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MONTEREY, CALIFORNIA

MBA PROFESSIONAL REPORT

**A Comparative Analysis of the Department of Defense (DoD) Passive
Radio Frequency Identification (RFID) Policy and Perspective in Terms
of Site Implementations**

**By: Jacqueline M. Meyer and
Sefa Demirel**

June 2006

**Advisors: Nicholas Dew
Ira Lewis**

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(DOD) PASSIVE RADIO FREQUENCY IDENTIFICATION (RFID)
POLICY AND PERSPECTIVE IN TERMS OF SITE
IMPLEMENTATIONS**

Jacqueline M. Meyer, Lieutenant Commander, United States Navy
Sefa Demirel, Lieutenant Junior Grade, Turkish Navy

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June 2006**

Authors:

Jacqueline M. Meyer

Sefa Demirel

Approved by:

Nicholas Dew, Lead Advisor

Ira Lewis, Support Advisor

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

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A COMPARATIVE ANALYSIS OF THE DEPARTMENT OF DEFENSE’S (DOD) PASSIVE RADIO FREQUENCY IDENTIFICATION (RFID) POLICY AND PERSPECTIVE IN TERMS OF SITE IMPLEMENTATIONS

ABSTRACT

The purpose of this MBA project is to conduct a comparative analysis of DoDs policy and perspective on passive Radio Frequency Identification (RFID) in terms of site implementations at the Fleet and Industrial Supply Center (FISC), Norfolk, Virginia, Ocean Terminal Division (OTD), and the Defense Distribution Depot San Joaquin (DDJC), California. The FISC, Norfolk, OTD, Container Freight Station has been at the forefront of DoD activities implementing passive RFID and is currently using RFID tags to process all shipments except household goods. DDJC is equipped with RFID readers and the required supporting infrastructure, and has been accepting pallets and cases with passive RFID tags since January 2005. DoD is in the midst of a fundamental transformation of its logistics capabilities, and RFID is becoming an integral element of that transformation with the potential to revolutionize the entire supply chain. On July 30, 2004, the Acting Under Secretary of Defense for Acquisition, Technology, and Logistics issued a memorandum delineating the final policy and an extensive plan for RFID implementation within DoD. This project will explain DoDs passive RFID policy and perspective and provide observations from the site implementations. Ultimately, the project will present the cause(s) of compliance variances between the projected plan based on DoD policy and the actual implementations at DoD activities.

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LIST OF ACRONYMS AND ABBREVIATIONS

ADUSD (SCI):	Assistant Deputy Under Secretary of Defense (Supply Chain Integration)
AFB:	Air Force Base
AHRIST:	Advanced HAZMAT Rapid Identification, Sorting, and Tracking
AIDC:	Automatic Identification and Data Capture
AISs:	Automated Information Systems
AIT:	Automated Information Technology
ALE:	Application Level Event
ALOC:	Air Lines of Communication
AOR:	Area of Operation
ASN:	Advance Shipment Notice
AUTO-ID:	Automatic Identification
AVI:	Automatic Vehicle Identification
AWOS:	Automated Weigh and Offer Station
CCN:	Carton Control Number
CCP:	Consolidation and Containerization Point
CCR:	Consolidated and Containerization Point
CONOPS:	Concept of Operations
CONUS:	Continental United States
COTS:	Commercial Off The Shelf
DDJC:	Defense Distribution Depot, San Joaquin, California
DDSP:	Defense Distribution Center, Susquehanna, Pennsylvania
DLA:	Defense Logistics Agency
DLB:	Defense Logistics Board
DLE:	Defense Logistics Executive
DoD or DOD:	Department of Defense
DTS:	Defense Transportation System
EAS:	Electronic Article Surveillance
EPC:	Electronic Product Code

ERP:	Electronic Resource Planning
ETC:	Electronic Toll Collection
E2E:	End-To-End
FISC:	Fleet and Industrial Supply Center
GATES:	Global Transportation Execution System
GAO:	Government Accountability Office
GHZ:	Gigahertz
GPS:	Global Positioning System
GTN:	Global Transportation Network
HAZMAT:	Hazardous Material
IPT:	Integrated Product Team
ISO:	International Organization for Standardization
IT:	Information Technology
ITV:	In-Transit Visibility
KHZ:	Kilohertz
LCL:	Less-Than-Container-Load
LIA:	Logistics Integration Agency
LRU:	Less-Than-Release-Unit
LTA:	Logistics Transformation Agency
MCWL:	Marine Corps Warfighting Laboratory
MIRR:	Material Inspection Receiving Report
MOPP:	Mission Oriented Protective Posture
MOUT:	Military Operations in Urban Warfare
MRE:	Meal, Ready-To-Eat
NAVSUP:	Naval Supply Systems Command
NSN:	National Stock Number
OCNUS:	Outside Continental United States
OMB:	Office of Management and Budget
OMC:	Optical Memory Card
OSD:	Office of the Secretary of Defense

OTD:	Ocean Terminal Division
OTMS:	Ocean Terminal Management System
RDO:	Redistribution Order
RF:	Radio Frequency
RFDC:	Radio Frequency Data Collection
RFID:	Radio Frequency Identification
RFMSL:	Radio Frequency Shipping Label
RO:	Read-Only
ROI:	Return on Investment
RW:	Read-Write
SCM:	Supply Chain Management
SSAA:	System Security Authorization Agreement
TACMEDCS:	Tactical Medical Coordination System
TAV:	Total Asset Visibility
TCN:	Transportation Control Number
UAA:	University of Alaska
UHF:	Ultra High Frequency
UPS:	United Parcel Service
USCENTCOM:	U.S. Central Command
UWB:	Ultra Wide Band
WAWF:	Wide Area Workflow
WORM:	Write-Once, Read-Many
WPS:	Worldwide Port System

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Sefa Demirel

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I. INTRODUCTION

A. PURPOSE

This project focuses on a comparative analysis of DoDs policy and perspective on passive RFID in terms of site implementations. DoD has issued a memorandum delineating the final policy and an extensive plan for RFID implementation within DoD¹. In compliance with that mandate, some DoD activities have already been equipped with RFID systems and have started implementing passive RFID in their business processes. However, the compliance of some DoD activities are questionable. The objective of this project is initially to identify the variances between projected RFID plans based on DoD policy and the actual implementation within DoD activities, and then to present the fundamental cause(s) of these variances.

B. BACKGROUND

Although the focus is on passive RFID, the authors have also included information on active RFID in order to give the reader a better overall understanding of the technology, and because it is a significant part of the DoD policy. For almost a decade active RFID technology has been in use within DoD, most notably during Operation Enduring Freedom and Operation Iraqi Freedom when it was placed on major items and consolidated cargo moving into the theater to provide in-transit visibility to Commanders. Among the services, the Army was the first to install active, data rich RFID technology at selected sites around the world in order to track containers through the logistics pipeline and to provide stand-off visibility of container contents. Fixed interrogators installed at key nodes read RFID tags attached to pallets or containers and provided data to a regional server prior to passing the data to the global asset visibility systems.²

¹ Under Secretary of Defense, Radio Frequency Identification Policy, July 30, 2004. Retrieved on March 27, 2006, from <http://akss.dau.mil/docs/Wynne%20Memo%20of%2007-30-2004.pdf>.

² Office of the Deputy Under Secretary of Defense (Logistics & Material Readiness), RFID: Frequently Asked Questions. Retrieved on January 23, 2006, from http://www.acq.osd.mil/log/rfid/rfid_faq.htm#rfid_technology.

Active RFID technology has also been used for in-transit visibility (ITV) applications on major end-items and consolidated cargo moving via the Defense Transportation System (DTS).³ The current DoD environment for use of active RFID encompasses all services, agencies, and Combatant and Supporting Commands to provide the ITV necessary for the proper exercise of statutory Directive Authority for Logistics.⁴

In direct contrast to DoD, the commercial sector has been using both active and passive RFID technologies since the 1980s. The most easily recognized form of RFID has been those systems used in toll road applications such as EZ-Pass,⁵ and on the retail side, theft prevention systems such as EAS (electronic article surveillance).⁶

DoD is in the midst of a fundamental transformation of its logistics capabilities, and RFID is becoming an integral element of that transformation. RFID allows logisticians to leverage new applications that enable them to see and manage the supply chain from end-to-end and not be limited by stovepipe systems. RFID also has the potential to revolutionize the entire supply chain by improving inventory management, asset visibility, and interoperability in an end-to-end integrated environment while maintaining the data accuracy advantages of various types of automatic identification technology (AIT).

With the ongoing efforts to expand the application of RFID technology, Acting Under Secretary of Defense for Acquisition, Technology, and Logistics, Michael Wynne, issued a memo on October 2, 2003, which delineated an extensive plan for RFID tracking at all packaging levels and on high-value individual assets. The goal was to reduce stock

³ Office of the Deputy Under Secretary of Defense (Logistics & Material Readiness), History of RFID. Retrieved on January 23, 2006, from <http://www.acq.osd.mil/log/rfid/Policy/Draft%20final%20RFID%20Policy%20Attachment-1%20Scope>.

⁴ Directive Authority for Logistics is Combatant commander authority to issue directives to subordinate commanders, including peacetime measures, necessary to ensure the effective execution of approved operation plans. Essential measures include the optimized use or reallocation of available resources and prevention or elimination of redundant facilities and/or overlapping functions among the Service component commands.

⁵ EZ-Pass is an electronic toll collection (ETC) method containing account information on an electronic tag installed in your car which is read by a receiving antenna at the toll plaza. The toll is electronically deducted from your prepaid toll account.

⁶ Electronic article surveillance, or EAS, is an anti-shoplifting system used by retail businesses. It involves attaching an electronically-detectable tag to the item of clothing or merchandise.

and improve forecasting through "Total Asset Visibility" (TAV).⁷ This was later followed by the Acting Under Secretary of Defense for Acquisition, Technology, and Logistics outlining the policy for the use of RFID within DoD in a memorandum released in July 2004.⁸ That directive required the integration of RFID technology throughout DoD. The policy states that DoD will be an early adopter of innovative, passive RFID technology that leverages the Electronic Product Code (EPC) and compatible RFID tag. By January 2005, DoD required its suppliers to use RFID tags on shipments to the Defense Distribution Depot in Susquehanna (New Cumberland), Pennsylvania (DDSP), and the Defense Distribution Depot San Joaquin (Tracy and Lathrop), California (DDJC). According to DoD Chief Logistics Auto-ID Technology Officer, Edward W. Coyle, DoD moves \$28.9 billion worth of material through its pipeline annually, and is positioning itself to leverage RFID to achieve full visibility and management of assets throughout its supply chain.⁹

Within DoD, the FISC, Norfolk, Ocean Terminal Division has been the vanguard for activities implementing passive RFID and is currently using RFID tags to process all shipments except household goods. Classified shipments are processed by the division at a separate remote site, and outsized shipments are processed in a storage area outside.

DDJC is equipped with RFID readers and the required supporting infrastructure, and has been accepting pallets and cases with passive ultra high frequency (UHF) RFID tags based on EPC specifications since January 2005. They have only partially implemented RFID in their business processes.

RFID technology provides a range of capabilities that enable the automatic capture of source data and enhances the ability to identify, track, document, and control deploying and redeploying forces, equipment, personnel, and sustainment cargo. RFID is a foundational technology on the path to improving asset visibility, data accuracy, and

⁷ RFID Journal, Military Edict: Use RFID by 2005, October 3, 2003. Retrieved on January 23, 2006, from <http://www.rfidjournal.com/article/view/604>.

⁸ DoD Logistics AIT Office. DoD RFID Background. Retrieved on February 1, 2006, from <http://www.dodait.com/>.

⁹ Industry week, DoD plans to expand use of rfid through supply chain in 2006, Tuesday, May 24, 2005. Retrieved on January 23, 2006, from <http://www.industryweek.com/printarticle.aspx?articleid=10319>.

inventory management within DoD. Ultimately, the DoD supply chain can be a fully integrated adaptive entity that leverages the current state-of-the-art enabling technologies to automate routine functions and achieve accurate and timely in-transit and in-storage asset visibility with the least human intervention.

C. SCOPE

RFID, with its expected advantages, has currently been a major trend in logistics worldwide. From a general view, whether it is commercial or military, there are many theoretical and potential application areas, benefits, and issues of passive RFID. From the military perspective, DoD is in the process of determining how and where the agency can benefit from RFID within their facilities and capabilities in terms of having an effective and efficient supply chain and supporting their warfighters. Therefore, DoD narrowed its initial application area. However, what is happening at site implementations? What about the potential consequences versus realized consequences of implementing RFID technology within the business processes? In site implementations, there may be some unexpected consequences that have not been identified in the memoranda or plans of the Office of the Secretary of Defense (OSD) or the services, but there may be significant obstacles to conducting efficient and cost-effective implementations. For example, there is a difference between the RFID policy and the site implementations for active RFID. As stated in the GAO report dated March 8, 2006, even though the DoD mandate states that active tags shall be returned and reused, the reality is that this is currently not happening. Units rarely return the active SAVI-brand RFID tags.¹⁰ As depicted in Figure 1, the study field is the red area which infers the variance between the DoD policy and the actual implementations.

The scope of this project will include: (1) an overview of RFID technology, (2) a literature review of DoD's RFID policy and perspective, (3) an in-depth review of RFID implementations at the FISC, Norfolk OTD and DDJC, (4) comparative analysis of

¹⁰ U.S. Government Accountability Office. Defense Logistics: More Efficient Use of Active RFID Tags Could Potentially Avoid Millions in Unnecessary Purchases (GAO-06-366R) Washington, DC: U.S. Government Printing Office.

implementations and policy compliance, and (5) a discussion of the cause(s) of variances between DoDs RFID policy and actual site implementations. This project will conclude with a summary and recommendations.

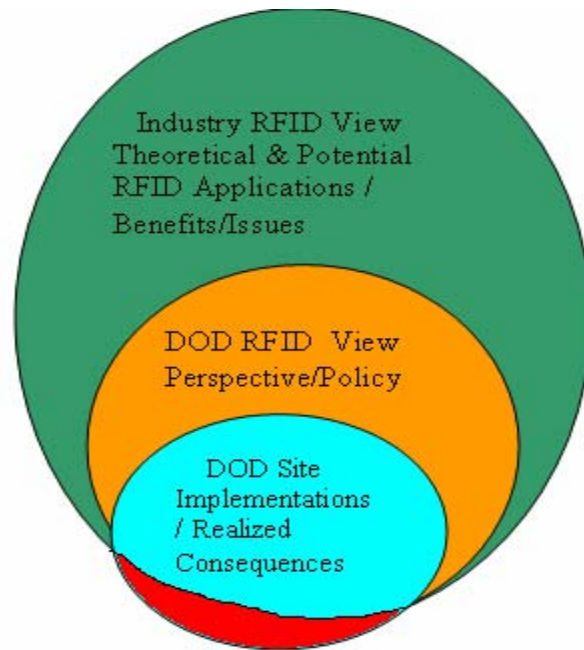


Figure 1. Study Field Based on the Different Views

D. METHODOLOGY

The methodology used in this research project will consist of the following steps:

1. Conduct a literature review of books, magazine articles, CD-ROM systems, and other library resources.
2. Conduct a thorough review of RFID technology.
3. Conduct a review of the current RFID mandates and implementations in the commercial sector.
4. Conduct a review of the current RFID policy of the Ocean Terminal Division, and observe the site implementation.
5. Conduct a site visit to FISC, Norfolk, Virginia, OTD.
6. Conduct a review of the current RFID policy of DDJC site visit to DDJC, San Joaquin, CA, to observe the site implementation.

7. Compare the compliance of the components to the DoD policy.
8. Identify the cause(s) of the variances between the sites' plans and actual implementations.
9. Prepare a summary and make recommendations.

II. OVERVIEW OF RFID

A. UNDERSTANDING THE RFID CONCEPT

RFID can be briefly described as one of the automatic identification (Auto-ID) methods using Radio Frequency (RF) technology to identify individual physical objects. In order to better understand the RFID concept, Auto-ID, the basic principle in which RFID evolved, and RF, the most important characteristic of an RFID system,¹¹ are discussed in subsequent paragraphs.

Auto-ID, often enunciated with automatic data capture together and known as Automatic Identification and Data Capture (AIDC), is a wide range of technologies which are used to support the machines used to identify objects, capture information about them and transfer the data into a computer system without employee involvement. There are many Auto-ID technologies aimed to increase efficiency, reduce data typing mistakes and have better personnel utilization. These technologies can be summarized as bar codes, smart cards, voice recognition, some biometric technologies (e.g. retinal scans), optical character recognition, RFID and others.¹² From bar codes (accepted as the origin of Auto-ID) to smart cards, almost all the industries have used Auto-ID in many applications; access and security systems, item tracking systems, inventory management and simplified checkout at retail stores. The relatively new technology, RFID, upgrades the Auto-ID capabilities and enhances implementation of the industries with significantly hard and soft savings.¹³

There are many different areas in which RF technology is used, such as radio, cellular phones, radar, and automatic identification systems. RF refers to electromagnetic waves with a frequency or wavelength from about 10 kilohertz (KHz) to about 300

¹¹ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.45.

¹² What is automatic identification?. Retrieved on February 17, 2006, from <http://www.rfidjournal.com/faq/16/48>.

¹³ Ajit Kambil, Jeffrey D. Brooks. Auto-ID Across the Value Chain: From Dramatic Potential to Greater Efficiency & Profit. Auto-ID Center. White Paper 2002, p.4.

gigahertz (GHz) suitable for utilization in radio communication.¹⁴ Although each country has its own RF regulations to control emissions and prevent interference between the equipment used by different industries, RF allocated for RFID uses ranges from 125 KHz to 2.45 GHz. Some frequencies used in the United States (U.S.) may not be valid in other countries.

	Low Frequency (LF)	High Frequency (HF)	Ultra High Frequency (UHF)	Microwave
Frequency Range	< 135 KHz	13.56 MHz	860-930 MHz [1]	2.45 GHz
Standards Specifications	ISO/IEC 18000-2	ISO/IEC 18000-3 Auto-ID HF Class 1 ISO 15963, ISO 14443 (A/B)	ISO/IEC 18000-6 Auto-ID Class 0, Class 1	ISO/IEC 18000-4
Typical Read Range	< 0.5m	~ 1m	~ 4 - 5m [2]	~ 1m
General	Larger Antennas resulting in higher cost tags. Least susceptible to performance degradations from metals and liquids.	Less expensive than LF tags. Best suited for applications that do not require long range reading of high number of tags. This frequency has the widest application scope.	In volume UHF tags have the potential to be cheaper than LF or HF due to recent advances in IC design. Good for reading multiple tags at long range. More affected than LF and HF by performance degradations from metal and liquids.	Similar characteristics to UHF but faster read rates. Drawback is microwaves are much more susceptible to performance degradations from metal and liquids.
Tap Power Source	Mainly passive using inductive coupling (near field)	Mainly passive using inductive coupling (near field)	Active and passive tags using E-field back scatter in the far field.	Active and passive tags using E-field back scatter in the far field.
Typical Applications	Access Control, Animal Tagging, Vehicle Immobilizers	Smart Cards, Access Control, Payment, ID, Item Level Tagging, Baggage Control, Biometrics, Libraries, Laundries, Transport, Apparel	Supply Chain- pallet and box tagging, Baggage, Handling, Electronic Toll Collection	Electronic Toll Collection, Real Time Location of Goods
Notes	Largest installed base due to mature technology. However will be overtaken by higher frequencies.	Currently the most widely available high frequency world-wide due to adoption of smart cards in transport.	Different frequencies and power allocated by different countries US 4W (EIRP) 915 MHz, Europe 0.5 W (ERP) 868 MHZ [2]	5.8 GHz More or less abandoned for RFID
Multiple Tag Read Rate	Slower	←-----→ Faster		
Ability to read near metal or wet surfaces	Better	←-----→ Worse		

¹⁴ Introduction to Radio Frequency Identification. Retrieved on February 2, 2006 from <http://www.currentdirections.com/features/index.html>.

Passive Tag Size	Larger ←-----→ Smaller
[1] Japan has recently announced allocation for 950 MHz band for RFID [2] 4-5m is for unlicensed readers and 10m for site license in the US. In Europe with current power restrictions only around 33 cm is achievable. However this is expected to improve to near 2m as power emissions increase from 0.5 Watts to 2 Watts.	

Table 1. Performance Overview of Most Commonly Used RFID Frequencies

The frequencies used within the RFID systems have different specifications and capabilities, and as a result can be used in different applications. Table 1 provides characteristics of the most commonly used RFID frequencies.¹⁵

In the next section, this thesis will discuss an RFID system and list its technological advantages and limitations.

B. THE RFID SYSTEM AND ITS TECHNOLOGY

In a typical passive RFID system, tags are attached to objects. Each tag consists of a microchip with a coiled antenna. The microchip is the internal memory and information is stored about an object, such as its unique serial number, or more elaborate information. The reader transmits electromagnetic waves that form a magnetic field. When the object passes thorough this field, the tag receives the waves and uses them to power the microchip's circuits to modulate the waves that the tag sends back to the reader. The reader converts these waves into digital data which is processed by the RFID software in order to transfer into the main computer system.¹⁶

The variety of the components of a RFID system manufactured by many different vendors with different capabilities and the characteristics of RF enable the users to install particular RFID systems for their application areas. The most commonly used RFID system in most industries is the passive RFID system, which also varies by the purposes of usage and implementation.

An RFID system has two equally important interconnected units – the physical structure and information technology (IT) system. The overall performance of the RFID

¹⁵ A Basic Introduction to RFID Technology and Its Use in the Supply Chain. LARAN RFID. White Paper, April 2005, p.4, 15.

¹⁶ How does an RFID system work? Retrieved on February 7, 2006, from <http://www.rfidjournal.com/faq/17/58>.

system depends on the harmonious cooperation of the individual capabilities of both of the units.¹⁷ From an end-to-end perspective, the components of an RFID system are as follows:

- Tag
- Reader
- Reader antenna
- Controller
- Sensor, actuator, and annunciator
- Host and software system
- Communication infrastructure¹⁸

1. RFID System Components

a. Tag

An RFID tag is a device that provides information to an observer by using RF waves without a requirement of line-of-sight visibility. RFID tags can be classified by their power source and data write-storage capability. First classification includes passive tags, active tags and semi-active (semi-passive) tags. A second classification includes read-only (RO) tags, write-once, read-many (WORM) tags, and read-write (RW) tags.¹⁹

Passive RFID tags have two components attached to each other; a microchip and an antenna. These components are strictly tightly coiled with a robust layer without any internal battery. The antennas of the tags draw power from the reader to activate the microchip that modulates the waves with the data written in its memory, and sends them back to the reader. Therefore, a passive tag always needs a reader

¹⁷ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.8.

¹⁸ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.7.

¹⁹ Ibid., 9.

sending RF waves for data transmission. The antenna length determines the dimensions and the read range in accordance with RF. The read range varies from one inch to 30 feet.²⁰

Active RFID tags have four components; a microchip, an antenna, an on-board power supply, and on-board electronics. The microchip and antenna have similar but superior functions with greater size than the microchip used in passive tags. Active tags, called transmitters, are able to transmit data as long as their internal power source (battery), also called an on-board power-supply, lasts. The battery's life is between two to seven years, and is also dependent upon the data transmission rate interval of the tag. Meanwhile, there is another type of active tag, also known as a transmitter/receiver (transponder), which is designed to be in sleep or low-power state in the absence of an external stimulant, such as a reader, in order to increase battery life. The on-board electronics, made up of microprocessors, sensors, and input/output ports, give the extra capabilities of an active tag, such as processing specialized tasks, displaying the dynamic parameters, and measuring the temperature of the environment. The read range of an active tag can be 100 feet or more.²¹

Semi-active (or semi-passive) tags are a combination of active and passive tags and eliminate the disadvantages of both types. They have similar internal on-board power supplies and electronics to active tags. However, they have to be induced by RF waves from a reader to migrate into an active mode like a passive tag. They perform the specialized tasks by using internal batteries and transmit data by using the power drawn from the waves of the reader. This design provides a faster and stronger transmission that allows a long read range like an active tag. The read range of semi-active (semi-passive) tags can be 100 feet under ideal conditions.²² Their respectively smaller size than active

²⁰ Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p. 9, 10, 11, 12.

²¹ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.15, 16.

²² Ibid., 17.

tags and more memory storage than passive tags are other important characteristics. Table 2 provides a comparison and summary of the advantages and disadvantages of the different types of tags.²³

Basically, an RO tag (often referred to as factory programmed) is the simplest type of tag, in which the data can be written once in its lifetime at the factory during manufacturing. The user cannot customize the data, and it is mainly a simple serial number or ID number provided within the tag. An RO tag is preferable for small business applications which do not require customer control over the data within the tag.²⁴

	Advantages	Disadvantages	Remarks
Passive	-Longer life time. -Wider range of form factors. -More mechanically flexible tags. -Lowest cost.	-Distance limited to 5m (UHF). -Strictly controlled by local regulations.	-Most widely used in RFID applications. -Tags are LF, HF, or UHF.
Semi-Passive	-Greater communication distance. -Can be used to manage other devices like sensors (Temp°, pressure etc).	-Expensive-due to battery, and tag packaging. -Reliability-impossible to determine whether a battery is good or bad, particularly in multiple transponder environments.	-Used mainly in real time systems to track high value materials or equipment throughout a factory. -Tags are UHF.
Active	-Do not fall under the same strict power regulations imposed on passive devices.	-Widespread proliferation of active transponders presents an environmental hazard from potentially toxic chemicals in batteries.	-Used in logistics for tracking of containers on trains, trucks etc. -Tags are UHF or microwave.

Table 2. Comparison of Passive, Semi-Passive and Active Tags.

All three tag types discussed above can be RO (read-only), WORM or RW (read-write).

A WORM or field programmable tag can be written once in its lifetime either by the manufacturer or by the user, but most commonly by the user at the time when processing of the associated object takes place. Normally, this type of tag is not re-writable, but in practice data may be written over about 100 times, which can cause the tag to fail. Similar to a RO tag, a WORM can be considered as a simple identifier;

²³ A Basic Introduction to RFID Technology and Its Use in the Supply Chain. LARAN RFID. White Paper, April 2005, p.4, 15.

²⁴ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.19.

however, it currently has the broadest usage in industry because it provides a good price-to-performance ratio with reasonable data security.²⁵

An RW tag (primarily known as a field programmable or reprogrammable tag) can be written over between 10,000 and 100,000 times or more, either by the reader or by the active tag itself. An RW tag is typically used for data storage where more memory is needed. Data security and high cost are the main issues that restrict RW usage in industry.²⁶

Now that the different types of RFID tags and their specifications and capabilities have been discussed, this thesis will move on to a different type of tag called the Electronic Product Code (EPC) RFID tag. The Auto-ID Center, a non-profit establishment which is a consortium of the major RFID users, vendors, DoD, and research universities, created EPC RFID tags in an effort to provide a standard that served the need of business to develop an affordable RFID tag which would be more widely used within the supply chain. EPC consists of simple and compact code ranges from 64 bits to 256 bits with four distinct fields as shown in Figure 2. It can be described as a unique identifier that can provide fast and detailed information of products, such as the version of the EPC, the manufacturer's identification, the product type, and the unique serial number of the item. Its similarity to the Universal Product Code (UPC) used in bar codes gives RFID users an opportunity for a smooth adoption to RFID implementation.²⁷



Figure 2. Layout of an EPC which is 96 Bits in Length.

²⁵ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p. 20.

²⁶ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.20.

²⁷ A Basic Introduction to RFID Technology and Its Use in the Supply Chain. LARAN RFID. White Paper, April 2005, p.23.

There are four different classes of EPC RFID tags²⁸ summarized below:

- (1) EPC Class 0/Class 1: Passive WORM type, 64/96 bits of data, a simple ID number, factory programmed, and the cheapest one.
- (2) EPC Class 2: Passive RW, capacity to store EPC together with 224 bits of user data, factory or user programmed,
- (3) Class 3: Active RW, most flexible type, more memory capacity.
- (4) Class 4: Active RW, largest user data capacity, 300 feet of minimum read range and the most expensive tag.

The new form of Class 0 and 1 tags is the UHF Generation 2 tag, also called the EPC Gen 2 tag. It is a global tag that is expected to lower costs and to have greater adoption by industry.

b. Reader

An RFID reader (also called an interrogator) is a key component of an RFID system. A reader is a multi-functional component that communicates with the tag and the computer system. In addition, the reader can store recently recorded data, with a limited memory, in the event of a break-down of the RFID system.²⁹ It is apparent that there are many different types of readers which have different features and capabilities.

Depending on the interface that a reader provides for communications, they are broken down into two types – serial and network readers. While a serial reader needs to be connected to a computer's serial port with a cable, a network reader is flexible and can be connected to a computer via a cable or a wireless network. Serial readers are more reliable than network readers, but they have their disadvantages. Unlike network readers, serial readers are restricted by the length of the cable, they need more access to ports to connect all of the serial readers, they require high maintenance time and cost, and they have low data-transmission rates.³⁰

²⁸ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.215, 216.

²⁹ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.22, 24.

³⁰ Ibid., 25.

Another classification can be made based on the mobility of a reader, and that is stationary or handheld. A stationary reader, called a fixed reader, can be mounted on a convenient surface of a fixed or moving object such as a wall, a portal, a truck or a container. A stationary reader needs external antennas and can accommodate up to four antennas at the same time. It is widely preferred by industry because of its lower cost. A specific type of stationary reader called an agile reader has the multi-frequency and multi-protocol capability. RFID printers are accepted as stationary readers that can print bar codes and write to an RFID tag. In many business applications, bar codes are currently used as a back-up and a contributor to RFID technology. When the RFID system goes down, bar codes can be used to continue the operation either by scanning automatically or by providing human-readable identification. In general, a mobile reader (called a handheld reader) is manufactured with built-in antennae and provides great flexibility; however, it is rarely used because of its high cost.³¹

The communication between a reader and a tag can be accomplished in three different modes based on the tag type: modulated backscatter, transmitter type, and transponder type. Tag write requires more time, closer proximity, and more power than tag read. In addition to these, there should only be one tag in the write range of a reader; however, many tags can be read at the same time. In a modulated backscatter, also known as beam power communication, the reader initially transmits the RF waves which activate the tags in order to send the data back to the reader. This type of communication includes passive and semi-active tags and cannot exist without a reader. In transmitter communications, the active tag sends out the data in a designed interval and initiates the interaction. In transponder communications, the specially manufactured active tag, the transponder, is waiting for excitement from the reader to activate itself. After the activation, the transponder starts transmitter communications.³²

c. Reader Antenna

A reader uses a reader antenna to communicate with a tag. Its function is to emit RF waves into the surroundings and to collect tag responses. It is connected to its

³¹ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.25, 26, 27, 29.

³² Ibid., 31, 32.

antenna via a cable which can restrict the design of the installation of an RFID system. One should consider the location of the antenna in order to have a broad read zone and to increase the read accuracy. The antenna footprint that determines the read zone or read window is never uniformly shaped, and it usually has dead zones which are areas in which a tag cannot be read. Although this important factor of reader antenna design might be a characteristic of the item as provided by the manufacturer, the final footprint can be observed and determined after some experience in the field.

Another critical factor in reader antenna performance is antenna polarization. The direction of oscillation of the RF waves emitted by the reader antenna is called the polarization of the antenna. Polarization determines the readability of a tag, including the reading distance and reading quality. There are two types of polarization – linear and circular. While a linear polarized antenna has a longer and narrower radiation beam, a circular one has respectively shorter and wider radiation beams. These radiation beams determine the specifications (wide to narrow) of the shape of the read zone. A linear polarized antenna is preferred where the tag orientation is fixed and predictable. In contrast, a circular polarized antenna is preferred where the tag orientation is unpredictable. The user can increase the read range by emitting stronger RF waves. However, doing so is limited in that antenna power cannot exceed the allowable limits established by national and international regulatory authorities.³³

d. Controller

A reader can have a built-in or separate controller that allows data communication with the computer or any external entity. According to Sandip Lahiri, author of the *RFID Sourcebook*, “A controller is the only component of an RFID system thorough which reader communications are possible; no other medium or entity provides this ability... A controller also provides a communication interface for the external entities to interact with it.”³⁴

³³ Sandip Lahiri. *RFID Sourcebook*. IBM Press Pearson plc. September 2005, p. 33, 35, 37, 38, 39, 40.

³⁴ *Ibid.*, 41.

e. Sensor, Annunciator, and Actuator

A sensor attached to a reader, which is an option, can automatically start and stop the reader based on any detections of an object, so that the working times of the reader can be utilized more efficiently. An annunciator is an electronic signal or indicator, and an actuator is a mechanical device for controlling or moving objects. It can provide audio-visual alarms, strobes or light stacks to reveal the status of the RFID process, such as bad tag data in the read zone, read failure, break-down of the connection, etc.³⁵

f. Host and Software System

The host and software system is the general term used for the hardware and software component separated from RFID hardware (i.e. reader, tag, and antenna). The system consists of four main components. The first component is the edge interface/system that integrates the host and software system with the RFID hardware. Its primary function is to get the data from the reader by eliminating duplicate reads and controlling the reader to activate the associated external actuators and annunciators. It also provides remote management of the reader and itself.

The second component is the middleware, which can be considered the most complex and critical component of the RFID system from a software perspective. The middleware shares data both inside and outside of an enterprise to manage the massive data produced by the RFID system efficiently, and to enable loose coupling between the edge interface and the enterprise back-end interface. The middleware should also be compatible with the many different software systems used within the supply chain.

The third component is the enterprise back-end interface that is used to integrate the middleware component with the enterprise back-end component. Finally, the enterprise back-end component built and functional already within the RFID system is the data storage and business processes engine for the entire enterprise. It provides the directory data for the tagged objects to the middleware component.

³⁵Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p. 41.

g. Communication Infrastructure

The communication infrastructure is an integral part of the system, and consists of the wired and wireless network and serial connections between readers, controllers and computers. It provides connectivity and enables security and systems management functionalities for the different components of a RFID system.³⁶ In terms of technology, a RFID system has many advantages and disadvantages which will be discussed next.

2. Technological Advantages

There are many technological advantages of RFID that attract companies and facilities to implement RFID within their business processes, including the biggest retailers and DoD. Advantages are as follows:

- *Contactless*: An RFID tag does not need physical contact to communicate with the reader.
- *Writable data*: RW RFID tags can be rewritten 10,000 to 100,000 times or more.
- *Absence of line-of-sight*: An RFID tag can be read from different angles without any requirement of line-of-sight visibility, and also through obstructing materials which are RF-lucent for the frequency used.
- *Variety of read ranges*: The reading distances of a RFID tag range from a few inches to more than 100 feet, depending on the type of tag and the RF used.
- *Write data-capacity range*: The data capacity of a RFID tag varies from a few bytes to virtually any amount of data depending on the type of tag and the physical dimensions and capabilities.
- *Support for multiple tag reads*: A RFID reader can automatically read several tags in its read zone in a short period of time.
- *Rugged*: RFID tags are able to function in harsh conditions to a fair extent. They are very durable and long-lasting.

³⁶ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p. 44.

- *Perform smart tasks:* In addition to its usual tasks, a RFID tag can perform specialized tasks such as measuring temperature and detecting motion.
- *Read accuracy:* The theoretical read accuracy is 100 percent as written in the media; however, it differs from implementation to implementation.³⁷

3. Technological Limitations

Although the frontrunners have been pushing RFID technology into their processes and into industry, there are also many companies and DoD facilities hesitating to implement RFID. The technological limitations listed below may be some of the reasons for their vacillation:

- *Poor Performance with RF-opaque and RF-absorbent objects:* If the object is packaged inside of an RF-opaque or RF-absorbent material such as metal or water, the RFID reader does not work well or completely fails in some cases.
- *Impacted by environmental factors:* The features of the operating environment are significant factors for read accuracy such as a large amount of metal or liquids.
- *Limitations on actual tag reads:* Within a specified time, there is a limit to how many tags can be read.
- *Impacted by hardware interference:* When the read zones of two or more readers overlap, their signals can interfere with each other resulting in duplicate or more tag reads. In addition, improper installation of a RFID system and the wrong orientation of tags can have negative affects on read accuracy.
- *Limited penetrating power of RF energy:* The capability of a RFID reader to read a tag from different angles, without any requirement of line-of-

³⁷ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.49-57.

sight visibility or through RF-lucent obstructing materials, is limited to the power of RF energy.

- *Immature technology*: The variety of vendors manufacturing tags and readers that have different capabilities utilizing multiple frequencies without any globally agreed upon standards not only increases the innovations and advancements of RFID technology, but also increases the practical issues of implementation.³⁸

Now that this thesis has covered the concept and system from end-to-end, the authors will look at industry's perception of RFID in order to get a better overall picture.

C. RFID WITHIN INDUSTRY

RFID technology dates back to World War II. First, passive RFID was used by the Germans to identify approaching airplanes to determine whether they were friendly or the enemy. In the 1950s and 1960s, there were many studies done on RF technology and its capability of remote identification. Some advances were obtained and companies started using RFID for anti-theft systems. In the 1970s, the U.S. government initiated and supported studies about RFID for hazardous material (HAZMAT) tracking. In 1973, the first RFID patent for a passive transponder that could unlock a door without a key was obtained by Charles Walton, a California entrepreneur. He licensed the technology to a lock maker and other companies.³⁹ More commercial use of RFID in business came about in the early 1980s for applications such as bridge tolls, tracing livestock movements, tracking railroad cars, in agriculture, tracking airfreight and automobile manufacturing. Because of the technological limitations and high cost, RFID could not be used for mass commercial applications.⁴⁰

In 1999, the Auto-ID Center conducted studies on EPC, which emerged as the global standard that turned RFID into a networking technology by linking objects to the

³⁸ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.59-62.

³⁹ The History of RFID Technology. Retrieved on February 17, 2006, from <http://www.rfidjournal.com/article/articleview/1338/1/129/>.

⁴⁰ Peter Jones, Colin Clarke-Hill, David Hillier, Peter Shears, Daphne Comfort. Radio Frequency Identification in Retailing and Privacy and Public Policy Issues. Management Research News, 2004, 27, 8/9 ABI/INFORM Global, p. 46.

Internet through tags. Then RFID received a boost from the ratification of EPC in 2003 which encouraged some of the biggest retailers in the world, namely Albertsons, Metro, Target, Tesco, Wal-Mart and DoD, to use RFID technology in their supply chain management systems. Pharmaceutical, tire, defense, and other industries followed this trend and started adopting RFID in their businesses processes. As discussed earlier, the second generation of EPC tags encourages and enables broad implementation of RFID.⁴¹

In addition to EPC tag development, the biggest leverage of today's widespread and broad adoption of RFID were the mandates announced by DoD and Wal-Mart – the world's largest military and retailer respectively. Both urged industry to expand the usage of RFID to track goods in their supply chain, encouraged further research on RFID, and promoted media coverage.⁴²

RFID has often been identified with the retail and distribution industries, especially after the Wal-Mart initiatives. Wal-Mart's first mandate required its top 100 suppliers to put EPC tags on the shipments and pallets they send to Wal-Mart's warehouses or distribution centers. So far, more than 500 Wal-Mart stores have started implementing RFID in their processes. Wal-Mart's goal is to increase this number to 1,000 stores and have more than 600 RFID-user suppliers at the end of 2006.⁴³ Wal-Mart's projected \$500 billion in sales by 2010 can help us to better understand the affect of their mandate on global supply-chain technology, and especially on RFID adoption.⁴⁴

What are the application areas and the benefits of RFID that can attract all types of business industries? A large number of books have lauded the benefits of RFID. Some of these benefits have been realized, and some are potential. Although there are differing opinions on this issue from various industries, many would agree that the value of RFID has not been exaggerated. RFID has made many contributions to the business sector

⁴¹ The History of RFID Technology. Retrieved on February 7, 2006, from <http://www.rfidjournal.com/article/articleview/1338/1/129/>.

⁴² RFID for the Real World. FKI Logistex. White Paper, 2005, p.3.

⁴³ Austin Weber. RFID on the Line. Assembly; Jan 2006; 49,1; ProQuest Science Journals, p.78.

⁴⁴ Larry Fennell. Technology and The Future: A Vendor's View. DSN Reatiling Today; Feb 25, 2005; 44,4; ABI/INFORM Global, p.52.

despite the fact that there have been many failed pilots and applications. In subsequent paragraphs, this thesis will discuss some of the prevalent application areas and the benefits realized thus far.

Today, the widest application area of RFID is supply chain management. Item tracking and tracing in the supply chain reduces product loss to manufacturers and retailers, which is about two to five percent of their stock. It enables the retailer to better understand the product's sale potential for better marketing and to improve inventory management with fewer stockouts. Inventory monitoring and control is more accurate if one can quickly locate misplaced items and restock them correctly. The retailer also has better asset monitoring and utilization if he can locate and control his stock. In the applications of asset monitoring and management, RFID improves operations and provides things such as better security and proactive vehicle maintenance with accurate and automatic data capture. It enables improved communication between customers, management, and staff.

RFID application in HAZMAT tracking decreases the potential damage caused by ruptured HAZMAT containers and increases public safety and awareness. RFID is also used as an anti-theft system which is an affordable solution with a very cheap 1-bit tag called Electronic Article Surveillance (EAS). EAS is actually defined as an RF tag and not an RFID tag. An RFID anti-theft system is a simple solution to a complex RFID system. It is very effective because detection of EAS tagged items is very difficult. EAS, with its simplicity, causes no privacy issues because it cannot be used to track customers. This is another reason for the wide adoption of RFID anti-theft systems.

In electronic payment applications, RFID enables fast, easy, and convenient payment. It reduces the need of carrying cash and provides security because one can limit the amount that is loaded on the tag. In access control applications, flexible security controls using specific identification data, read by an RFID reader, is fairly economical with the new, cheaper RFID tags. In addition to cost-effectiveness, RFID has a relatively mature and well understood technology based on a wide variety of manufacturers and users. Another benefit is that it provides a standard-based solution with ISO 15693 that is

the de facto standard used for this type of tag. In the application area of anti-tampering, RFID provides flexible security control with the RFID tags working as sensors to detect the presence of explosives or radioactive emissions. Real-time notification of tampering is another important benefit.⁴⁵ Next, this thesis will look at the DoD policy and perspective on RFID technology.

⁴⁵ Sandip Lahiri. RFID Sourcebook. IBM Press Pearson plc. September 2005, p.63-89.

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III. RFID WITHIN DOD

A. DOD MANDATE

DoD interest in RFID dates back to World War II, when radio waves were used to determine whether approaching planes belonged to our allies or our enemies. The advances in technology today offer major improvements over previous technologies, such as bar codes and magnetic striped cards. Today, technological advancements and decreased costs have stimulated a proliferation of the technology and DoD is on the forefront of implementation.⁴⁶

In October 2003, the Under Secretary of Defense for Acquisition, Technology, and Logistics issued the policy which directed the first phase of the mandate, which directed the use of high data capacity RFID use in the DoD operational environment, and required suppliers to place passive RFID tags on the lowest possible piece part/case/pallet packaging by January 2005. Next, Mr. Alan Estevez, Assistant Deputy Under Secretary of Defense, Supply Chain Integration, took the lead to facilitate the implementation of the RFID policy when he held a RFID Policy Kick-off meeting which served as the organizational meeting for the DoD RFID Integrated Product Team (IPT)⁴⁷ and three subordinate working groups: Business Process, Technical and Implementation, and Implementation and Oversight.

By December 2003, the first DoD RFID Summit for Industry was conducted, the intent of which was to discuss DoD RFID policy, engage suppliers, and begin the process of implementation. In February 2004, the policy was updated to include the Policy Principles for use of Passive RFID Technology in the DoD Supply Chain. Then the 2004 RFID Industry Summit for Industry was held and brought together industry and government representatives for presentations and discussions on RFID policy, progress on implementation, industry applications, and lessons learned. Shortly thereafter, in July

⁴⁶ Office of the Deputy Under Secretary of Defense (Logistics & Material Readiness), RFID: Advance Shipment Notice (ASN). Retrieved on February 1, 2006, from http://www.acq.osd.mil/log/rfid/advance_shipment_ntc.htm.

2004, the final RFID policy for implementing RFID across the DoD was published, and it codified the business rules for active RFID and implementation of passive RFID.⁴⁸

In addition to publishing its policy, DoD selected two DLA depots, Defense Distribution Depot Susquehanna, PA (DDSP) and San Joaquin, California for initial implementation, with the primary objective of preparing the sites to receive tagged material beginning January 1, 2005. This pilot program was the beginning of phase one and tested the effectiveness of using passive RFID tags to enhance asset visibility and management.

The RFID-enabled receiving process began with tagged cases and pallets being read as they were received through the receiving dock doors, and individual parcel cases were read after being placed on conveyor belts. The tag data was then used to establish the “tail-gate” date, at which point the agency assumes ownership and responsibility for the supplies and becomes the starting point of the payment cycle. To complete the loop, the RFID data was reconciled against serialized Advanced Shipment Notices (ASN) which resulted in improved order fulfillment accuracy and inventory visibility. Testing of tags and readers continued throughout 2004 to determine the optimal configuration for tag read accuracy and later that year, the focus shifted to software for device, data, and process management.⁴⁹

Effective November 14, 2005, DoD issued a final rule amending the Defense Federal Acquisition Regulation Supplement⁵⁰ (DFARS) to include its new policy which applies to package marking with passive radio frequency identification (RFID) tags. The policy requires contractors to affix passive RFID tags at the case and palletized unit load levels when shipping packaged operational rations, clothing, individual equipment, tools,

⁴⁷ The purpose of an IPT is to facilitate decision-making by making recommendations based on timely input from the entire team. The IPT approach simultaneously takes advantage of all members’ expertise and produces an acceptable product the first time.

⁴⁸ DoD Logistics AIT Office. DoD RFID Background. Retrieved on February 1, 2006, from <http://www.dodait.com/>.

⁴⁹ Globe Ranger. DOD Gears up For RFID at the Defense Logistics Agency Depots. Retrieved on January 10, 2006 from http://www.globeranger.com/documents/FINALDOD_noboothnumber.pdf.

⁵⁰ The DFARS are the Defense Federal Acquisition Regulations Supplement, a supplement to the Federal Acquisition Regulations designed specifically for DoD acquisition professionals and contractors.

personal demand items, or weapon system repair parts to the Defense Distribution Depots in Susquehanna, PA or San Joaquin, CA.⁵¹

The second phase of the RFID mandate began in January 2006 and included the tagging of cases and pallets of subsistence and comfort items, petroleum, chemicals, ammunition, and pharmaceuticals, to name a few, that will be shipped to 32 depots and two DLA distribution centers. Commodities in the following Classes of Supply will require RFID tags to be placed on all individual cases, all cases packaged within palletized unit loads, and all palletized unit loads:

- Class I – Subclass – Packaged Operational Rations
- Class II – Clothing, Individual Equipment, and Tools
- Class III(P) – Packaged Petroleum, Lubricants, Oils, Preservatives, Chemicals & Additives
- Class IV – Construction & Barrier Equipment
- Class VI – Personal Demand Items
- Class VIII – Medical Materials (excluding Pharmaceuticals)
- Class IX – Weapon Systems Repair Parts and Components.

The updated Supplier Guide contains this information and will be updated as necessary as the technology and supporting business processes evolve.⁵²

Phase 3, which is scheduled to commence in January 2007, will require suppliers to tag cases and pallets of all goods dispatched to the various DoD locations.⁵³ This phase of the mandate requires DoDs logistics systems involved in shipping, receiving, and inventory management to use RFID to perform business transactions.⁵⁴ This mandate

⁵¹ U.S. Department of Defense, Federal Register / Vol. 70, No. 176 / Tuesday, September 13, 2005 / Rules and Regulations. Retrieved on February 1, 2006, from http://www.acq.osd.mil/log/rfid/Federal_Register_2005_09_13_RFID_Final_Rule.pdf.

⁵² Office of the Deputy Under Secretary of Defense (Logistics & Material Readiness), RFID: What's New – 2006 Commodities. Retrieved on February 3, 2006, from <http://www.acq.osd.mil/log/rfid/index.htm>.

⁵³ RFid Gazette. RFID deployment drivers. 6 December, 2005. Retrieved on February 1, 2006, from http://www.rfidgazette.org/2005/12/rfid_deployment_1.html.

⁵⁴ Bhuptani, M., & Moradpour, S. (2005). RFID Field Guide: Deploying Radio Frequency Identification Systems. New Jersey: Sun Microsystems Press. p. 151.

creates enormous implications and challenges for more than 43,000 DoD suppliers.⁵⁵ The mandate also requires the use of an EPC tag numbering scheme in addition to DoD tag data constructs for encoding and applies to both its top suppliers and small businesses.

Traditionally, the DoD acquisition process has been paper-based and very labor intensive, and much of the time is maintained by manual and repetitive data inputs from a multitude of sources. This process has tended to limit access to much of the source data provided by various contractual, financial and logistic documents. Under the RFID mandate, this process is beginning to change. The Wide Area Workflow⁵⁶ (WAWF) application enables electronic form submission of invoices, government inspection, and acceptance documents in order to support DoD's goal of moving to a paperless acquisition process.

An additional requirement in the RFID mandate is that contractors must send an advance shipment notice. The WAWF is the current method used for submitting an Advance Shipment Notice (ASN), and the RFID mandate requires that all vendors who are contractually obligated to affix passive RFID tags to material must also send an ASN via WAWF. The ASN is not a new process/transaction, but it is the same existing Material Inspection Receiving Report⁵⁷ (MIRR) transaction being sent to WAWF with additional data (RFID data elements) added to the transaction. In April 2005, WAWF added the RFID tag ID as an additional data element in the MIRR.⁵⁸

In July 2002, Army General Tommy Franks, Commander of U.S. Central Command, issued a memorandum requiring that all containers arriving in the CENTCOM theater (or area of operations (AOR)) have RFID tags. The CENTCOM policy currently

⁵⁵ Bhuptani, M., & Moradpour, S. (2005). RFID Field Guide: Deploying Radio Frequency Identification Systems. New Jersey: Sun Microsystems Press. p. 151.

⁵⁶ WAWF is a paperless contracting application to eliminate paper from the receipt/acceptance and invoice/payments process of the contracting life cycle.

⁵⁷ A MIRR is a form that is used by the government to document contract compliance and by the contractor to submit an invoice. The contractor is responsible for preparing the MIRR, except for entries that an authorized government representative is required to complete.

⁵⁸ Office of the Deputy Under Secretary of Defense (Logistics & Material Readiness), RFID: Advance Shipment Notice (ASN). Retrieved on February 1, 2006, from http://www.acq.osd.mil/log/rfid/advance_shipment_ntc.htm.

states that ITV of deploying or redeploying personnel, cargo, and equipment is critical to operations, and therefore all activities, including operating nodes within the USCENTCOM AOR and nodes where RFID tagged cargo or equipment originates, terminates or transits to include, but are not limited to, supply, distribution, and military and commercial aerial and sea ports, will have RFID read capability. CENTCOM is requiring all active, data-rich RFID tags to be written with content level detail to the National Stock Number (NSN), noun nomenclature level in accordance with approved formats.⁵⁹ CENTCOM has determined this level of visibility to be critical given its ongoing operational tempo.⁶⁰

B. ADVANCING RFID TECHNOLOGY WITHIN DOD

During the 1990s, DoD became interested in RFID in an effort to address its supply chain challenges. DoD has since become very active in RFID research and development in an effort to improve asset visibility, inventory management, security, and quality control. Today, all DoD components use RFID.

In 2004, DoD joined EPCGlobal™ in piloting a program using active and passive RFID tags attached to Meals, Ready-To-Eat (MRE) combat rations under the Combat Feeding Program. DoD traced the rations from the vendor to the consuming unit through several supply chain participants and locations. Since MREs are packaged in foil, reading the tags posed many challenges as the metal made it difficult to read the tags. Additionally, DoD utilized active tags to track the temperature variations in order to get a better determination of the final shelf-life of the MREs.⁶¹ This gives DoD the ability to track the quality of material in several key classes, especially ordnance and perishables.

The Air Force has evaluated TransCore eGo RFID transponder tags and readers as part of an automatic vehicle identification (AVI) and access control system at Hanscom

⁵⁹ Military Information Technology. RFID: "In the Box" Visibility. Retrieved on February 28, 2006, from http://www.military-information-technology.com/print_article.cfm?DocID=168.

⁶⁰ Ocean Systems Engineering Corporation and SRA International, Inc., Alpha Informatics, Limited Advanetrix, Incorporated. Third Generation Radio Frequency Identification With Satellite Communication (3G RFID W/SATCOM) Business Process Analysis Report dtd 27 April, 2004.

⁶¹ Radio Frequency Identification (RFID) primer. Retrieved on March 1, 2006, from http://ocw.mit.edu/NR/rdonlyres/Sloan-School-of-Management/15-762JSpring-2005/23F46055-7F21-4046-B2C3-7E96680790DD/0/rfid_primer.pdf.

AFB, MA, for future base security applications. This could lead to adoption at other military installations.⁶² The Army also tested a similar system for access control at Fort Monmouth, NJ, for the U.S. Army Communications-Electronics Command, Research, Development and Engineering Center, Night Vision and Electronic Sensors Directorate.⁶³

DoD has been using high data capacity active RFID tags for over a decade for in-transit asset visibility of air pallets and intermodal freight containers; and up until Operation Enduring Freedom in Afghanistan, the Army had been the principal user of RFID technology.

RFID technology is also used to facilitate “in the box” visibility by providing a full content manifest for sea-land vans or air shipment pallets. This is important in theater since the shipping information can be read in the field using a handheld interrogator. A variety of fixed or mobile interrogators are located at airports, airfields, distribution centers, and depots or in other areas where in-transit visibility is required.

The Marine Corps Warfighting Laboratory (MCWL), in collaboration with Marine Corps Systems Command and the Navy Bureau of Medicine and Surgery, is developing a prototype system to enhance casualty evacuation. The system is intended to ease locating casualties for evacuation and to provide treatment record consistency utilizing the Tactical Medical Coordination System (TacMedCS).⁶⁴ This system uses passive RFID technologies to automate some of the casualty evacuation process. It is a wristband which contains a passive electronic longitudinal evacuation record, utilizes non-physical contact data transmission and storage media, and uplinks casualty information to a web-based server.

⁶² TransCore. Hanscom Air Force Base Boosts Security with Automatic Vehicle Identification and Access Control System Featuring TransCore eGo™ Products. Retrieved on March 1, 2006, from <http://transcore.com/news/news030414.htm>.

⁶³ TransCore. U.S. Army Taps TransCore for Access Control Technology Testbed. Retrieved on March 1, 2006, from <http://www.transcore.com/news/news030107.htm>.

⁶⁴ Marine Corps Warfighting Laboratory. Medical Coordination System (TacMedCS) Fact Sheet. Retrieved on March 1, 2006 from <http://www.defenselink.mil/transformation/factsheets/TacMed.pdf>.

The goal of the project is to provide ITV and TAV for casualties and avoid patients showing up in the treatment process without documentation.⁶⁵ The system was tested in the field by Fleet Hospital 3, which is a 116-bed expeditionary medical facility that treated thousands of wounded coalition personnel, prisoners of war, and civilians in Iraq from March to May 2003. Approximately 242 of the patients treated at the facility received a RFID wristband in the casualty receiving area.⁶⁶ The fact is that the data can be read even if the patient is wearing clothing or protective gear such as MOPP gear, Kevlar body armor, and various other forms of military clothing. The tag will only transmit from approximately one foot away, and only when interrogated with a RFID scanner.⁶⁷

The Defense Logistics Agency (DLA) is engaged in an AIT project called Advanced HAZMAT Rapid Identification, Sorting and Tracking (AHRIST) which uses RFID and Radio Frequency Data Collection (RFDC) technology. AHRIST provides recognition and identification of regulated hazardous materials and can enhance product safety for hazardous items in addition to advancing compliance with several Titles of the Code of Federal Regulations: 10 (Energy), 29 (Occupational Safety and Health), 40 (Environment) and 49 (Transportation).⁶⁸ As with many other RFID applications, this will provide DLA with total visibility of its regulated hazardous assets throughout the logistics supply chain. Meanwhile, the Air Force is using RFID to support ammunition containers aboard prepositioned ships.⁶⁹

At a Military Operations in Urban Terrain (MOUT) training site at Fort Benning, GA, the Army is using an ultra-wideband (UWB) RFID system to track soldiers engaged

⁶⁵ Munsey, C. (2004). TACMEDS. Navy Times. 1 March 2004. Retrieved on March 1 from http://www.namrl.navy.mil/NAMRL_NEW_NEWS/TACMEDCS%20Navy%20Times%20March%202004.htm.

⁶⁶ Munsey, C. (2004). TACMEDS. Navy Times. 1 March 2004. Retrieved on March 1, 2006 from http://www.namrl.navy.mil/NAMRL_NEW_NEWS/TACMEDCS%20Navy%20Times%20March%202004.htm.

⁶⁷ Marine Corps Warfighting Laboratory. Medical Coordination System (TacMedCS) Fact Sheet. Retrieved on March 1, 2006 from <http://www.defenselink.mil/transformation/factsheets/TacMed.pdf>.

⁶⁸ Stephensen, A. (2001). Agile, focused and harmonized, DLA moves forward. Retrieved March 1, 2006, from http://www.findarticles.com/p/articles/mi_qa3766/is_200101/ai_n8944577.

⁶⁹ Military Information Technology. RFID: "In the Box" Visibility. Retrieved on February 28, 2006, from http://www.military-information-technology.com/print_article.cfm?DocID=168.

in combat training. The soldiers wear 900 MHz radios with GPS units that are used to track their outdoor movements, and they also wear RFID tags for indoor tracking. The radios then transmit the soldiers' GPS coordinates to RF receivers installed throughout the MOUT site.⁷⁰

The Air Force requested assistance from Northrop Grumman Information Technology to implement passive RFID technology within their global supply chain beginning with a project called Radio Frequency Military Shipping Label (RFMSL). Mark Reboulet, program manager for automatic identification technology at the USAF, was charged with initiating the RFMSL as a 30-day trial in selected locations, including Air Force bases in Charleston, South Carolina; Goldsboro, North Carolina; Dover, Delaware; and a depot run by the Defense Logistics Agency. Shipments were sent through an aerial port in Dover to two Air Force bases in Germany. “We wanted to demonstrate that we can track shipments through the entire supply chain without changing our business processes,” says Reboulet. “We sought to improve visibility in the shipping process without modifying field staff procedures.” The pilot implementation involved a collaboration of vendors’ products and services.⁷¹

Ultimately, DoD plans to use RFID as an integral part of a comprehensive suite of AITs which would allow accurate and hands-free data collection. The goal is to build a fully integrated, adaptive entity that uses state-of-the-art enabling technologies and advanced management information systems to automate routine functions – all of this in addition to achieving accurate and timely in-transit, in-storage, and in-repair asset visibility with the least amount of human intervention.⁷² RFID is a foundational technology on the path to achieving this vision as DoD moves toward a single, seamless, responsive enterprise visibility network that will be accessible across the network backbone and usable by both people and systems throughout the supply chain.

⁷⁰ RFID Journal. U.S. Army Uses UWB to Track Trainees. Retrieved on February 28, 2006, from <http://www.rfidjournal.com/article/articleview/1987/1/1/>.

⁷¹ RFID In Supply Chain Improves Military Cargo Visibility. Retrieved on April 7, 2006, from http://www.integratedsolutionsmag.com/Articles/2006_03/060308.html.

⁷² Army Logistitian. RFID Vision in the DOD Supply Chain. Retrieved from <http://www.almc.army.mil/alog/issues/MayJun05/rfid.html>.

C. DOD'S VISION FOR RFID

DoD and the services acknowledge that there are many benefits associated with RFID technology, and RFID benefits are usually seen in the areas of inventory management and visibility, operational improvements, shrinkage, and asset tracking. In addition to these benefits, DoD and the services have their own vision for applying RFID technology in their programs.

According to Assistant Deputy Under Secretary of Defense, Supply Chain Integration Mr. Alan F. Estevez:

The end state for the DoD supply chain is to be a fully integrated adaptive entity that leverages state-of-the-art enabling technologies and advanced management information systems to automate routine functions and achieve accurate and timely in-transit, in-storage, and in-repair asset visibility with the least human intervention.⁷³

OSDs vision is that DoD take a leadership role in its adoption of RFID technology. It will also be a critical part of a very comprehensive suite of automatic identification technologies that are currently being used to provide accurate, hands-free data capture – all in an effort to support the various business processes that DoD is incorporating in its supply chain enterprise. The suite includes, but is not limited to, the following technologies:

- Linear bar codes
- Two-dimensional (2D) bar codes
- Optical memory cards (OMCs)
- RFID tags
- Satellite-tracking systems.

Likewise, the Acting Under Secretary of Defense for Acquisition, Technology, and Logistics, Mr. Michael W. Wynne, who also serves as Defense Logistics Executive (DLE), in his RFID policy memorandum of July 30, 2004, stated that an RFID-capable DoD supply chain is a critical element of Defense Transformation and will provide a key

⁷³ Army Logistician, May-June 2005, RFID Vision in the DoD Supply Chain, Retrieved on 26 Mar 06 from <http://www.almc.army.mil/ALOG/issues/MayJun05/rfid.html>.

enabler for the asset visibility support down to the last tactical mile that is needed by warfighters.⁷⁴ Earlier, during a meeting with suppliers, Wynne commented that, "If you want to transform defense and you don't transform logistics, you're [foolish]."⁷⁵

At Naval Supply Systems Command (NAVSUP), Rear Admiral Alan S. Thompson, Director, Supply, Ordnance, and Logistics Operations Division, stated that the Navy's position is that return on investment (ROI), specifically cost savings, and contribution to readiness are paramount RFID investment considerations.⁷⁶ With that in mind, the Navy intends to take a measured approach to deploying passive RFID technology, targeting those applications that achieve a positive ROI. However, in their concept of operations for active RFID, NAVSUP wants to achieve, improve, and maintain ITV and TAV throughout the entire supply chain using active RFID as the enabler.

From an Army perspective, the Logistics Integration Agency (LIA - now the Logistics Transformation Agency - LTA) has globally installed RFID technology at selected sites to facilitate the tracking of containers as they move through the logistics pipeline. It is also being used to provide stand-off visibility of container contents.⁷⁷ Nonetheless, based on funding projections, it will be 2016 or perhaps even later before passive RFID will be fully implemented into the Army and Navy supply chain.⁷⁸ Additionally, the Army is transitioning from its Legacy Standard Automated Management Information System to the Single Army Logistics Enterprise System, and is currently evaluating if it makes good business sense to convert these legacy systems.⁷⁹

⁷⁴ Under Secretary of Defense, Radio Frequency Identification Policy dated July 30, 2004. Retrieved on March 27, 2006, from <http://akss.dau.mil/docs/Wynne%20Memo%20of%2007-30-2004.pdf>.

⁷⁵ RFID Journal. DoD Stresses RFID Cooperation. Retrieved on March 27, 2006, from <http://www.rfidjournal.com/article/view/674>.

⁷⁶ Navy AIT Program Office, Naval Supply Systems Command (NAVSUP), Navy RFID Implementation Plan dated 8 December 2005. Retrieved on March 27, 2006, from http://www.snt.navsup.navy.mil/documents/Navy%20RFID%20Imp%20Plan_8%20Dec%2005.pdf.

⁷⁷ DoD AIT Logistic <http://www.rfidjournal.com/article/view/674s> Office. DoD RFID Background. Retrieved on 26 Mar 2006, from <http://www.dodait.com/>.

⁷⁸ GAO. Better Strategic Planning can help Ensure DoDs Successful Implementation of Passive Radio Frequency Identification. Retrieved on March 30, 2006, from <http://www.gao.gov/new.items/d05345.pdf>.

⁷⁹ Ibid., 30.

The Marine Corps' vision is to integrate existing and new technologies into standard Automated Information Systems (AISs) and use these technologies to support future logistics operations.⁸⁰ This vision is reflected in testimony of Brigadier General Edward G. Usher III, Director Logistics Plans, Policies and Strategic Mobility, before the House Armed Services Committee on Readiness regarding logistics. The endstate for RFID is full integration into the End-to-End (E2E) distribution process. One of the objectives is to use RFID technology to obtain visibility to the battalion level and push "tagged" shipments as far forward as possible.⁸¹

Like all of the other services, the Air Force has their vision for RFID as they work to meet the objectives of the OSD RFID policy. They are doing so by establishing an AIT architecture that provides an effective transfer of data from automated data collection capabilities to legacy systems and ultimately the Air Force Enterprise Resource Planning (ERP) system. According to their RFID implementation plan, the Air Force's vision for RFID is to provide real-time location and condition data, enabling instantaneous satisfaction of consumer demands through the development and initiation of RFID implementations that add value to their logistics processes. They hope to accomplish this through standardization, balanced effectiveness, efficiency, and ROI while focusing on RFID implementations that will enhance supply chain processes and total asset visibility. The Air Force recognizes that it might be difficult to show an ROI in their open loop supply chain that is linked with other services, government agencies, and industry; however, they maintain the position that ROI, specifically cost savings and contribution to readiness, are paramount investment considerations.⁸²

DLAs application of RFID has been limited to receiving and shipping processes at major supply depots; however, they envision passive RFID application in other areas to include materiel handling equipment control, shipment sorting, and inventory

⁸⁰ United States Marine Corps Radio Frequency Identification Tag Manual and Tag Placement Guide (Draft). Retrieved on March 27, 2006, from <http://www.mfp.usmc.mil/TeamApp/G4/Topics/20050921163451/RFID%20Manual%20Part%201.pdf>.

⁸¹ Global Security.org. Brigadier General Edward G. Usher III, Director Logistics Plans, Policies and Strategic Mobility, before the House Armed Services Committee on Readiness regarding logistics. Retrieved on March 30, 2006, from http://www.globalsecurity.org/military/library/congress/2004_hr/04-03-30usher.htm.

⁸² U.S. Air Force RFID Implementation Plan, Version 4.0, dated 17 November 2005, pg. ES-1.

management. These additional applications of RFID technology will be implemented as the technology matures and the agency achieves more experience in its use.⁸³

From a transportation perspective, according to Trish Young, the Deputy Director, Strategy and Policy for USTRANSCOM:

As the Department of Defense In Transit Visibility proponent, USTRANSCOM is always seeking to enhance the visibility of the distribution end-to-end logistics pipeline. For current operations, technology enablers like radio frequency identification, serve to bridge some current holes in terms of providing the warfighter full scale visibility coverage.⁸⁴

A number of DoD suppliers, including Boeing, Lockheed Martin, Northrop Grumman, GE Transportation, and Raytheon, have tested RFID or are running pilot projects in order to comply with DoDs RFID policy. In mid 2005, Boeing became the first defense contractor to support the DoD RFID initiative when they began utilizing RFID technology to improve their management of receipt of goods from the defense industry. Using the data for a shipment of F-15 parts, Boeing transmitted data electronically through DoDs e-commerce system, Wide Area Workflow. Although the use of this technology is not yet a contractual requirement, Boeing believes RFID will increase product value and tracking ability. "With that in mind, Boeing decided to move ahead with proving the technology and in support of the DoDs direction," says Steve Georgevitch, Boeing Supply Chain Manager. Eventually, Boeing says, RFID will result in reduced costs and quicker delivery, with total asset visibility the goal.⁸⁵

Likewise, Lockheed Martin, a major U.S. defense contractor, will use Zebra equipment and supplies to create smart labels for items it ships to DoD as they prepare for the DoD RFID mandate. In August 2005, they launched two major RFID pilots within

⁸³ Logistics. Success with active RFID. Retrieved on March 27, 2006, from <http://www.publicservice.co.uk/pdf/dmj/december2004/DMJ27%200307%20CraigRomero%20ATL.pdf>.

⁸⁴ USTRANSCOM. Radio frequency tagging helps track cargo. Retrieved on March 27, 2006, from <http://www.transcom.mil/pa/body.cfm?relnumber=030325-2>.

⁸⁵ Supply Chain Review. Boeing First DoD RFID Contractor. Retrieved on April 6, 2006, from <http://www.defencetransformation.com/cgi-bin/axs/ax.pl?http://www.supplychainreview.com.au/index.cfm?li=displaystory&StoryID=22674>.

the internal supply chains of their aeronautic and maritime business units. The maritime pilot was an in-depot operation that would RFID tag and track certain military ship parts made by the company. This supply chain begins with broken or faulty parts being sent back to the company for repair. Lockheed's second aeronautic pilot tracked products for military aircraft, ranging from fighter jets to utility planes, using RFID. The process included tagging the products at a receipt facility, where they then move to an inventory warehouse and on to a kitting facility for assembly into production kits, after which they move to the production floor.⁸⁶

Within DoD, funding for RFID will become a critical issue. In February 2005, DoDs contract with Savi Technology doubled from \$207.9 million to \$424.5 million, and the purchasing period was extended for two years until January 2008. This was due partly to the increased commitment and transportation of parts in support of the war in Iraq.⁸⁷ To that end, the Office of Management and Budget (OMB) is playing a significant role in DoDs transformation efforts because substantial resources will be needed to provide DoD with the funding necessary to fulfill its RFID vision. In the President's 2007 budget, OMB is targeting resources and restraining funding in selected areas of operation in an effort to improve programs and processes including enhancing Supply Chain Management.⁸⁸

These diverse visions for RFID are a result of the various and often urgent demands placed on the military services and other DoD components, and they need to be supported by the latest technologies. According to the Government Accountability Office (GAO), these components have made progress in developing policy and guidance to

⁸⁶ Data Monitor Computerwire. Lockheed Martin Launches Major RFID Internal RFID Pilots. Retrieved on April 6, 2006, from <http://www.computerwire.com/industries/research/?pid=5A4EEC6C-3E33-4600-877F-076ABE6DB755>.

⁸⁷ RFID Update. DoD Doubles Active RFID Spend to \$425M. Retrieved on April 8, 2006, from <http://www.rfidupdate.com/articles/index.php?id=1052>.

⁸⁸ Office of Management and Budget. Focusing on the Nations Priorities. Retrieved on April 7, 2006, from <http://www.whitehouse.gov/omb/budget/fy2007/defense.html>.

implement passive RFID; however, they are generally concerned about the unknown return on investment and have been hesitant about providing funding.⁸⁹

The application of RFID technology within DoD is poised to significantly impact and potentially improve the way service components, manufacturers, distributors, and retailers conduct business and interact with each other. It holds the promise for greater efficiency, control, and inventory accuracy. However, DoDs mandate is an attempt to make this a massive unified application and adoption of RFID. Although many companies are working diligently to refine specifications for RFID, this growing interest in implementation by so many different organizations and stakeholders in what can be seen as a very dynamic technology may be the factor that inhibits its advancement. An end-to-end focus is needed vice a segmented individual view.

In order to meet the requirements of the RFID policy, OSD developed a department-wide RFID concept of operations (CONOPS) which outlines the transformational role of RFID technology in DoD logistics, and articulates the specific uses of both active and passive RFID throughout the DoD supply chain. It calls for all DoD components to prepare a RFID implementation plan that encompasses both active and passive RFID technology which supports the DoD vision. However, a review of the components' plans revealed that there are conflicting goals between the OSD CONOPS and the DoD components' plans. The OSD CONOPS states that the implementation plans will be standardized, however there are marked differences between the military services plans.

Although the Navy has conducted a business case analysis and numerous pilots, it does not think that there is a compelling case to support a wide deployment of passive RFID in their environment. They plan to prioritize selected systems, nodes and platforms to maximize utility and minimize implementation investment and operational risk.

The Marine Corps has implemented active RFID in many of their business processes that support ITV for Unit Move, Sustainment (Resupply), and Prepositioning.

⁸⁹ Government Accountability Office. Better Strategic Planning can help Ensure DoDs Successful Implementation of Passive Radio Frequency Identification, pg. 29-30. Retrieved on March 30, 2006, from <http://www.gao.gov/new.items/d05345.pdf>.

However, their implementation of passive RFID is on a much slower pace. They will be conducting a series of pilots in relatively static organizations so that they place minimum burden on the operational forces. The first pilot will be in FY 2008 when they will test the capability of the technology. The second pilot is scheduled for FY 2009 and will evaluate RFID technology in conjunction with future logistics processes and Global Combat Support System-Marine Corps implementation. In 2010, they will initiate their third pilot at a Traffic Management Office followed in 2011 by the fourth pilot which will test deployed capabilities of RFID in their logistics operations in austere operational environments.⁹⁰

The Air Force's plans to implement active and passive RFID in areas where there is a positive ROI or discernable improvement on unit readiness. Their current schedule for implementing both passive and active RFID capabilities goes out to FY 2011.

The Army has a very well established active RFID architecture with more than 800 write sites and 1,000 fixed and mobile interrogator sites. However, they are only using passive RFID technology in select segments of their supply chain and they anticipate that widespread use is still several years away in a phased implementation. They want passive RFID read rates to be at or near 100 percent in reliability within Army tactical processes before the technology can be considered for use in transactions of record. Ultimately, the Army's plan for early adoption of passive RFID technology is "based on improving business processes and not solely to conform to broadly applied mandates or commercial initiatives."⁹¹

Collectively, the service components have complied with OSDs requirement to prepare a supporting RFID implementation plan that encompasses both active and passive RFID technology, yet their plans are not as aggressive as DoDs RFID Supplier Implementation Plan, which states that beginning January 1, 2007, RFID tagging will be required for all DoD manufacturers and suppliers who have new contracts. To date, OSD

⁹⁰ HQ, U.S. Marine Corps, Deputy Commandant, Installation and Logistics. USMC Radio Frequency Identification (RFID) Implementation Plan dated 13 February, 2006.

⁹¹ Department of the Army, Deputy Chief of Staff, G4. U.S. Army Strategic Plan for Implementation of Radio Frequency Identification (RFID) Technology. Version 2.2, dated November 18, 2005.

has not specifically delineated guidelines for internal DoD shipments between DoD locations, so the requirement to read passive RFID tags is only applicable to strategic distribution facilities such as DLA and maintenance facilities. Nonetheless, the RFID mandate appears to have motivated the DoD components to begin planning for the implementation of RFID throughout the supply chain. Although there is still some hesitation to fully incorporating passive RFID into the business process, without the OSD policy the components may have been slower to get their individual implementation plans in place.

OSDs policy can be seen as a strategic intent of what the department wants to achieve in the long term since it conveys a significant stretch for the DoD components, gives them direction and an opportunity to incorporate RFID into their business processes and the entire supply chain. It looks at tomorrow's opportunities and does not focus on today's challenges for implementing the technology, and this is something that is being dealt with by the components. OSD has laid out an ambitious vision without all of the details, and they expect all stakeholders to come on board. Perhaps the intent of their stretch goal is to motivate their components to give that extra effort to press on with RFID implementation.

IV. SITE IMPLEMENTATION OBSERVATIONS

A. OVERVIEW

1. Defense Distribution Depot, San Joaquin (DDJC), CA

DDJC is DLA's western Strategic Distribution Platform, with facilities at Tracy and Lathrop. The depot receives, stores, and ships supplies to military customers located mainly in the western U.S. and the Pacific Theater of operations, and in some cases worldwide. The San Joaquin Depot is one of two Primary Distribution Sites that belong to DLA's 26-depot Defense Distribution Center headquartered in New Cumberland, Pennsylvania.⁹²

As a Strategic Distribution Platform, DDJC serves as the west coast hub for distribution activities. It currently stores a wide range of supplies and equipment commonly ordered by the military services, including clothing and textiles, food, medical supplies, construction materials, electrical supplies and components, sonobuoys, tires for both aircraft and vehicles, and a variety of secondary repair parts. DDJC also operates DLA's west coast Consolidation and Containerization Point, consolidating overseas shipments from other defense distribution centers as well as from commercial vendors for all of the military services in the Pacific theater of operations.⁹³

2. FISC, Norfolk, Virginia, Ocean Terminal Division

The FISC Norfolk Ocean Terminal Division (OTD), Container Freight Station, operates a common-user DoD ocean terminal facility that offers a variety of waterfront logistics support. The division is comprised of two branches: the Ship Operations Branch and the Container Freight Station Branch. The Ship Operations Branch provides a pier-side presence and is responsible for conducting ship loading and discharging, including the receipt, staging, lift, stow, lash, discharge, and onward movement of a variety of cargo to their many stakeholders. Shipments of any less-than-release-unit (LRU) freight,

⁹² Global Security, Tracy Facility, San Joaquin Depot. Retrieved February 22, 2006, from <http://www.globalsecurity.org/military/facility/tracy.htm>.

⁹³ Defense Distribution Center, DDJC. Retrieved February 22, 2006, from <http://www.ddc.dla.mil/Sites/ddjc.asp>.

except explosives or refrigerated items, may be consigned to the FISC Norfolk Ocean Terminal for delivery to activities around the world.⁹⁴

The Ocean Terminal Division also receives less-than-container-load (LCL) shipments from military depots, military shippers, and vendors from throughout the continental United States (CONUS). These shipments are consolidated by consignee and destination, and are loaded into International Organization for Standardization (ISO) 20 and 40-foot SEAVAN⁹⁵ containers for transport via commercial sealift. The Ocean Terminal processes approximately 50,000 transactions annually with approximately 60 percent of those items being received from the Defense Distribution Supply Center Susquehanna, PA.⁹⁶

B. RFID BUSINESS PROCESSES

1. DDJC

DDCs two Strategic Distribution Platforms, Defense Distribution Depots San Joaquin, CA (DDJC) and Susquehanna, PA (DDSP) are the only two DLA sites with installed portals and have only been used for processing pre-arranged receipts. These implementations were carried out in response to the DoD supplier RFID implementation plan which mandated that goods shipped to DDJC and DDSP beginning January 1, 2005 must be tagged and the distribution depots must be capable of processing them.

DDJC also conducted a passive RFID pilot project that simulated the tracking of combat rations through 11 points along the supply chain and later validated tag placement for effective readability on vendor shipments of Individual Protective Equipment from DDJC to Blue Grass Army Depot in Kentucky. These pilots effectively demonstrated that the hardware and software were functioning properly, and that they could read tagged material at the unit pack and pallet levels. DoD was able to track the inventory in real-time throughout the entire simulated supply chain. Alan Estevez, the Deputy Under

⁹⁴ Ocean Terminal, Container Freight Operations. Retrieved on February 22, 2006, from http://www.nor.fisc.navy.mil/Code400/OceanTerminal/Ocean_Term.htm.

⁹⁵ A SEAVAN is a container owned and/or controlled by a commercial shipping company.

⁹⁶ Office of the Secretary of Defense. Initial Implementation analysis for Passive Radio Frequency Identification (RFID), version 1.0 of February 14, 2006. Retrieved on April 1, 2006, from http://www.acq.osd.mil/log/rfid/Initial_Implementation_Analysis_Final.pdf.

Secretary of Defense for Logistics and Material Readiness (Supply Chain Integration), called the successful pilot the "definitive RFID proof of principle that will dramatically enhance DOD's capability for end-to-end logistics."⁹⁷

Both depots also tested RFID hardware and connectivity by shipping Redistribution Orders (RDOs) to each other in an effort to determine if there were any problems in the system before receiving material from vendors. DDSP attached the RFID tags to the RDOs and sent e-mail notifications of the RFID tag numbers and associated Carton Control Numbers (CCNs) to DDJC. Likewise, DDJC emailed the tag numbers for the RDOs they shipped to DDSP. When the tagged material arrived at DDJC Warehouse 10, it passed through the RFID portal in order to test the communication between the portal software and the Equipment Control System. This process was repeated at the DDSP warehouse. At the time of the authors' site visit, there were five portals installed at DDJC and, according to management, the depot needs 20 to cover the warehouses that will be processing material.

Each portal consists of a Matrics AR400 multi-protocol reader with 4 antennas, a Venture Research I/O Controller, a photo-eye and a light stack.⁹⁸ The installation consisted of RFID-enabled portals at dock doors and conveyors with GlobeRanger's iMotion Edgeware software platform. As material is being received, the iMotion orchestrates the procedure of the photo-eye initiating the receiving process by turning on the RFID reader and updating the light stack, signaling that the portal is ready for receiving. When the EPC Class 0 and Class 1 tags are detected, additional feedback is provided to the forklift operator and tag reads are filtered and aggregated into Application Level Event (ALE) Reports. The data is then routed to the DSS database for Track-and-Trace reporting.⁹⁹ There was only an 80 percent read rate for material shipped between depots so DDJC has upgraded their system to read Gen 2 tags to try to improve read rate accuracy.

⁹⁷ RFID Journal. DOD Completes Successful Pilot <http://www.rfidjournal.com/article/articleview/828/1/1/>.

⁹⁸ Globeranger. DoD Gears up for RFID at the Defense Logistics Agency Depots. Retrieved on April 23, 2006, from http://www.globeranger.com/documents/FINALDOD_noboothnumber.pdf.

⁹⁹ Globeranger. DoD Gears up for RFID at the Defense Logistics Agency Depots. Retrieved on April 23, 2006, from http://www.globeranger.com/documents/FINALDOD_noboothnumber.pdf.

Unlike the OTD, DDJCs receiving process is automated and utilizes a conveyor system to move material throughout several of the warehouses. Tagged cases and pallets are read as they are received through dock doors and individual parcel cases are read after placed on conveyor belts. A “tail-gate” date is established using the RFID tag date, and at that time DDJC assumes ownership and responsibility for the material, and the payment cycle is initiated. The RFID data is also reconciled against serialized Advanced Shipment Notices (ASN) which improves order fulfillment accuracy and inventory visibility.

In receiving small parcels at Building 16, these items are passed through a window at the front of the building and placed on a conveyor which passes through the RFID portal. They then continue on the conveyor and personnel segregate the material into colored tote bins (red, blue, and green) and a sheet of colored paper is attached to each tote which indicates the receiving date of the material. This receiving conveyor system, Automated Weigh and Offer Station (AWOS), uses a Holo Track system that provides a mechanized sort capability which links the small parcel carrier and the existing small parcel receiving conveyor system. The system significantly minimizes the amount of manual sortation needed for processing small parcels. Although the system provides 13 sort lanes with diverters and workstation equipment to process the material, all packages are diverted through one lane on the conveyor belt because DDJC does not have the resources to operate all 13 installed lanes.

Small parcels are shipped out via FedEx, UPS, and Emery Worldwide (now a UPS subsidiary), and these companies receive and load their own packages at the doorways. In the case of FedEx, a series of their tracking numbers were assigned to DDJC and they are loaded in the DSS. The tracking number is printed on the DDJC bar coded shipping label and ties the tracking number to the DDJC TCN. This is called a power ship label. Currently, UPS is not participating in the tracking number program. The data on the tags are tied in with the 856 (Ship notice/manifest transaction) in DLAs DSS and the receipt is processed. The 856 links supplier RFID tag ID to supply/transportation/UID data. Data sent to DSS feeds the Global Transportation

Network (GTN) and the Global Air Transportation Execution System (GATES) through 856 transactions. At this time, RFID is not being used for inventory management at DDJC.

DSS is an automated information system that manages all functional business processes of DoDs warehouse operations including receipt, storage, consolidation, packing, shipping, inventory, inspection, and workload management. Both commercial-off-the-shelf (COTS) software packages and developed application software are a part of the system. The DSS also supports the JV2010 concept of focused logistics by bringing all of the DoD distribution depots under the same joint, automated process, taking advantage of advanced business practices, systems integration, and global networks.¹⁰⁰ Also, the collection of tag data populates many databases that contribute to total asset visibility within DoD. In addition to RFID tags, all items have bar coded labels attached.

At the Consolidation and Containerization Point (CCP), material comes to the induction table and is sorted via automated shoots. Items shipped from CCP are bound for overseas (OCONUS) locations and are loaded and shrink-wrapped onto Air Force Air Lines of Communication (ALOC) pallets to which active SAVI RFID tags are attached.

In evaluating the RFID implementation process at DDJC, it was noted that they have the ability to receive and ship material using both active and passive RFID tags at this time; however, in an interview with management, there is currently no significant amount of benefits being realized from the passive RFID implementation because it is not a part of the activity's daily business practices. DDJC is currently not receiving tagged material from vendors or other distribution centers.

There are currently plans for the site to participate in an RFID pilot with the University of Alaska Anchorage (UAA); however, at the time of the authors' visit, the CONOPS was not in place.

¹⁰⁰ Global Security. Defense Distribution System. Retrieved on March 27, 2006, from <http://www.globalsecurity.org/military/library/budget/fy1997/dot-e/other/97dss.html>.

2. Ocean Terminal Division

The CFS processes approximately 50,000 export shipment units annually into approximately 3,000 SEAVAN containers. These shipment units range in size from single small envelopes to large multiple-pallet configurations. Each shipment, regardless of size, requires the same documentation and manifesting steps when received at the terminal and loaded into a SEAVAN container. Each piece of every shipment loaded into a SEAVAN container must be accounted for to ensure the manifest created for that SEAVAN reflects an accurate representation of the contents.¹⁰¹

During an interview, management stated that OTD wanted to be on the cutting edge of RFID technology, and to accomplish this goal they volunteered to become the first DoD site to prototype the use of passive RFID technology in a live transshipment environment. Initially, the testing at the Container Freight Station was planned as a short-term quality control initiative to gain material visibility within the facility and identify potentially undocumented shipments in SEAVAN containers. There were ongoing concerns about inaccuracies in the on-hand inventory journal for the terminal and an unacceptable number of shipments were being loaded into SEAVAN containers without being properly documented on the manifests. These errors potentially reduce a consignee's ability to utilize in-transit visibility (ITV) data to properly plan for receiving and facilitating foreign country customs clearance. To correct the problem, passive RFID was implemented. The project achieved passive RFID read rates exceeding 85 percent and overall business process effectiveness of 100 percent manifest accuracy. After demonstrations to senior DoD officials that the project had been successful, the decision was made to expand the in-house pilot to an official Navy initial implementation of passive RFID.¹⁰² These efforts occurred during a time when material shipments to the Gulf region required greater levels of visibility in the logistics pipeline, and there were

¹⁰¹ NAVSUP, FISC, Norfolk, VA, Final Report of the Passive Radio Frequency Identification Project at the Fleet and Industrial Supply Center, Norfolk, Virginia, Ocean Terminal Division. Retrieved on February 14, 2006 from <http://www.acq.osd.mil/log/rfid/FISC%20Norfolk%20OT%20Report%20v8.pdf>.

stricter customs documentation requirements for clearing cargo coming into allied countries. With a history of documentation errors, improving manifest accuracy was essential.

Currently, the requirement to read passive RFID tags is only applicable to strategic distribution facilities such as DLA and maintenance facilities, so material going to the OTD does not have an RFID tag except for those being shipped from DDSF. Beginning in 2007, all material being shipped to the OTD must have a RFID tag. The process begins at the receiving section where RFID tags are affixed to each piece in a shipment and the corresponding Electronic Product Code (EPC) is linked with the appropriate TCN and piece number in the Ocean Terminal Management System (OTMS) – a program that was locally developed by the management, the Transportation Systems Analyst who manages the RFID program. Tags are used to process all shipments except household goods, with classified material being handled at a separate site, and outsized shipments going to the outside storage area.

The initial implementation started with Alien Technology equipment because NAVSUP, who was providing the funding, had already initiated testing Matrics technology at another activity. The portal system included an Alien Technology four port reader and Alien Class 1 EPC Tags; currently there is only one in place. Now that the investment has been made with this brand and there is no additional funding available to change systems, there is no plan to expand the operation at this time. According to management, the process is at its maximum state with the current hardware.

Nonetheless, the OTD has designed and is testing, time permitting, a second experimental system that they developed with a different antenna configuration. It is a metal turntable on which a pallet is placed and then has to be manually turned so that the reader can read the tags. Four antennas are arranged on the left side of the portal and are stacked vertically with the reader overhead. If there is any discrepancy in the number of tags read, then the checker has to manually turn the load until the remaining tags are read.

¹⁰² NAVSUP. Final report of Passive Radio Frequency Identification Project at the Fleet Industrial Supply Center, Norfolk, Virginia, Ocean Terminal Division. P. 10. Retrieved on January 6, 2006, from <http://www.acq.osd.mil/>.

This is a very labor intensive process. Forklift operators have to ensure that the pallet is properly placed on the table, centered and balanced so that it can be turned. This process had only been in place for two months at the time of the authors' visit, and it was only tested when the checker had the time, such as during a slow period. This is not a very efficient process because of the logistics of properly placing the pallet on the turntable.

The size of material in a shipment can range from a small envelope to multiple pallets, and all material is moved via forklift with nothing being depalletized or processed on high-speed conveyors or automated sortation equipment. As each shipment is received, a label is printed for each item in the shipment. A passive RFID tag is then scanned and assigned to that piece and OTMS links the tag identification number to the TCN and piece number of the shipment. The stuffing portal utilizes the OTMS software and the system is operated by a 'checker'. This individual is responsible for managing several drivers as they load material into their assigned SEAVANS. When a driver is assigned to load a specific SEAVAN, the operator creates a record in OTMS linking the driver's code to that SEAVAN. The record also includes information from the Worldwide Port System (WPS) regarding the consignee and port of debarkation (POD) for the container. As a driver prepares to go through the tunnel with freight, the operator activates the system and pulls up the appropriate record. Computer monitors in the tunnel provide visual feedback as to the status of the read. When the correct number of tags has been read, OTMS interprets input from the EPC reader and updates a transaction list which is approved by the checker.

When drums or other items are not read as they pass through the portal, the driver must return to the entrance of the portal and drive the items through again. If they still do not read, he goes back to the checker and she uses a handheld scanner that is tethered to her workstation to read the tag. This can be a time consuming process and was repeated numerous times when bulk metallic objects were being processed in the portals. This is indicative of the importance of the correct placement of tags on the material. It determines the ease or difficulty of the tag being read and can expedite or slow down the scanning process. The initial read rate accuracy was 85 percent.

Once all tags are read, an audible notice is given to release the driver, the checker selects OTMS and a load ticket is generated which the driver removes from the printer at the end of the portal. This is the proof that the driver has completed the process, and it is attached to the load after he gets to the container that is being stuffed. The container is then stuffed by a separate individual, secured and braced with wood, and the entrance is boarded up, indicating to the supervisor that the loading process has been completed.

OTMS captures all data that is associated with the scanned shipments and consolidates it as it updates both the shipment and container records in the Worldwide Port System (WPS) as necessary. Upon completion of container loading, a hardcopy of the container consist list is printed and affixed to the inside of the container door. The consist information is also written to a DoD In-Transit Visibility (ITV) active RFID tag which is then fastened to the outside of all containers going to the CENTCOM area of responsibility, and a seal is placed on the lock. The container is now ready for shipment.

In evaluating the installed RFID system at the OTD, it is only being utilized in the container stuffing process to ensure manifest accuracy and accountability of items being transshipped. Since no tagged material is being received, RFID is not a part of the receiving process and they continue to scan the bar coded labels that are attached to the majority of the material they receive. Even though the OTD is one of DoDs frontrunners for implementing RFID, their passive tags are only for internal use at this time. It is only the active SAVI tag that is attached to the outside of the SEAVAN that is being read by other activities.

C. REALIZED BENEFITS

The OTD experienced several benefits from the implementation of passive RFID including an overall improvement in their operational efficiency. First, by doing away with the handheld scanners they were able to process material faster because in most cases, the checker no longer has to individually scan bar codes. With an EPC-enabled stuffing process, they were able to go to a single dedicated checker as opposed to a separate checker for each SEAVAN being loaded. The portal serves all containers being loaded. This reduced manning, even during peak operating hours, allowed them to reallocate as many as twelve personnel within the organization to areas such as frustrated

material processing and driving. Under their legacy procedures, they were often supplemented with Naval Reservists or Stevedores from the Division's Ship Operations Branch. Another benefit from the implementation of the RFID portals was an improvement in shipment accuracy for the containers that were processed using RFID vice scanning the bar codes.¹⁰³ Other benefits of implementation include a reduction in manual employee intervention in processing outbound shipments, increased manifest accuracy, and increased efficiency of the checking process. They have mitigated the problem of shipping material that is not properly documented.

For the pilot period that DDJC utilized their RFID portals to receive material, they observed some warehouse management improvements when the RFID tag was automatically read at conveyor speed. This allowed for identification of the contents of the case without manual reorientation. Warehouse efficiency was also improved because there was a reduction in the number of times workers handled a case to determine its contents. These changes created process improvements that reduced warehouse cycle times.

Another benefit was the improvement of the delivery receipt and reconciliation process. RFID provided automatically gathered, accurate information about the contents of shipments which made it possible to ensure that the correct material was received. This facilitated improved shipment receipt reconciliation and allowed for the timely identification of discrepancies. It should be noted that the tagged material shipped between DDSF and DDJC and those received from vendors such as Lockheed-Martin, who volunteered to ship tagged material to the site during their pilot projects, were processed in a very controlled environment with emails going back and forth to notify all involved that the material was enroute.

D. REALIZED CHALLENGES

As with the implementation of most new technology, many challenges abound for RFID. The technology is becoming more pervasive, and when you add the significant

¹⁰³ NAVSUP. Final report of Passive Radio Frequency Identification Project at the Fleet Industrial Supply Center, Norfolk, Virginia, Ocean Terminal Division. p. 27. Retrieved on January 6, 2006, from <http://www.acq.osd.mil/log/rfid/FISC%20Norfolk%20OT%20Report%20v8.pdf>.

transaction volume it will generate, the results are some important technological challenges. These may be experienced in the areas of scalability, where data bases will need to process input from thousands of readers which are distributed across the DoD global supply chain, system availability, interoperability, integration, and administration.

One of the immediate challenges for RFID implementation that DoD components are facing is training. Increasingly, these components are exploring options for making better use of all that RFID has to offer, and many have come to recognize that a number of the benefits of the technology – better supply chain visibility and inventory management – will be realized only by devising a long-term strategy beyond compliance. What is essential for that long-term strategy is investing in the necessary training and professional certification for those personnel who will be implementing and utilizing these innovative RFID solutions. Lack of training or inadequate training can significantly compromise the implementation and utilization of the technology.

RFID is a complicated and evolving technology; therefore, expertise is absolutely essential for its usage to be a success in any organization. Personnel utilizing these systems must have the skill sets and “need-to-knows” related to RFID, of which there are many. According to a survey of solution providers, consultants, and systems integrators conducted by the Computing Technology Industry Association of America (CompTIA), the number of individuals skilled in RFID continues to fall short of demand, and companies will need to devote more time and dollars to training and education.¹⁰⁴ Anyone who is involved in a functional process that utilizes RFID, such as populating tags with data or interfacing with RFID architecture equipment or data, should have the necessary training for the business process to be effective.

During site visits, it was observed that most personnel who utilized the RFID related equipment only had the most basic knowledge about operating the system. The wealth of the expertise resided with one individual. In the case of the OTD, the authors were referred to management whenever a question was raised about the equipment and

¹⁰⁴ Var Business. RFID Skills in Demand, Survey Says. Retrieved on April 18, 2006, from <http://www.varbusiness.com/sections/governmentvar/govt.jhtml?articleId=181401217>.

operation of the system. Although training an apprentice, many questions were deferred to management. The same situation was observed at DDJC.

What has become a definite challenge for some sites is the integration of RFID with the Navy-Marine Corps Intranet (NMCI). The NMCI implementation is a paradigm shift as computer ownership was removed from individual Navy commands and outsourced to Electronic Data Systems (EDS) of Plano, Texas. With the implementation of RFID, the OTD was faced with a dilemma. Their operating system utilizes the NMCI, and the contract with EDS includes Service Level Agreements to meet Naval Information Technology (IT) service requirements. At the time of RFID implementation at OTD, the readers were not an approved NMCI network device. Without a contract line item number to support them as an ordered service, they could not be hung off the existing Ethernet network. A workaround was devised which required NMCI-approved USB hubs and multiple USB-to-serial converters.¹⁰⁵

It was discovered during the site visit that gaining access to the NMCI system was a very long and complicated process for the OTD. NMCI Network Access and system change request procedures were complicated and take a significant amount of time and effort to complete. The activity has to submit several documents including a Request for Modification (RFM), a Configuration Change Request (CCR), and a System Security Authorization Agreement (SSAA) which links the SCR process into the NMCI approval. Making even the most basic request for changes was difficult and lengthy at best.

Another issue that proved to be complicated by NMCI was the portal location. The best location for the device in the warehouse would be between the staging area and the stuffing doorways; however, that location did not have an existing NMCI drop so a request to install a drop would have to be made. It has been over 12 months since the OTD has submitted a request to relocate a drop so that they could place their portal closer to the stuffing gates, and at the time a visit was made, no approval had been received. Management stated that previous requests for NMCI network drops had been submitted

¹⁰⁵ NAVSUP. Final report of Passive Radio Frequency Identification Project at the Fleet Industrial Supply Center, Norfolk, Virginia, Ocean Terminal Division. P. 25. Retrieved on January 6, 2006, from <http://www.acq.osd.mil/log/rfid/FISC%20Norfolk%20OT%20Report%20v8.pdf>.

and still had not been approved after two years. The portal was ultimately located in a less than ideal position near the receiving doorways that already had workstations installed.

Another challenge can be seen in the ongoing planning and execution of each components implementation plan as they quickly come up against OSDs aggressive schedule. Integrating RFID into legacy information systems can be a lengthy process, and the components have implementation plans that extend beyond the January 2007 goal set by OSD. At the time of the authors' site visit, the OTD was still utilizing the equipment they procured for the initial pilot with no immediate plan to expand or upgrade since funding was not available in the current fiscal year's budget. The bulk of the funding for the pilot was provided by the Navy AIT Steering Group and Office of the Assistant Under Secretary of Defense for Supply Chain Integration funds. Likewise, DDJC did not have any near term plan to expand the amount of RFID equipment installed in their warehouses.

Tag placement on metal containers such as drums, containers holding liquids or dense material proved to be a significant challenge as they affect the readability of the tags. It took many trials before the OTD identified an optimum location where tags could be accurately read. Current practice is to attach the EPC tag to a hanging tag, otherwise known as a toe tag, or attaching it to a foam spacer. Rubberized items such as tires are shrink-wrapped and the tag is placed on an area where there is a space between the rubber and the plastic wrap itself. Although this improved the read rate of these items, there were occasions observed when these types of material had to be manually scanned. Tag manufacturers are testing new tags to improve their readability when used in these applications, and eventually this problem could be eliminated.

One of the problems that noted during the site visit at the OTD is the large quantity of frustrated material which is a result of receiving material with insufficient data on the shipping or packing documents or the documentation is missing. Although the majority of this material is eventually identified, extensive research must first be conducted before the material is directed to the ultimate consignee. According to

management, OTD is forced to receive material that is not properly documented because it is a transshipment point and receiving personnel have two hours to complete the receipt of each shipment.

Any delays beyond the two hour timeframe can result in the assessment of penalties. The bulk of the frustrated material observed were commercial packages, many of which are shipped from GSA under the GSA Advantage program or material ordered by DoD customers using their Government Purchase Card. Commercial suppliers filling these purchases are not systematically required by the DoD activity ordering the item to provide adequate information on their shipping documents. OTD holds regular meetings with GSA to address this problem; however, the discrepancies continue. Discrepancies are identified after the delivery has been made and the shipper has left. Truck drivers delivering the material have no additional information about the shipment other than what is included in the Bill of Lading. The level of data required to complete the transaction to transship the material is not available and receiving personnel are unable to identify the consignee.

With so few details about the contents of the packages, each must be opened to determine if there is additional documentation inside and the material is then placed in the frustrated in-route location. If there is a packing list enclosed or other documentation, it is forwarded to the Customer Service Section for further screening and research which includes contacting the shipper to try to obtain consignee information so that the freight can be transshipped. When identification is made, documents are returned to the receiving section and the receiving process is completed to include the generation of a FISC TCN bar coded label and the assignment of an EPC tag if applicable.

In accordance with current DoD regulations, Government Purchase Cards may be used to acquire items on existing government contracts as well as acquire items directly from suppliers that are not on a specific government contract.¹⁰⁶ This means that material that is not under a government contract does not have to be tagged. Nonetheless, this will

¹⁰⁶ Office of the Secretary of Defense. United States Department of Defense Suppliers' Passive RFID Information Guide, Version 8.0. Retrieved on April 22, 2006, from http://www.acq.osd.mil/log/rfid/DoD_Suppliers'_Passive_RFID_Information_Guide_v8.0.pdf.

be a small portion of the material received at the OTD. The extent of this problem of frustrated material could be minimized when the OTD begins receiving tagged material and perhaps change their business processes to include receiving using passive RFID. Any material that is frustrated has no visibility and the extended delay can cause the requisitioner to place a second order. At the time of the authors' visit, management stated that there was no plan to incorporate the use of passive RFID in their receiving processes. They will continue to process incoming shipments by scanning the bar codes.

E. POTENTIAL APPLICATIONS

Several areas were observed during site visits where the authors felt additional applications of RFID could improve the business processes. First, there is the option of using smart shelves in inventory management at distribution centers such as DDJC. A smart shelf has an integrated RFID reader and is stocked with tagged items which allow the reader to track inventory levels. The objective is to support replenishment, ensure that the shelf is never empty, facilitate real-time inventory management and continuous inventory awareness, and monitor the issue rate. When the inventory reaches a set low limit, a message alert is transmitted and an automated reorder is generated to minimize stockouts.

At the OTD, receiving is the initial touch point for accepting shipments. As passive RFID-tagged material is delivered to the gateways, pallets could pass through the portals via forklift as they move into the warehouse and the tag data is captured. This information is transmitted to OTMS which visually displays the receipt of material in addition to providing a screen check-off feature to represent the receipt of each tag that was read. If this system is fully implemented, the hands-off read capability and receipt processing feature would eliminate the need for any handheld receipt scanning, saving a significant amount of time and effort in the overall material receipt process. This capability would be coupled with the ability to quickly identify the contents of a package. This feature could also be incorporated into DDJCs receiving process and DSS, and the data could include not only the contents of a package, but its stow location via integration

with a smart shelf unit. The benefits of such a system would be improved data timeliness, material accountability and asset visibility in addition to a significant reduction in the manual labor of receipt processing.

Finally, a primary objective of RFID-based systems is to provide real-time visibility throughout the supply chain. To accomplish this, distribution centers and transshipment activities need to become fully integrated parts of the real-time, RFID-enabled supply chain. Therefore, DDJC and the OTD will need to make the best fit of available RFID capabilities within their operation as they receive, store, locate, use, and ship material to and from facilities that may be located in the most remote corners of the globe.

V. RFID COMPLIANCE VARIANCES WITHIN DOD

One of the goals of implementing RFID is to improve an organization's business processes through the application of technology because by itself, RFID will not improve the functionality of the supply chain. Each DoD component has been examining their processes to determine what the most effective ways are to incorporate RFID technology into the context of their operation.

As a whole, the various components, specifically the Navy, Army, Air Force, Marine Corps, DLA and USTRANSCOM, agree that they support the DoD vision for RFID within the supply chain. OSDs desired end state is a fully integrated, adaptive entity that uses state-of-the-art enabling technologies and advanced management information systems to automate routine functions and achieve accurate and timely in-transit, in-storage, and in-repair asset visibility with the least amount of human intervention.¹⁰⁷ However, as the components move out with their individual implementation plans, several aspects of these plans do not comply with OSDs guidelines.

Comparative analysis between OSD and the DoD components is primarily based on a thorough literature review of the various implementation plans. In addition, the results from several DoD and GAO reports and other RFID related documents were reviewed, and on-site analysis at DDJC and the Norfolk FISC OTD were conducted.

The GAO conducted an extensive study about passive RFID implementation within DoD and generated the report "Better Strategic Planning Can Help Ensure DoD's Successful Implementation of Passive Radio Frequency Identification," GAO-05-345, September 2005. The report compared OSD and DoD implementation plans.

¹⁰⁷ Alan F. Estevez "RFID Vision in the DoD Supply Chain." Army Logistician, May-June 2005. Retrieved on May 7, 2006, from <http://www.almc.army.mil/ALOG/issues/MayJun05/rfid.html>.

In conducting analysis for this thesis, RFID variances were categorized into six areas:

1. Vision – the desired future state of RFID.
2. Approach – perceptions and intentions.
3. Assumptions – best case scenario.
4. Risks and challenges – theoretically accepted possibilities for DoD and its components and actual experiences of DDJC and OTD.
5. Application areas and benefits – projected and actual.
6. Guidance and timeline – how the activities have been guided to date by DoD.

The question of “what” as it relates to the variances is now answered. The results of the authors’ analysis are summarized below in Table 3.

Area	OSD	Components	OTD	DDJC
Vision	- Industry leader - Wide-spread integration - Convinced - Business perspective	- No unique vision - Reluctant about widespread integration - Uncertain -Military/Operational perspective	- DoD leader - Internal implementation - Convinced -Business perspective	- No unique vision - Partial implementation - Unconvinced -Military perspective
Approach	- Proactive - Early-adopter - Phase-based - Power to shape the technology and standards - De-centralization	- Reactive - Wait and see - Mandated - Positive ROI and cost savings - “Child “ of OSD - Centralization	- Proactive - Self-initiated - Determined - Follow the technology - Centralization	- Reactive - Mandated - Centralization
Assumptions	- Many assumptions - Ignores the risks and challenges	- Realistic - Defining DoDs assumptions as risks and challenges	- Experiencing the trials of implementation - Pessimistic	- Experiencing the trials of implementation - Pessimistic
Risks / Challenges	- No projected risks/challenges - Ignores existing risks/challenges	- Projected many risks and challenges - Uses R&C as reasons for inaction	- Resolved many of the challenges	- Not ready for future challenges
Application Areas and Benefits	- In-transit - In-storage - In-repair - In all logistics nodes - Open-loop implementation - No need to pilot implementation	- Mostly in-transit - Many pilot implementations planned, only a few for in-storage and in-repair - Closed-loop implementation - Suspicious about the benefits	- Partial in-transit - No planned further application - Closed-loop implementation	- Partial in-transit - No plans for further applications - Suspicious about the benefits
Guidance	- Policy guide, CONOPS, web-site, summits, analyses, working groups	- Implementation plans - Slow motion - Low investment	- Good training program - Little Procedural documentation	- Little training - HQ DLA provides support and guidance

Table 3. Summary of a Comparative Analysis of RFID Compliance Variances within DoD.

A. VISION

As previously discussed, DoD and its components have a diverse vision for passive RFID. DoD's vision is "To have a widespread integration of RFID into the business processes where appropriate in the supply chain as a part of AIT technologies."¹⁰⁸

DoD wants to have passive RFID implementation throughout the entire supply chain so that all nodes may benefit from the value that the technology can provide with the cost burden divided among the various components. The significant contribution of active RFID to ITV has already been proven, and it has inspired DoD to use active and passive RFID together from end-to-end in its supply chain in order to improve accuracy, timeliness, and inventory management. As an early adopter of active RFID within military logistics, in addition to a strong conviction of passive RFID, DoD was motivated to take the leadership position of passive RFID adoption in order to have a key role in the RFID industry.¹⁰⁹ The top executives from OSD followed the industry applications of passive RFID very closely and then shaped their vision from a business perspective which resulted in similarities between the DoD and Wal-Mart mandates.¹¹⁰

DoD components are generally committed to active RFID technology because it has been tested and utilized in the field for many years. They share a similar vision and are highly motivated to follow the OSD vision. However, the situation is different with passive RFID implementations. DoD components do not have a unique vision for passive RFID that conforms to and complements OSD's vision. In contrast to OSD, component visions are affected by their military perspective, and at this time they may be employing just enough effort to meet the requirements of the DoD mandate, particularly if there are technical, personnel or financial constraints. Because the law assigns logistics

¹⁰⁸ Office of the Secretary of Defense. Department of Defense Concept of Operations (CONOPS) for Radio Frequency Identification (RFID), version 2.0 of September 15, 2004.

¹⁰⁹ Office of the Secretary of Defense. Final Regulatory Flexibility Analysis of Passive Radio Frequency Identification (RFID), version 1.0 of August, 2005. Retrieved on April 1, 2006, from http://www.acq.osd.mil/log/rfid/EA_08_02_05_UnHighlighted_Changes.pdf.

¹¹⁰ Emeterio V. Hernandez & Christopher A. Thomas, Investigating the Department's of Defense's Implementation of Passive Radio Frequency Identification (RFID), MBA Professional Report, December 2005.

responsibilities to individual components, there is generally not a wide integration of DoD logistics. DoD components do not appear to be completely sold on the technology at this stage of its development and appear to be hesitant with their implementation plans as they look for benefits from passive RFID in areas such as positive ROI and cost savings, significant contribution to readiness, and close to 100 percent read accuracy.

One factor that has impacted the sites observed is the Office of Management and Budget (OMB) Circular A-76, *Performance of Commercial Activities*, which deals with how to carry out competitive sourcing. DoD uses the A-76 process to determine the most effective and efficient way to do certain types of work (functions) done by Federal employees. A cost comparison competition determines if the function will continue to be done by Federal employees or contractors. Regardless of who wins the competition, employees will see changes in their job requirements or some duties may be dropped altogether.¹¹¹ During the site visit to OTD, the organization was undergoing an A-76 study. With a potential future reduction in the labor force, this may have been one of the driving factors for aggressively pursuing more automated technologies such as passive RFID. An added benefit would be reduced costs in the long run, which are one of the desired goals of the A-76 process.

The initial vision of OTD was to become the frontrunner in the implementation of passive RFID within DoD. OTD began their pilot implementation and incorporated RFID into their business processes even though DoD did not have a passive RFID policy. In addition, they are not required to have read capability until 2007, when they will begin receiving tagged material. Their degree of conviction in implementing the technology has been strong and they have implemented passive RFID to the maximum extent possible with the funding they received. The current focus of the OTD is to continue using passive RFID for internal transactions. However, as they receive tagged material, they will continue to be plagued by the external factors that have contributed to their

¹¹¹ Office of Strategic Management and Planning. A-76/Competitive Sourcing. Retrieved on May 7, 2006, from <http://osmp.od.nih.gov/a76.asp>.

challenge with frustrated shipments, e.g. material without the necessary documentation to identify the ultimate consignee. This could be minimized by incorporating an RFID portal into the receiving process.

As for DDJC, the authors came away with the same impression that they had of the other DoD components – that they do not have a clear vision about RFID implementation. After being designated as an implementation site, DDJC received a limited amount of tagged material from DDSP which they used to test that the tags could be read successfully and that the data was exchanged accurately. Today, the portals are still in place and this satisfies the DoD mandate, but DDJC no longer receives tagged material so their RFID system is not being utilized as envisioned by OSD. Relative to OTD, DDJC has more potential application areas and a much larger volume of transactions. The consequences of a successful implementation could result in significant cost and time savings as well as inventory reduction. However, there were no obvious additional efforts being made or much enthusiasm or interest in potential future implementations such as in inventory management.

B. APPROACH

Rather than waiting for future improvements, maturity of the technology, and the reactions of the industry, OSD adopted a proactive approach to realize its vision. They have been closely monitoring different business applications of the industry and incorporating what they consider the best options into their processes in an effort to improve efficiency, accuracy, timeliness, and to reduce costs.

OSD first analyzed the passive RFID technology and its adoption and developed three alternatives:

1. The market adopts passive RFID without DoD involvement.
2. The market adopts passive RFID with DoD involvement according to a phased implementation plan.

3. The market adopts passive RFID with DoD involvement according to an immediate implementation plan (no phasing).¹¹²

OSD chose the second alternative and became an early proponent of the technology and its standards in a way that reflects unique defense requirements, and initiated movement towards a phased-based implementation. It also considered the costs of the alternatives and came to the conclusion that late-adoption would result in higher costs.¹¹³ On the other hand, OSD does not want to manage the implementation from the Pentagon. They believe that their vision has been deployed and that there are sufficient guidelines, including all of the necessary management tools such as goals, objectives, metrics, and timelines in place that components can follow. According to the OSD, the remainder must be accomplished by the components.¹¹⁴

Active RFID implementation was initiated in response to a military need. However, at this point, passive RFID has been viewed to a great extent as OSDs “baby” by the components, because they were rarely involved in the decision-making processes of DoD-wide passive RFID implementation.¹¹⁵ Consequently, they are totally reactive to the requirements as mandated, and they have no incentive at this time to accomplish more. The approaches of the components can be described as “wait and see.” In addition to demonstrating that they do not want to be early-adopters in the industry, they are reluctant to be early-adopters within DoD.

The components do not agree with the cost analysis done by OSD and they continue to stress that they want to see a positive ROI, cost savings, and contributions to

¹¹² Office of the Secretary of Defense. Final Regulatory Flexibility Analysis of Passive Radio Frequency Identification (RFID), version 1.0 of August, 2005. Retrieved on April 1, 2006, from http://www.acq.osd.mil/log/rfid/EA_08_02_05_UnHighlighted_Changes.pdf.

¹¹³ Office of the Secretary of Defense. Final Regulatory Flexibility Analysis of Passive Radio Frequency Identification (RFID), version 1.0 of August, 2005. Retrieved on April 1, 2006, from http://www.acq.osd.mil/log/rfid/EA_08_02_05_UnHighlighted_Changes.pdf.

¹¹⁴ U.S. Government Accountability Office. Better Strategic Planning can help Ensure DoDs Successful Implementation of Passive Radio Frequency Identification. Retrieved on March 30, 2006, from <http://www.gao.gov/new.items/d05345.pdf>.

¹¹⁵ Emeterio V. Hernandez and Christopher A. Thomas, Investigating the Department’s of Defense’s Implementation of Passive Radio Frequency Identification (RFID), MBA Professional Report, Naval Postgraduate School, December 2005 p. 25.

readiness, as well as seeing a full implementation. Their implementation concept of the components is “central management.” They not only want to set the necessary guidelines, funding and tools needed for implementation, but they also want to lead their activities until the end of the initial roll-out of the technology.

As for the observed sites, a marked difference in ideology could be seen. OTD is very proactive in their utilization of RFID technology even though they are operating under funding constraints and are not in a position to expand or upgrade their equipment. They are maximizing on the benefit of decreased human-intervention within the businesses processes. It was observed that the passive RFID implementation at OTD is being centrally managed with the full support of the top execution.

As with OTD, the RFID program in DDJC is centrally managed as well. However, guidance is provided by DLA headquarters. At this time, DDJC is not routinely using their portal to process the incoming material because there are currently no suppliers shipping tagged material to this site. DDJC has been mandated by OSD to implement RFID so that they can receive tagged material.

C. ASSUMPTIONS

OSD developed a Department-wide RFID CONOPS as a guideline for the components to follow while preparing their implementation plans and provided 29 assumptions which are categorized in four sections, namely: general, organizational, process, and technology.¹¹⁶ The following are examples of each category, respectively:

- Passive UHF RFID tag costs will decline over the next several years.
- There is sufficient funding to implement the policy in the timeframe mandated.
- The integration of RF technologies into the business processes of the components will be managed with the same level of attention as a major system fielding.
- Worldwide acceptance of frequency standards for UHF RFID will exist.

¹¹⁶ Office of the Secretary of Defense. Department of Defense Concept of Operations (CONOPS) for Radio Frequency Identification (RFID), version 2.0 of September 15, 2004.

The components are realistic and know that these assumptions make the implementations easier on paper but that their reality is very different. The implementation plans of the Navy, Army, and DLA, the comparatively larger users, do not contain any assumptions. The plans of Air Force and Marine Corps contain only a few assumptions; however, there is an overarching theme in the implementation plans of these last two components. They consider the assumptions in OSDs CONOPS to be risks or challenges. These differences in perception, as provided below, are distinct:

- The future price decrease is not taken as a criterion for full implementation by the components. Their paramount criteria for full implementation were positive ROI, cost savings and contribution to readiness.
- The components do not agree with OSD regarding funding and have declared that the current budgetary system does not allow them to allocate money for RFID implementations within the stated timeline.
- DoD components see passive RFID as a technology insertion into their AITs and not as a major system fielding.
- The components delineate many concerns about the RF standards and the technology standards as well.

OTD and DDJC do not have the luxury of accepting the risks and challenges as assumptions or of creating an ideal environment for success. They are the end-users who are experiencing the daily realities of implementation. They face both current and projected problems with the application of the technology into their legacy business practices. Like the units throughout DoD, DDJC and OTD are realistic about their expectations of the technology.

The initial assumption of OTD was that implementing passive RFID would result in cost and accuracy efficiencies and the site was shown to top executives as an avant-garde in RFID technology. However, during the site visit, the authors got the impression that OTD has a very pessimistic view of OSDs January 2007 mandate to tag. They believe that many suppliers will fail to tag their material which will force the OTD to continue to manually process many of their receipts, thereby prolonging their challenge

with frustrated material. Currently, there is no plan to incorporate RFID into their receiving process, which is contrary to OSDs vision.

DDJC has different concerns about full implementation as it pertains to implementing RFID into their inventory management processes. According to DDJC, at this time they cannot implement passive RFID into shelf level inventory management. Since they receive the items at case level, it would be very difficult and labor-intensive at this time to tag individual items. In addition, they would need to install several additional readers in various locations around the warehouse which would require additional funding. Managing the resulting high volume of data would also be a challenge.

D. RISKS AND CHALLENGES

The GAO reported on the implementation of passive RFID within DoD and identified four distinct challenges that are not being mitigated:

1. Passive RFID technology is a new technology that is evolving. Consequently, EPC standards, which identify specific information about items, are being revised; development of newer generation tags is creating uncertainty about upgrades and replacement of equipment; concerns have been raised about the industrial base's ability to meet the demand for tags and equipment; and training must be provided.
2. The performance capabilities of the technology are still being determined, creating operational issues concerning systems integration, the fragility of tags, the percentage of accurate read rates, and spectrum frequency.
3. The ROI from passive RFID has been difficult to determine and without the data needed to create a business case analysis, the services have been reluctant to provide funding for implementation.
4. Certain regulatory and administrative requirements remain, including the approval of a multi-vendor contract for passive RFID purchases.¹¹⁷

¹¹⁷ Government Accountability Office. Better Strategic Planning can help Ensure DoDs Successful Implementation of Passive Radio Frequency Identification. Retrieved on March 30, 2006, from <http://www.gao.gov/new.items/d05345.pdf>.

This thesis agrees with the challenges as described in the report; however, the authors disagree with the GAO regarding DoDs identification of these issues. After conducting a literature review of DoDs RFID policy and guidelines, a lack of documentation of risks and challenges was noted, unlike the components who have detailed them in their individual implementation plans. DoD refers to these challenges as assumptions, and in response to the GAO report, asserted that they have been resolved. With no defined risk or challenge, there is no need for mitigating actions. In stark contrast, the components delineate their problems as risks, challenges, and vulnerabilities in the categories of funding, technology, regulatory, and ROI.

The challenges that are being experienced by DDJC and OTD have been detailed in Chapter IV, and by January 2007, when suppliers will be shipping tagged material to all sites, they will increase in magnitude if efforts are not made to mitigate them. There were no observed plans being made to address these issues.

E. APPLICATION AREAS AND BENEFITS

According to OSD, RFID will be incorporated into business transactions in the supply chain wherever appropriate.¹¹⁸ From the operational view of DoD, this wide spectrum could include all processes within and between each logistics node including the following:

- Manufacturers/Suppliers
- Distribution Centers/Repair Depots
- Ports of Embarkation/Ports of Debarkation
- Theater Distribution Center/Theater Distribution Repair Depots
- Transportation/Supply Offices
- Customers.¹¹⁹

DoD wants to utilize RFID in in-transit, in-storage and in-repair processes and use these transactions for both visibility and record. However, the emphasis has been placed

¹¹⁸ Under Secretary of Defense, Radio Frequency Identification Policy, July 30, 2004. Retrieved on March 27, 2006, from <http://akss.dau.mil/docs/Wynne%20Memo%20of%2007-30-2004.pdf>.

¹¹⁹ Office of the Secretary of Defense. Department of Defense Concept of Operations (CONOPS) for Radio Frequency Identification (RFID), version 2.0 of September 15, 2004.

on implementing RFID in shipping, receiving, and transportation processes. This is the first phase of a wide-spread open-loop implementation. The second phase is to incorporate RFID into inventory management processes using a combination of bar codes and RFID. This format requires the lowest level of passive RF tagging which is at the case level. It is envisioned that beginning in FY 2007, RFID will be used to perform business transactions where appropriate in logistics AISs. DoD did not project any pilot implementations for logistics nodes.

From the perspective of this thesis, DoD components are looking for a ROI, cost savings, and functionality in an austere operational environment. Most of their pilot implementations have related to in-transit applications. Components also want to see near 100 percent reliability in read rates for transactions of both visibility and record, and their intention is to test and apply their passive RFID systems within closed-loop systems rather than between nodes as an open-looped system.

The Army has plans for pilots in areas such as inventory management and maintenance. Since the components are very suspicious about the passive RFID benefits, they often emphasize having realistic plans and focus on the evaluation of the benefits. They do not find the technology mature enough and cost-effective enough to engage in extensive implementations. Although they cannot quantify the benefits at this time, they are seeking qualitative benefits to readiness and a positive ROI.

The initial intent of OTD was to utilize passive RFID for transactions of record in order to benefit from the technology; however, they have been using it only as a visibility tool for container stuffing. The current RFID utilization is a closed-loop internal implementation that has no interactions with the other nodes, and consequently no contribution to the supply chain. According to OTD, passive RFID should be implemented throughout the supply chain in order to maximize the benefits. DDJC currently does not have a plan to incorporate RFID into their closed-loop systems such as inventory management. They are effectively utilizing their AWOS system to process customer requirements and do not appear to be eager to implement RFID in either in-transit or in-storage areas.

F. GUIDANCE AND TIMELINES

OSD issued their CONOPS to provide the components with specific guidelines for meeting the mandated RFID requirements and moving forward towards DoD-wide implementation.¹²⁰ They also utilized working groups, conducted RFID summits and conferences, provided analyses of the results of the various implementation pilots, and required their components to prepare implementation plans; however, the first documents were not available until after the required deadline as the components struggled to determine how to most effectively apply this immature technology. In developing their plans, they anticipated that the DoD policy would go through many revisions. Table 4 was developed by GAO at a time when the Army and Marine Corps plans were in draft form and the Air Force had not developed their plan. Since that time, the Air Force and Marine Corps have approved plans for passive RFID but the Army's remains in draft form. Nonetheless, it provides a managerial perspective of the various components' strategy.

OSD considered the cost of implementing and operating RFID technology a normal cost of operation and maintenance or working capital fund which should be funded, and did not attempt to provide supplemental appropriations from the federal or military budget.¹²¹ In July 2004, when they promulgated their RFID policy for passive RFID tag application to specific classes of material effective January 2005, funding guidelines were not clearly defined. The timing was not in line with the regular budgetary submission periods, so this meant that components would have to take highly unusual measures to identify funding in order to fully comply with OSDs mandate to deploying their initial passive RFID infrastructure.

The DoD policy requires contractors to affix passive RFID tags at the case and palletized unit load levels when shipping packaged operational rations, clothing,

¹²⁰ Office of the Secretary of Defense. Department of Defense Concept of Operations (CONOPS) for Radio Frequency Identification (RFID), version 2.0 of September 15, 2004.

¹²¹ Under Secretary of Defense, Radio Frequency Identification Policy, July 30, 2004. Retrieved on March 27, 2006, from <http://akss.dau.mil/docs/Wynne%20Memo%20of%2007-30-2004.pdf>.

individual equipment, tools, personal demand items, or weapon system repair parts to DDJC.¹²² The observed variance here is that they are not routinely receiving tagged shipments.

¹²² U.S. Department of Defense, Federal Register / Vol. 70, No. 176 / Tuesday, September 13, 2005 / Rules and Regulations. Retrieved on February 1, 2006, from http://www.acq.osd.mil/log/rfid/Federal_Register_2005_09_13_RFID_Final_Rule.pdf.

Component	General & long-term goals and objectives	Description of specific actions	Performance Measures	Key external factors	Schedules and milestones	Resources and annual cost estimates	Accountability	Evaluation
OSD	Partially	Partially	No	No	Partially	Partially	Yes	Partially
DLA	Partially	Partially	No	Yes	Partially	Partially	Yes	No
USTRANSCOM	No	Partially	No	No	No	Partially	Partially	No
Army	Partially	Partially	Partially	Yes	Partially	No	Yes	No
Navy	Partially	Partially	Partially	Yes	Yes	Yes	Yes	Partially
Air Force	No	No	No	No	No	No	No	No
Marine Corps	Partially	Partially	No	Yes	No	Partially	Yes	No

Table 4. Comparison of Key Management Principles to DoD's and its Military Component's Passive RFID Policies and Implementation Plans.¹²³

¹²³ U.S. Government Accountability Office. Better Strategic Planning can help Ensure DoDs Successful Implementation of Passive Radio Frequency Identification. Retrieved on March 30, 2006, from <http://www.gao.gov/new.items/d05345.pdf>.

Guidance about RFID policies and procedures is presented to OTD personnel through weekly training sessions. There is ongoing cross-training, and during the authors' visit it was observed on several occasions where personnel stepped in to assist their coworkers. Personnel are encouraged to submit recommendations for improving business processes and there was participation from all levels of the chain of command. At DDJC, training is documented on their intranet site, and there were a variety of presentations that documented the business processes.

The DoD components appear reluctant to fully embrace OSDs RFID vision even as they work towards compliance. Their efforts to define how they will deploy passive RFID are ongoing and they continue to invest in various RFID pilot implementations. They have also incorporated target dates and goals for modifying their business process; however, there are variances between their plans and OSDs vision. Nonetheless, their general reluctance to swiftly implement passive RFID will continue if the components feel they are being forced to implement the technology before they have had adequate time to develop a solid business case analysis or identify a ROI. As the components take a measured approach to passive RFID and address the technical challenges, they must also look at the cultural and organizational issues that come from a general resistance to change and innovation.

VI. ANALYSIS OF THE CAUSES FOR COMPLIANCE VARIANCES

Incorporating new IT into an existing infrastructure can be a significant challenge for any organization, and DoD is no exception. Add to this scenario a series of diverse integrated systems and non-integrated IT systems and the process becomes even more complicated because many internal and external factors influence the complexity of the implementation. Passive RFID technology is constantly changing and the uncertainty of the standardization of both the technology and the associated regulations in a very dynamic military environment has many consequences for stakeholders. This thesis has identified several variances between OSDs passive RFID vision and the components' vision and proffers several reasons for the discrepancies.

In order to objectively identify possible causes for the identified compliance variances between OTD and DDJC, it was assumed DoDs passive RFID implementation to be a project so the factors that go into making a project a success were evaluated. To accomplish this, a theory developed by Pinto and Slevin was used which was detailed in an article entitled "Critical Factors in Successful Project Implementation".¹²⁴ This theory was expanded in a second article by Pinto and Prescott entitled "Variations in Critical Success Factors Over the Stages in the Project Life Cycle".¹²⁵

The theory offers four stages of a project in its life cycle: conceptualization, planning, execution and termination. These stages and the dominant critical success factors of each stage are shown in Table 5. Since the DoD components have completed their implementation plans, some tagged material is being shipped from suppliers to designated activities, and there are many ongoing pilot projects, it was determined that DoD's passive RFID implementation is in the beginning portion of the execution phase. Therefore, for the first three phases of the project life cycle, this thesis evaluated the

¹²⁴Jeffrey K. Pinto & Dennis P. Slevin, 1987, "Critical Factors in Successful Project Implementation", IEEE Transactions on Engineering Management, 34, 22-27.

¹²⁵Jeffrey K. Pinto & John E. Prescott, 1988, "Variations in Critical Success Factors Over the Stages in the Project Life Cycle", Journal of Management, Vol. 14, No 1, 5-18.

critical factors and found that some of them were significant in several stages. Table 5 provides a breakdown of the four stages of a project's life cycle.

	Phase I Conceptualization	Phase II Planning	Phase III Execution	Phase IV Termination
Hypothesized Dominant Critical Success Factors	Project Mission	Project Mission	Schedule/Plans	Client Acceptance
	Client Consultation	Top Management Support	Personnel	Client Consultation
		Client Consultation	Technical Tasks	
		Client Acceptance	Trouble-Shooting	
			Client Consultation	
			Monitoring and Feedback	
			Communication	

Table 5. Stages in the Project Life Cycle¹²⁶

This thesis will utilize a Project Implementation Profile (PIP), in conjunction with the four stages of a project life cycle, to make an assessment. The PIP was developed through field research conducted by Slevin and Pinto (1986, 1987). They identified ten critical factors related to project implementation success. They are as follows:

- a. Project Mission - Initial clarity of goals and general directions.
- b. Top Management Support - Willingness of top management to provide the necessary resources and authority/power for project success.
- c. Project Schedule/Plan - A detailed specification of the individual action steps required for project implementation.
- d. Client Consultation - Communication, consultation, and action listening to all impacted parties.

¹²⁶ Jeffrey K. Pinto & John E. Prescott, 1988 "Variations in Critical Success Factors Over the Stages in the Project Life Cycle", Journal of Management, Vol. 14, No 1, 5-18.

- e. Personnel - Recruitment, selection, and training of the necessary personnel for the project team.
- f. Technical Tasks - Availability of the required technology and expertise to accomplish the specific technical action steps.
- g. Client Acceptance - The act of “selling” the final project to its ultimate intended users.
- h. Monitoring and Feedback - Timely provision of comprehensive control information at each stage in the implementation process.
- i. Communication - The provision of an appropriate network and necessary data to all key actors in the project implementation.
- j. Trouble-Shooting - Ability to handle unexpected crises and deviations.¹²⁷

A. CONCEPTUALIZATION

The first stage of a project life cycle is conceptualization. This is where a strategic need is recognized by senior management. Next, management establishes preliminary goals and alternative courses of action. All options that are available to accomplish these activities should be explored at this time.¹²⁸ The two critical factors identified at this stage were Project Mission and Client Consultation.

1. Project Mission

In order for the mission to be understood by stakeholders, it should be unambiguous and the operational goals should be clearly delineated. At this stage, the Assistant Deputy Under Secretary of Defense (Supply Chain Integration) Alan F. Estevez had clearly stated his vision as follows:

The end state for the DoD supply chain is to be a fully integrated adaptive entity that leverages state-of-the-art enabling technologies and advanced management information systems to automate routine functions and

¹²⁷ Jeffrey K. Pinto & John E. Prescott, 1988. “Variations in Critical Success Factors Over the Stages in the Project Life Cycle,” *Journal of Management*, Vol. 14, No 1, 5-18, p. 8.

¹²⁸ *Ibid.*, 8, 9.

achieve accurate and timely in-transit, in-storage, and in-repair asset visibility with the least human intervention.¹²⁹

The above statement was further detailed in the RFID vision in an OSD supply chain document. Although the components have developed diverging visions for their organizations, the authors recognize that OSD provided specific guidance for the project mission.

2. Client Consultation

This is where those responsible for a project communicate, consult, and participate in action listening with all impacted parties.¹³⁰ For a project to be successful, it requires close and frequent consultation with the components to ensure that their plans are in alignment with management's vision. To accomplish this, frequent meetings should be held to discuss progress and it should be clearly demonstrated that the stakeholders understand what the project is all about. Stakeholder buy-in is essential to the success of any project because if those who are affected by the actions of top management are only mildly supportive of what the organization does, it then becomes more difficult to make progress or to change processes. Overcoming obstacles and challenges become very difficult.

OSD did not consult or communicate effectively with the components prior to implementing their passive RFID policy; unsurprisingly, significant stakeholder ownership did not develop. Short-circuiting the stakeholder buy-in process may only have delayed the reaction that OSDs decision evoked from the components affected by it.

B. PLANNING

The second stage of a project life cycle is planning. In this stage, a more formalized set of plans to accomplish the initially developed goals are established. Among the important activities in the Planning phase is the enlisting of top management support to commit a variety of organizational resources (human, budgetary, etc.) as they

¹²⁹ Army Logistician, May-June 2005, RFID Vision in the DoD Supply Chain. Retrieved on March 26, 2006 from <http://www.almc.army.mil/ALOG/issues/MayJun05/rfid.html>.

¹³⁰ Jeffrey K. Pinto & John E. Prescott, 1988. "Variations in Critical Success Factors Over the Stages in the Project Life Cycle", *Journal of Management*, Vol. 14, No 1, 5-18, p. 24, 25.

will be required.¹³¹ Pinto and Prescott (1988) found the factors of Mission, Top Management Support, and Client Acceptance to be critical to project success.¹³² Since this thesis discussed the importance of Project Mission previously, it will not be repeated in this section.

1. Top Management Support

According to Pinto and Prescott, this is the provision of a wide variety of resources for the project team throughout the project, as well as demonstrating both written and verbal support for the project team.¹³³ It is important because stakeholders will be looking to management to determine if they have adequate personnel, financial, and material support to field the project. In addition when support is vocal and senior management are visibly backing the effort, stakeholders tend to generalize that the project is important. This support can be seen as a conduit for implementing top managements' plans and goals for the organization.¹³⁴ If there are no high level personnel advocating for the project, it could be interpreted as being unimportant or unnecessary.

OSD has been both visible and vocal about their full support of their passive RFID vision and policy. Assistant Deputy Under Secretary of Defense (Supply Chain Integration) Alan F. Estevez and Acting Under Secretary of Defense for Acquisition, Technology, and Logistics Michael W. Wynne frequently conduct interviews, presentations, supplier summits, and symposiums where they tout the many benefits of RFID technology. However, as the components move out with their individual implementation plans, several aspects of these plans do not comply with OSDs guidelines.

¹³¹ Jeffrey K. Pinto & John E. Prescott, 1988. "Variations in Critical Success Factors Over the Stages in the Project Life Cycle", *Journal of Management*, Vol. 14, No 1, 5-18, p. 24, 25.

¹³² Jeffrey K. Pinto & John E. Prescott, 1988. "Variations in Critical Success Factors Over the Stages in the Project Life Cycle", *Journal of Management*, Vol. 14, No 1, 5-18, p.13.

¹³³ Jeffrey K. Pinto & John E. Prescott, 1988. "Variations in Critical Success Factors Over the Stages in the Project Life Cycle", *Journal of Management*, Vol. 14, No 1, 5-18, p.13.

¹³⁴ Jeffrey K. Pinto & Dennis P. Slevin, 1987, "Critical Factors in Successful Project Implementation", *IEEE Transactions on Engineering Management*, 34, 22-27, p. 24.

For example, the Navy has conducted a business case analysis and numerous pilots but the service has not stated that there is a compelling case to support a wide deployment of passive RFID in its environment. Some subordinate Navy commands could assume the position that their leaders are posturing and that is they are not necessarily convinced about the necessity, success and benefits of the project. The Air Force plans to implement active and passive RFID in areas where there is a positive ROI or discernable improvement in unit readiness. Likewise, the Army is only using passive RFID technology in select segments of their supply chain and they anticipate that widespread use is still several years away in a phased implementation. The take away here is there is a lack of senior level management support among the DoD components.

2. Client Acceptance

Client Acceptance deals with selling the project to the clients for whom it is intended; in this case, the DoD components. It is the final stage of the implementation process and it is here that the ultimate efficacy of the project is determined.¹³⁵ Management of this stage is also important because the client must be sold on the idea that the plan, as presented, is effective. Acceptance of previous stages in the project life cycle does not necessarily transfer to this stage.

Research for this thesis did not reveal any effort on OSDs part to “sell” their passive RFID vision and plans to the components. Instead, the components were mandated to adopt passive RFID. Nonetheless, a credible and comprehensive business plan or implementation plan for passive RFID technology is critical to OSDs commitment to “transforming its logistics business processes through innovation and exploitation of technology”.¹³⁶ However, based on the hesitancy of some DoD components to engage their implementation plan, it does not appear that OSD has successfully articulated or demonstrated that this major change has sufficient value at this stage of its development.

¹³⁵ Jeffrey K. Pinto & Dennis P. Slevin, 1987, “Critical Factors in Successful Project Implementation”, IEEE Transactions on Engineering Management, 34, 22-27, p. 24.

¹³⁶ Under secretary of Defense, Acquisition and Technology. Memorandum entitles Implementation plan for Logistics Automatic Identification Technology dated March 17, 2000.

In the case of DDJC, they have installed and tested their equipment but are not routinely receiving tagged material. The scenario is different for OTD because they are utilizing their portals daily for internal processes. They are not mandated at this time to receive tagged material. This activity is highly motivated to be the frontrunner in DoDs passive RFID implementation.

C. EXECUTION

The third stage in the project life cycle is Execution, and at this point, the actual work of the project is performed. Materials and resources are procured and transformed into the intended project result. Further, performance capabilities are verified. Five factors were strongly related to project success, namely Project Mission, Trouble-Shooting, Project Schedule/Plans, Technical Tasks, and Client Consultation.¹³⁷ Project Mission and Client Consultation were previously covered so the information will not be repeated here; however, OSDs implementation of passive RFID is at the execution stage, so we the factors of Communication, Monitoring and Feedback, and Personnel will also be addressed.

1. Trouble-Shooting

This is where the components are implementing their passive RFID plans. After developing their plans and incorporating RFID into their business processes, it is important to have trouble-shooting mechanisms in place to address divergences from the initial budget, schedules, or performance expectations.¹³⁸ Organizations should expect to experience problems and challenges, particularly with projects of this magnitude because you cannot anticipate every area that will develop tribulations. Some activities develop quality control measures into their programs to ensure that implementation is regularly monitored and reassessed in order to prevent components from deviating from the overarching plan and vision. Both DDJC and OTD primarily rely on the project managers to carry out trouble-shooting. The authors did not identify any OSD oversight measures

¹³⁷ Jeffrey K. Pinto & John E. Prescott, 1988. "Variations in Critical Success Factors Over the Stages in the Project Life Cycle", *Journal of Management*, Vol. 14, No 1, 5-18, p. 9.

¹³⁸ *Ibid.*, 14.

being applied in either of these sites. Nonetheless, they continue to be presented as the standard for passive RFID implementation.

2. Project Schedule/Plans

It is important for an organization to develop a detailed plan of the different phases of implementation and it is broken down into four stages, namely formulation, conceptualization, detailing, and evaluation. This factor also refers to the degree to which time schedules, milestones, manpower, and equipment requirements are delineated.¹³⁹ Management should also have a method for measuring performance.

The components have complied with OSDs requirement to prepare a supporting RFID implementation plan that encompasses both active and passive RFID technology, though there is still some hesitation to fully incorporating passive RFID into their business processes. On July 30, 2004, OSD published its final RFID policy which required DoD components to update their active RFID plans to include passive RFID by October 29, 2004. Although the Navy, Marine Corps, and Air Force have approved policies in place, the Army's policy remains in draft form as of May 2006. DLA had incorporated RFID into their implementation plan for Logistics Automatic Information Technology as early as March 2000. Ultimately, without detailed guidance from OSD, the components have been following their own agenda.

The authors did not see any evidence of OSD oversight or monitoring at OTD or DDJC. This indicates that OSD might not be measuring the progress of the implementation against its scheduled projections, and therefore variances are not being addressed or revised.

OSD has experienced problems executing their own plans for RFID implementation. It took almost two years to develop and issue the DoD Final RFID DFARS which was published in the *Federal Register* on September 13, 2005, with an effective date of November 14, 2005. The regulation was originally scheduled to be published in October 2004, but OMB declared the proposed rule a significant rule which

¹³⁹ Jeffrey K. Pinto & Dennis P. Slevin, 1987. "Critical Factors in Successful Project Implementation," IEEE Transactions on Engineering Management, 34, 22-27, p. 24.

meant that DoD had to develop a detailed Regulatory Flexibility Analysis. After the Analysis was approved by OMB, the RFID proposed rule was published on April 21, 2005.¹⁴⁰ This could have been seen by the components as a lack of commitment to staying on task so it was not a surprise that the components did not meet the deadline set by OSD for completing their passive RFID plan. OSD has laid out an ambitious vision without all of the details, and they may perhaps have unreasonably expected all stakeholders to come on board.

By setting timelines for RFID implementation by components, OSD could be seen as providing a “company” policy for implementation in order to avoid different activities and services addressing the issues in their own ways. However, based on the various implementation plans, many of the senior levels of management are not convinced that it is beneficial for their organization at this time. This means that OSD has limited high level backing for their strategy and there is no collective plan for the components to move ahead in a timely manner. Organizationally, DoD did not catch up with RFID technology before the necessary organizational or doctrinal changes were made.

3. Technical Tasks

An important issue at this stage is the availability of personnel who are technically proficient in RFID technology. If a project is developed without the necessary technical support, it is at a high risk for failure. RFID is a relatively immature technology, so training and educating employees is one of the biggest challenges the components face. At DDJC and OTD, the authors did not observe a high skill level. Personnel knew only enough about the technology to accomplish their assigned tasks. This lack of on-site RFID technical skills is one of the impediments to successful implementation of the technology.

For many DoD organizations, there may be legitimate technical issues and institutional constraints that cause resistance to the acceptance of an immature technology, and OSD needs to address their concerns once they are identified. Variances can perhaps be attributed to a concern for efficacy. Users may not believe that the

¹⁴⁰ iMobile News. Newsbrief. Retrieved on May 18, 2006, from <http://www.imobilesystems.com/news.htm>.

technology works as well as it is advertised because it is still very technically immature. It may also be a case of perception versus reality.

Although passive RFID may potentially bring many benefits over the long term, DoD components are facing many formidable obstacles to its adoption. Technological, financial and cultural issues must all be addressed before the benefits can be fully realized, and the many challenges they are encountering in the short term should not be ignored by OSD. In addition, technology standards are changing rapidly, so it is essential that DoD components develop a process to periodically review their analyses and decisions based on new developments and a method for capturing the knowledge gained. Due to funding issues at this time, OTD is unable to implement upgrades in their system and will continue to use the equipment that was provided for their pilot.

Another factor that the authors attribute the compliance variance at DDJC and OTD to is the level of education and training that personnel are receiving. Because the transformation is from legacy processes to a new high technology process that utilizes passive RFID technology, there needs to be an intensive training program for all involved. It should range from a high level overview of the system to more specific in-depth knowledge of the various job functions.

At the OTD adequate documentation of the specifics of the various business processes and the associated technology was not observed. However, OTD did conduct training on a regular basis, including cross-training for some functions. The critical position of portal checker was held by a very highly motivated and capable individual. At this time, attrition is extremely low at both facilities so retraining of new personnel is minimal. DDJC maintains their training document on the DLA intranet. DDJC management informed the authors that training was accomplished electronically. At both sites, it was observed that although personnel were well trained in their own job related functions, they were not well versed in the work process flow upstream and downstream from their positions.

4. Monitoring and Feedback

At this stage, key personnel receive feedback by this project control process, which is focused on how the project is comparing to initial projections. It includes project schedule, budget, personnel performance, and monitoring. This gives the project manager the opportunity to identify and correct problems early before they become major impediments.¹⁴¹ All personnel involved in the project should have the opportunity to provide feedback and make recommendations. This process could be formalized or accomplished during review meetings.

To ensure integration and consistent operations, the Defense Logistics Board (DLB) will review the internal implementation plans, benefits, compliance requirements, and requisite budget requirements annually based upon an assessment of the implementation to date. This review will include an updated analysis of implementation successes as well as provide guidance for expansion of RFID capabilities into additional applications and supply chain functions. This is delineated in DoDs CONOPS. In addition, the DLB will review these requirements prior to FY 2007 implementation. At the time of this writing, the authors were unable to determine the status of these reviews.

5. Personnel

This relates to issues of recruitment, selection, and training, and includes developing a team with the necessary skills and commitment to perform their assigned tasks.¹⁴²

Except for the technical assistance provided by the various contractors who assisted DoD in implementing their RFID systems, the components retained their regular staff, many of whom did not have the opportunity to develop a good understanding of the RFID technology they were expected to use or supervise the use of. The important issue here was selecting the right people to staff key positions such as project managers. The authors felt that even though the requisite technical skill level was not there to a large

¹⁴¹ Jeffrey K. Pinto & Dennis P. Slevin, 1987. "Critical Factors in Successful Project Implementation," IEEE Transactions on Engineering Management, 34, 22-27, p. 25.

¹⁴² Jeffrey K. Pinto & Dennis P. Slevin, 1987. "Critical Factors in Successful Project Implementation," IEEE Transactions on Engineering Management, 34, 22-27, p. 25.

degree, most of the personnel were motivated to learn the new business processes. At both OTD and DDJC, the turnover rate was very low, which would be an asset during a period of significant change.

6. Communication

This factor incorporates feedback mechanisms and requires the exchange of information both vertically and laterally within the organization. It should be effective and frequent and has to include information about project goals, changes in policies and procedures and status reports.¹⁴³ Discussions should be held in an open atmosphere of cooperation and acceptability and all ideas and suggestions should be acknowledged.

Since April 2004, OSD has conducted annual industry RFID summits and has been working with key RFID suppliers. These events are designed to provide opportunities for collaboration between DoD and industry partners. They have been a very effective form of communication between these two groups; however, there is less communication between OSD and the components. This lack of clarity in communications may have jeopardized the development of the components' implementation plans.

D. SUMMARY OF THE CHAPTER

This thesis addressed the critical success factors from the perspective that OSD is the owner of the passive RFID project. These factors are summarized below in Table 6, which also includes the effects of the compliance variances on each critical factor. Finally, it was decided whether that factor had been achieved or not. This provides an overall picture of the effects of the compliance variances and their causes.

¹⁴³ Jeffrey K. Pinto & Dennis P. Slevin, 1987. "Critical Factors in Successful Project Implementation," IEEE Transactions on Engineering Management, 34, 22-27, p. 25.

Factors/ Variances	Vision	Approach	Assumptions	Risks and Challenges	Application Areas and Benefits	Guidance	SUCCESS ACHIEVED OR NOT
Project Mission							Yes
Top Management Support							Yes
Project Schedule/Plan						X	Partial
Client Consultation		X	X	X	X		No
Personnel							N/A
Technical Tasks			X	X	X		Partial
Client Acceptance	X	X	X	X	X	X	No
Monitoring and Feedback							N/A
Communication	X	X				X	Partial
Trouble-Shooting			X	X			N/A

Table 6. Critical Success Factors Versus Compliance Variances

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VII. CONCLUSIONS AND RECOMMENDATIONS

A. CONCLUSIONS

In general, the methodology that was utilized to determine the reasons for variances indicates that Client Consultation and Client Acceptance are the two primary contributing factors. However, other dynamics can explain the observed variances between OSDs vision for passive RFID and the components' vision. Managers often recognize that change can be threatening because it is a paradigm shift for the organization, and those involved now have to learn new ways of thinking and working when their old behaviors have become imbedded. Because it is the path of least resistance, some organizations prefer to maintain the status quo and so they hesitate to implement the changes delegated by higher authority.

According to Feldman and March in their article entitled "Information in Organizations as Signal and Symbol," a great deal of the information that is used to justify a decision is collected and interpreted after the decision has been made or substantially made.¹⁴⁴ This occurred in the case of OSDs passive RFID policy where the mandate went out to the components and suppliers and was followed by numerous RFID implementation pilots across DoD components. Feldman and March also proffer that organizations say that they do not have enough information to make a decision while available information is ignored.¹⁴⁵ An example of this is the Navy, which is not satisfied with the results of their passive RFID business case analysis or the numerous pilots they have conducted.

Next, the GAO indicated that DoD could more efficiently and effectively implement passive RFID if they developed a comprehensive strategic management approach to ensure that sound management principles are guiding implementation efforts. The authors observed two major individual implementation pilots, but these isolated efforts are not likely to cause dramatic change in such a large and complex organization

¹⁴⁴ Feldman, M and March, James. Information in Organizations as Signal and Symbol. *Administrative Science Quarterly*, Vol. 26, No. 2 (Jun 1981), p. 174.

¹⁴⁵ *Ibid.*, 174.

as DoD. For this change to be timely and effective, careful and constant management and monitoring is required. The compliance that OSD is seeking from both its suppliers and components is based on regulations and mandates, and each involves an element of force which may be necessary since their timeline is short. The consequences of this type of implementation plan are the trade-off.

OSDs passive RFID policy can be seen as a strategic intent of what the department wants to achieve in the long term, and it conveys a significant stretch for the DoD components. The policy provides direction and an opportunity to incorporate RFID into their business processes and the entire supply chain. It also looks at tomorrow's opportunities but does not focus on today's challenges or provide the necessary funding or personnel for implementing the technology, and this is something that the components are dealing with. OSD has laid out an ambitious vision without all of the details, and they expect all stakeholders to come on board as delineated in their schedule. Perhaps the intent of their stretch goal is to motivate their components to give that extra effort to press on with their passive RFID implementations.

Compliance from the commercial sector is taking place because their biggest customer, DoD, demands innovation as a condition of doing business. On the other hand, DoD is a military organization, and since passive RFID is a strategic initiative being spearheaded by OSD, one may not observe any overt resistance to this initiative from the services. However, a more subtle or passive-aggressive form of resistance may be occurring, which means that the logistics transformation that OSD expects could be slow in coming. This is seen in the implementation plans that are in varying stages. For example, the Army's plan is still in draft form and the Marine Corps' plan has a timeline that goes out to 2011.

January 2007 is the deadline for full supplier implementation. At that time, all individual cases, palletized unit loads, and unit packs for unique identification items shipped to all DoD locations will require RFID tags for all commodities. Therefore, it is important that OSD address these variances and bring the components into alignment with their vision.

B. RECOMMENDATIONS

First, the authors recommend that OSD slow down the process of fully implementing passive RFID into the entire supply chain and continue to utilize a phase-based strategy. OSD should recognize that the implementation is not going as envisioned. Numerous issues that are central to passive RFID implementation remain unresolved with no identified solutions. An example is the issue of the components having neither the funding nor the incentives to advance their implementation plans, particularly in a time of austere funding within DoD. Also, OSD currently provides more guidance to suppliers than to the components.

Secondly, OSD should incorporate Client Consultation and Client Acceptance in order to fully and effectively integrate passive RFID into DoD logistics processes. These two factors facilitate the adoption of the other marks of success identified earlier. It is important for OSD to garner the support of the components' top management and provide them with incentives to execute OSDs vision for passive RFID.

The third recommendation is for OSD to develop an integrated process team (IPT) and conduct a comprehensive and comparative analysis of DoDs policy and the components' implementation plans. This will also provide OSD with an opportunity to obtain client consultation. The components have gained a lot of experience from their pilot projects which they can use to reinvigorate the current policy. The objective of the analysis is to achieve consensus which would result in client acceptance in addition to determining the best strategy for achieving the following:

- Minimization or elimination of the variances that currently exist in the components' implementation plans.
- Recognize and address the challenges, risks, and issues identified by the components and devise appropriate solutions.
- Develop a synchronized schedule and milestones.
- Demonstrate that the cost burden of implementation is shared fairly and the necessary resources are planned for the long-term.
- Provide critical management tools such as communication and monitoring.

- Ensure that OSDs policy and the components' implementation plans are in alignment.
- Evaluate RFID programs against quantifiable, pre-defined metrics which are tied to core business goals.

OSD should reformulate their strategy for passive RFID implementation throughout the supply chain and focus on the components' capabilities to include balancing organizational value, risk mitigation, and cultural acceptance.

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