dictates that the Marine Corps needs 563 ATE to maintain a readiness of 450 operational ATE. Five hundred sixty three includes 113 spares. If the readiness level is currently 80% and is it improved by 40% then the Marine Corps will need to procure 45 less spares. This analysis is continued for readiness level of 85% and 95%, as well as readiness improvements of 50% and 60%.

450	0.4	0.5	0.6
0.8	45	56.25	67.5
0.85	32	40	48
0.9	20	25	30

Table 2. Reduction in Spare ATE

The 2006 budget states the per unit cost for TETS is \$72,000 FY06. (See Appendix B) This allows a dollar amount to be placed on the reduction of spares.

450	0.4	0.5	0.6
0.8	\$32,400,000	\$40,500,000	\$48,600,000
0.85	\$22,870,588	\$28,588,235	\$34,305,882
0.9	\$14,400,000	\$18,000,000	\$21,600,000

Table 3. Monetary effect of Reduction in Spares

2. Technical Publications

The Marine Corps is currently digitizing its technical manuals. The 2006 procurement budget displays the cost of the digization process which is \$17,000,000 FY06. (See Appendix C) This current initiative reduces any benefit from ARGCS proposal for digital technical manuals.

D. ORGANIZATIONAL TESTER

It is anticipated that the organizational tester will reduce the number of false pulls, which in turn will reduce the demand for SECREPS. A decreased demand for SECREPS translates into savings through the acquisition of fewer SECREPS. The Marine Corps' 2005 Operation and Maintenance Budget for Spares and Repair Parts budgeted \$129.4 million for depot level reparableables. (See Appendix D) The 2005 budget amount was used because the 2006 budget does not include the 2006 supplemental funding yet. Sensitivity analysis was conducted around this number.

The Marine Corps currently does not track the no fault found rate in the maintenance cycle. Based upon conversations with numerous subject matter experts the no fault found rate varied widely from 5% to 50%; therefore, sensitivity analysis was conducted around this number.

Repairable Budget	0.05	0.3	0.5
\$120,000,000	\$6,000,000	\$36,000,000	\$60,000,000
\$130,000,000	\$6,500,000	\$39,000,000	\$65,000,000
\$140,000,000	\$7,000,000	\$42,000,000	\$70,000,000

Table 4. Monetary Saving due to less SECREPS required

These results indicate the amount that would be saved from a full fielding of organizational tester to organizational level maintenance activities. The greater the current no fault found rate will result in a higher potential for cost savings. Currently, reductions in no fault found rates are a result of a close relationship between the intermediate and organizational level maintenance activities. When intermediate maintenance activities actively assist organizational level maintenance activities with preventative maintenance training and limited technical inspections then the no fault rate drops due to increased expertise at the organizational level.

VI. CONCLUSION

A. OVERVIEW

After collecting the available data and analyzing this information given the ARGCS projections this study is able to present its findings; however, there are limitations to these results given the restraints that there are no cost projections on the ARGCS system nor does the Marine Corps collect data on many areas that ARGCS claims to improve. This leaves areas for future research on this topic that will be able to build upon the analyzation that will be able build upon this business case analysis.

B. FINDINGS

This study's findings center around the analysis done in the three capability areas: knowledge management, organizational level tester and commonality. Each area displays benefits offered by various ARGCS technologies.

1. Knowledge Management

The learning curve analysis displays significant improvement over current misdiagnosis rates at the conclusion of a transition period. This improvement depends heavily upon the current misdiagnosis rate and the rate of learning.

2. Commonality

Throughout the Marine Corps the ability for a single platform of ATE provides potential for monetary savings within the Marine Corps. This study focused on the savings provided by the reduction of spare ATE needed throughout the Marine Corps. The mean time between failures will decrease and fewer ARGCS systems will be in the maintenance cycle meaning more will be available for use.

3. Organizational Level Tester

The findings of this study indicate that the organizational level tester will reduce the number of false pulls and the demand for SECREPS. The decreased demand for SECREPS translates into monetary savings because less SECREPS will be caught within the maintenance cycle and they will be more readily available for use.

C. LIMITATIONS

The limitations to this study center on the absence of cost projections for ARGCS and the lack of Marine Corps data in the areas which ARGCS claims to improve. The demonstration for ARGCS is scheduled to start in February 2007 - after the publication of this study. Moreover, the Marine Corps doesn't collect data on false pull rates; therefore it is difficult to measure how much ARGCS will improve the current false pull rates. Additionally, the Marine Corps doesn't collect data on how a Marine interprets the results provided by TETS; therefore, it is difficult to determine the TETS's current actual misdiagnosis rates. Before the Marine Corps can understand how ARGCS can improve their maintenance capabilities in any area they must measure these areas to establish a basis for comparison.

D. FUTURE STUDIES

As more data is collected and becomes available, further research will be able to improve upon this study. It is recommended that a future study examine the potential of decreasing the logistic footprint for both non-deployed and deployed units. The logistics footprint issue is complicated which involves reduced quantity of SECREPS, maintenance vans deployed, total number of ATE required and perhaps reduced personnel. These all appear to be related to secondary effects of greater commonality with ARGCS technologies.

E. CLOSING

The capabilities represented in ARGCS technologies show potential to improve maintenance in Marine Corps ground equipment and throughout the military. Further research and increased data collection will help refine this analysis.

APPENDIX A. OPERATIONAL PARAMETERS FOR ARGCS

Operational Parameters (1)

Operational Parameter	Measurement	Today's Baseline	Threshold	Objective/Goal
System Interoperability	Application Test Program Interoperability	Minimal to Non-Existent	85%	100%
System Fielding to Support	Time to Field in Years	2-8 Years	.5-2 Years	.25-1 Year
Accuracy Enhancements and System Improvements	Industry/ Commercial Standardization	Minimal	85%	100%
System Performance	Reduce Time to Diagnose and Repair	Use of Specialized Testers	15% Reduction in Time to Repair	40% Reduction in Time to Repair

Operational Parameters (2)

Operational Parameter	Measurement	Today's Baseline	Threshold	Objective/Goal
Optimize Logistic and Support Cost	Dollars	\$500 Million /year	30%	50%
Proliferation/System Support/Maintainability	Footprint	Space/Weight Required	30% Reduction in Maintenance Footprint	50% Reduction in Maintenance Footprint
Marginal Testing Performance Scalability	Morphable/ Mission Scalability System	Minimal to None	90%	100%
High NEOF/RTOK/A799/NFF Rates	Unnecessary Failure Repair Actions	Manual Process (Low Effectiveness)	40%	100%

APPENDIX B. WEAPON SYSTEM COST ANALYSIS, TETS

Exhibit P-5, Weapon WPN SYST Cost Analysis		Appropriation Budget Activity/Item: Procurement, Marine Corps (1126) Communications and Electronics Equipment (4)		P-1 Line Item Nonstatement: THIRD ECHELON TEST SYSTEM			Weapon System Type:		Date: February 2006													
Weapon System Cost Elements		ID	Prior Yrs	FY 06		FY 08			FY07													
		CO	Total Cost \$000	Total Cost \$000	Qty Each	Unit Cost \$	Total Cost \$000	Qty Each	Unit Cost \$	Total Cost \$000	Qty Each	Unit Cost \$										
Third Echelon Test System							9360	13	720000	1512	2	756857										
Eng/Tech Svcs							213			325												
Training																						
Support Equipment																						
Software Integration							175			300												
Logistics Support																						
Program Management							90			130												
Total							8838			2287												
Active							8838			2287												
Reserve																						
<p>REMARKS: Third Echelon Test System (TETS)- Buying different systems each FY due to unit price change. Electro Optics & Radio Frequency</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 100px;">QTY</td> <td style="width: 100px;">QTY</td> </tr> <tr> <td>FY06 13 EO/RF</td> <td></td> </tr> <tr> <td>FY07 2 EO/RF</td> <td></td> </tr> <tr> <td>FY08 EO/RF 11 EO</td> <td></td> </tr> <tr> <td>FY09 14 EO/RF</td> <td></td> </tr> </table> <p>Software Integration-Buying software, not hardware or equipment. MC Automatic Test Equipment - Fielded System Readiness, supports 450+ ATE Systems.</p> <p>Marine Corps Application Systems-Engineering efforts to develop hardware and software applications to support multiple weapon systems.</p>													QTY	QTY	FY06 13 EO/RF		FY07 2 EO/RF		FY08 EO/RF 11 EO		FY09 14 EO/RF	
QTY	QTY																					
FY06 13 EO/RF																						
FY07 2 EO/RF																						
FY08 EO/RF 11 EO																						
FY09 14 EO/RF																						

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APPENDIX C. WEAPON SYSTEM COST ELEMENT, DIGITIZATION

Exhibit F-5, Weapon WPN SYST Cost Analysis		Appropriation/Budget Activity/Source No: Procurement, Materie Corps (1100) / Communications and Electronics Equipment (E)			F-1 Line Item Description: REPAIR & TEST EQUIP			Weapon System Type:			Date: February 2006		
Weapon System Cost Elements		FY 05			FY 06			FY 07					
		TotalCost \$000	Qty Each	UnitCost \$	TotalCost \$000	Qty Each	UnitCost \$	TotalCost \$000	Qty Each	UnitCost \$			
CALIBRATION FACILITY (Transportable)							9121	1	9121000				
ENGINEERING & LOGISTICS SUPPORT Navy ISEA Activities Training Material and Training Team Provisioning & Tech Manuals Software Updates							481						
*DIGITIZATION OF DOD TECH MANUALS							17000	VAR	VAR				
TOTAL Active Reserve							26602						
<p>*NOTE: In FY06, the Digital of Tech Manuals was in BLI 4420. It transitioned to BLI 4181 in FY08.</p>													

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APPENDIX D. OPERATIONS AND MAINTENANCE MARINE CORPS SPARES AND REPAIR PARTS

Department of the Navy
Operations and Maintenance Marine Corps
Spares and Repair Parts
(Dollars in Millions)

	<u>FY 2005</u> <u>(\$ in M)</u>	<u>FY 2006</u> <u>(\$ in M)</u>	<u>FY05/FY06</u> <u>CHANGE</u> <u>(\$ in M)</u>	<u>FY 2007</u> <u>(\$ in M)</u>	<u>FY06/FY07</u> <u>CHANGE</u> <u>(\$ in M)</u>
DEPOT LEVEL REPARABLES (DLRs)					
<u>COMMODITY:</u>					
COMBAT VEHICLES	62.4	28.1	-34.3	28.4	0.3
OTHER					
MISSILES	1.0	0.0	-1.0	0.0	0.0
ORDNANCE	6.8	0.6	-6.2	0.1	-0.5
ELECTRICAL & COMMUNICATIONS	14.7	2.7	-11.9	5.7	3.0
ENGINEERING	9.6	0.1	-9.5	0.2	0.2
AUTOMOTIVE	35.0	10.5	-24.5	12.3	1.8
TOTAL	129.4	42.0	-87.4	46.8	4.8
 <u>CONSUMABLES</u>					
<u>COMMODITY:</u>					
COMBAT VEHICLES	308.4	143.4	-165.0	135.9	-7.5
OTHER					
MISSILES	5.0	0.1	-4.9	0.0	-0.1
ORDNANCE	33.6	3.1	-30.6	0.5	-2.5
ELECTRICAL & COMMUNICATIONS	72.4	13.9	-58.5	27.4	13.5
ENGINEERING	47.5	0.3	-47.2	1.2	0.8
AUTOMOTIVE	173.0	53.6	-119.3	58.9	5.2
TOTAL	639.9	214.4	-425.5	223.9	9.4

Changes FY05/06

FY05 numbers include Title IX funding and changes reflect a return to pre-war funding levels .

Changes FY06/07

Increases to both DLRs and Consumables are largely due to price growth.

OP-31 Spares and Repair Parts

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