

1 Background Information

1.1 Acknowledgements

The RFID Solutions Center would like to express our thanks to SAIC for their help in making this report possible.

1.2 Contract Information

Offering Department: U.S. Air Force Research Laboratory,
Materials and Manufacturing Directorate ("AFRL/MLM")

Recipient: Wright Brothers Institute

Vehicle: Memorandum of Understanding / Partnership Intermediary Agreement ("MOU" / "PIA")
FA8650-06-3-9000

Contract: Collaborative Purchase Order ("CPO") FA8650-06-3-9021

Title: RFID Rapid Adoption Collaboration Initiative ("RRACI")

The objective of the program is for the recipient to stimulate the rapid transition of radio frequency identification (RFID) technologies by developing an RFID solutions center. The RFID solutions center shall provide an effective way to collaborate with government end users, contractors, and defense industry suppliers. The solutions center shall provide education, training, and application of specific system design capabilities to transition RFID technologies to meet military needs. The RFID solutions center shall provide the capabilities and services that shall assist the government in streamlining both internal and external supply chain challenges to support the war fighter.

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Project Summary Report:

Naval Inventory Control Point (NAVACP)

Advanced Traceability and Control (ATAC) Passive RFID Enablement

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2 EXECUTIVE SUMMARY

Recent operations have highlighted the importance of a lean and effective global reverse logistics capability to return high cost DoD assets from worldwide operating locations to U.S. repair sites. Using the Navy as an example, the Naval Inventory Control Point (NAVICP) is responsible for managing the nearly 200,000 DLR's, spending over \$3.0B in transportation and re-distribution costs and nearly \$1.8B in repair in FY2003. To reduce costs and improve performance, NAVICP operates the Advanced Traceability and Control (ATAC) program for Navy and USMC retrograde materials. SAIC recently completed a project that enabled the ATAC with passive RFID capability. EPC compliant RFID tags were applied at the item and case level to manage retrograde shipments to the ATAC Norfolk and Distribution Depot Norfolk (DDNV). Stock in Transit (SIT) loss was reduced and electronic Proof of Delivery (POD) identified \$12.6MM of missed receipts.

The RSC proposes to extend the scope of the ATAC RFID implementation to support retrograde shipments to Naval Aviation Depots (NADEP) and commercial vendor repair facilities. Instrumentation can begin immediately, tagging within 90 days of launch and an operational pilot of 180 days is anticipated. The RSC also proposes to develop a supply chain event management (SCEM) capability to identify missed receipts of RF tagged materials and automatically notify key participants to support resolution. This will serve to demonstrate the ability of RFID enabled information capture to support business intelligence tools such as SCEM or Advanced Planning Systems (APS) to derive real business value within the supply chain. In addition to reducing the stock in transit losses and ensuring POD receipts as already shown, applying RFID can further aid the effort to reduce retrograde costs by:

- › Providing visibility to inbound DLR's shipments, allowing better planning
- › Allowing prioritization for the receipt, processing and induction of the repairable
- › Enabling better planning of transportation shipments to balance cost and time
- › Communicating condition information to streamline receipts at the DOP

Additional benefits are likely to be captured by connecting the RFID initiatives within the repair facilities, including the improvement of internal processes and the linkage to Unique Identification (UID). These changes can be readily and rapidly applied to all service retrograde processes.

3 Introduction

Deployment of passive Radio Frequency Identification (pRFID) capabilities within the DoD supply chain was mandated to begin in January 2005. In support of this policy initiative, Naval Inventory Control Point (NAVACP) has been exploring ways, through pilot projects, to tie together processes across the supply chain using pRFID technology as a foundation for improved business processes and logistics performance. These initial implementations are intended to validate the application of pRFID technology as the transactional vehicle for updating systems of record. This case study provides information on the continuation of work inside of NAVACP to integrate pRFID into the retrograde program.

3.1 About Passive RFID

Radio-frequency identification (RFID) is an automatic identification method, relying on storing and remotely retrieving data using devices called RFID tags or transponders. Utilizing radio frequency waves, an RFID tag can be applied to or incorporated into a product for the purpose of location and identification. UHF Passive RFID can be read from several meters away and beyond the line of sight of the reader. Most RFID tags contain at least two parts. One is an integrated circuit for storing and processing information, modulating and demodulating a (RF) signal and can also be used for other specialized functions. The second is an antenna for receiving and transmitting the signal.

RFID technology is in increasing use in enterprise supply chain management, improving the efficiency of inventory tracking and management. The Department of Defense, along with major commercial companies such as Wal-Mart, is implementing systems to test the ability of this technology to improve asset visibility, product integrity and readiness throughout the supply chain.

The use of RFID in the DoD supply chain has the potential to provide real benefits in inventory management, asset visibility, and interoperability in an end-to-end integrated environment. RFID encapsulates the data accuracy advantages inherent in all types of automatic identification technology (AIT). Additionally, RFID is a totally non-intrusive methodology for data capture (requires no human intervention), is non-line of sight technology, and is a technology that possesses both read and write options within the same equipment item.

RFID addresses a key challenge that has been noted at every node within the DoD supply chain – lack of visibility of item data. As an integral aspect of the overarching suite of AIT capabilities, RFID will become a key technology enabler for the DoD logistics business transformation and will support long-term integration of the Unique Identification (UID) into the DoD end-to-end supply chain. RFID (both active and passive) is required by DoD to:

- › Provide near-real time in-transit visibility for all classes of supplies and materiel
- › Provide “in the box” content level detail for all classes of supplies and materiel
- › Provide quality, non-intrusive identification and data collection that enables enhanced inventory management
- › Provide enhanced item level visibility

3.2 Background

The NAVICP Advanced Traceability and Control (ATAC) system plays a vital role in the Navy's \$26 billion retrograde supply chain by providing a pipeline that annually returns 500,000 shipments of Not Ready For Issue (NRFI) repairable weapon system components to the repair and refurbishment centers. The ATAC does this through key partnerships with military and commercial transportation organizations, Defense Logistics Agency (DLA) Defense Depots (DDs), and DoD organic and non-organic repair facilities. The ATAC has been tremendously successful in improving the financial and operational performance of the retrograde supply chain.

The ATAC fills both functional and financial requirements within the Navy Supply Chain. Functionally, the ATAC receives and processes retrograde materials, ensuring completeness and correctness of identifying information and packaging. Financially, the ATAC accepts the material and provides immediate credit to the end user, ensuring the availability of critical operating funds.



Figure 1: ATAC Network

The ATAC system utilizes two hub facilities located in the continental United States; The Eastern Hub is located at the Naval Station Norfolk, Virginia, and the Western Hub is located at Naval Air Station North Island, California. Material is shipped from 235 locations, including capital ships such as aircraft carriers and other deployed locations, to the ATAC hubs for processing and further transfer to depots and repair facilities. The hubs are critical links in the supply chain and utilize the electronic Retrograde Management System (eRMS) to monitor shipment movement and delivery.

Even though there has been tremendous success with ATAC, there remain challenges around manifest accuracy and stock in transit (SIT) visibility with its many partners within the supply chain. One approach to improving these challenges is the technical enablement of the business processes with pRFID tags and readers. The benefits of pRFID enablement were demonstrated during a pilot implementation at the Eastern Hub in 2005.

The success of the pilot implementation has led to the current effort to develop a comprehensive approach for pRFID enablement of both ATAC hubs. By developing and documenting core common processes and technologies, implementation and integration costs can be reduced and the overall Return On Investment (ROI) for the project increased. Furthermore, these same processes and technologies can serve as foundational elements for other Navy pRFID implementations and throughout the DoD Supply Chain.

The objective of this project was to extend the initial RFID implementation to demonstrate the value of RFID and deliver a case study around methods for effectively deploying pRFID for ATAC Navy Retrograde. The implementation will capture critical lessons learned in support of the broader rollout of the technology, including technology limitations, benefits of the RFID technology, material tagging guidelines and operational benefits.



3.3 Scope

The scope of the ATAC RFID implementation effort was to provide a design plan, installation report and case study for all work completed for the ATAC program hub locations in Norfolk, VA and San Diego, CA between October 2006 and September 2007. The design plan is contained within a system design document that encompasses all of the necessary details for an integrated system implementation.

Due to the timing for the Navy's ERP implementation during the past year, the decision for moving ahead with the integration of pRFID was not made until late August 2007. This eliminated the possibility to stand up a full tagging operation at the two ATAC hub locations.

3.4 Project Team

This project was conducted by a team of passive RFID and Academia professionals and supported by SAIC. The project team was comprised of SAIC, the Wright Brother's Institute, and Alien Technology. The team members are described below.

US Navy AIT Program Office

The Navy AIT Office is the "AIT Clearinghouse" for the Navy. The AIT Office is responsible for certification of AIT equipment for inclusion in the CLIN 0023 catalog which offers enhanced, commercial off the shelf (COTS) software and hardware peripherals.

SAIC

Science Applications International Corporation (SAIC), a leading systems, solutions and technical services company, offers a broad range of expertise in defense modernization efforts, intelligence, homeland security, logistics and product support, health and life sciences, space and earth sciences and global commercial services.

Wright Brothers Institute

The Wright Brothers Institute was the recipient of the grant and is the prime contractor for this contract.

Alien Technology Corporation

Alien Technology Corporation (ATC) was the sole subrecipient of the grant and provided overall program management as well as significant support through the RFID Solution Center (RSC) for training, integration facility support, and RFID solution engineering support. Alien Technology provides UHF Radio Frequency Identification (RFID) products and services to customers in retail, consumer goods, manufacturing, defense, transportation and logistics, pharmaceuticals and other industries. The RFID Solutions Center, a division of ATC, is the most advanced facility devoted entirely to the application of RFID technology. Open to enterprises, government agencies and their partners, the Center comprises 23,000 square feet of educational, R&D and real-world implementation resources designed to enable the global RFID community to tap the potential of RFID technology.

3.5 Report Layout

The remainder of this report describes the study design, experiments, findings, conclusions, and recommendations.



4 Methodology

The following sections outline the SAIC team’s methods and techniques for project completion. The team assembled process information, location data analysis, and ATAC business process details to generate Site Survey and Business Process Analysis reports that culminated in the development of the system design documentation. The results of the system design document are then used to complete the installation of RFID infrastructure at the ATAC locations in San Diego, CA and Norfolk, VA. Details of the installation were documented in the pRFID Installation Report.

For the BPA, SAIC assessed the “as is” legacy business processes to document the procedures currently in place to monitor the movement and life cycle events at the ATAC hub operations in Norfolk, VA and San Diego, CA. The BPA documents “as is” business processes, and identifies processes within the operation that AIT integration can help optimize or streamline.

The Functional Requirements Specification (FRS) is used to ensure the solution developed is suitable, accurate, and compliant to the business process it will be required to support; and provides the necessary level of security. The FRS addresses NAVICP ATAC’s need to improve material visibility and accountability across the hub operations.

The System Design Document (SDD) is intended to serve as the foundation for the development of an implementation plan for an integrated solution and serve as the guiding document for all subsequent activity. The SDD was developed to document the business processes, technical installation, solution configuration and the data and system integration requirements for pRFID enablement. It also provides the essential characteristics of the solution as derived in the Business Process Analysis (BPA) and will convert the FRS the final design architecture, per the expressed requirements of the client and its stakeholders.

Specifically, the SDD describes:

- › The “to-be” business processes needed to support the implementation of the pRFID tracking system
- › The required setup, configuration, and installation of the RFID components
- › The required infrastructure and software applications for the ATAC pRFID tracking system
- › The data and systems integration information necessary for the development and configuration of the integrated solution within the ATAC Hubs at San Diego and Norfolk

The pRFID Installation Report provides an overview of the RFID installations completed at the ATAC Eastern Hub in Norfolk VA and ATAC Western Hub in San Diego CA. The guiding document for the installations is the SDD, which documents the business processes, technical installation, solution configuration and the data and system integration requirements for pRFID enablement.

The Installation Report is intended specifically for:

- › Project Management, who oversee the business and technical aspects of the project.
- › The Business Process and Operations team who need to understand the impact of the “to- be” business processes in their day-to-day processes and operations.



Figure 2: ATAC Choke Point with RFID Portals



- › Software development and IT personnel working closely with the organizations setting up the infrastructure, configurations, and subsequently maintain the systems.
- › Personnel involved in the ATAC pRFID tracking system project.

The SDD and Installation Report are limited with regards to system details and development requirements for the eRMS system, which supports the ATAC operations. Development of these documents was conducted with limited access to key eRMS personnel and with limited direct information concerning the system capabilities and architecture.

5 Conclusions

The RSC BRE project did not result in a single large impact easily measured with performance metrics. The combined effect of the successful completion of the individual tasks was a more robust, user acceptable, system. The findings from the results of each of the tasks described in the Scope section are described in the Findings section below.

The project resulted in the following findings:

- › The ATAC system is a prime candidate for the integration of pRFID with their existing system of record (eRMS). This supply chain moves \$26 billion dollars worth of materials every year with a system accuracy of 99+%. The average cost per unit moved is \$25K, thus any increased visibility throughout the system will provide significant financial benefits.
- › The ATAC Norfolk and San Diego hubs operate with minimal staffing and will benefit with the use of RFID and Automatic Identification Technology (AIT) to enhance data capture and throughput capabilities.
- › The ATAC business processes are very similar between the Eastern and Western Hubs and can be effectively standardized, even though the facilities are very different in physical shape and operation.
- › pRFID enablement of the ATAC processes can be performed in a modular fashion.
- › There are significant business benefits to pRFID enablement.
- › Implementation at the ATAC hubs and supporting locations should be conducted in a phased approach, as outlined in the recommendation section.
- › Additional work is required to develop the necessary system details to enable eRMS and to integrate with other systems.
- › No operational tagging was conducted as part of this project. Additional issues in the enablement and startup are likely to be uncovered as the enablement progresses.
- › On a broader scale, use of pRFID information can be used to evaluate wholly new concepts with the retrograde supply chain, including location of repair depots, inventory positioning policies, etc.
- › This information from the business process and technology solutions implemented can serve as critical input to developing the enterprise approaches to RFID for the Navy.



5.2 Recommendations

As described in the Business Process Enablement section of the SDD, the implementation of pRFID within the ATAC is recommended to be a phased approach over time, capturing benefits and gaining experience as the processes are instantiated and then refined.

The proposed implementation phases are:

- › Phase I - ATAC Hub
- › Phase II - eRMS Nodes
- › Phase III - ATAC Process Improvement

Figure 1 below describes the proposed phases in a notional high-level plan for implementation. This plan is intended to serve as input to the actual implementation plan development process.

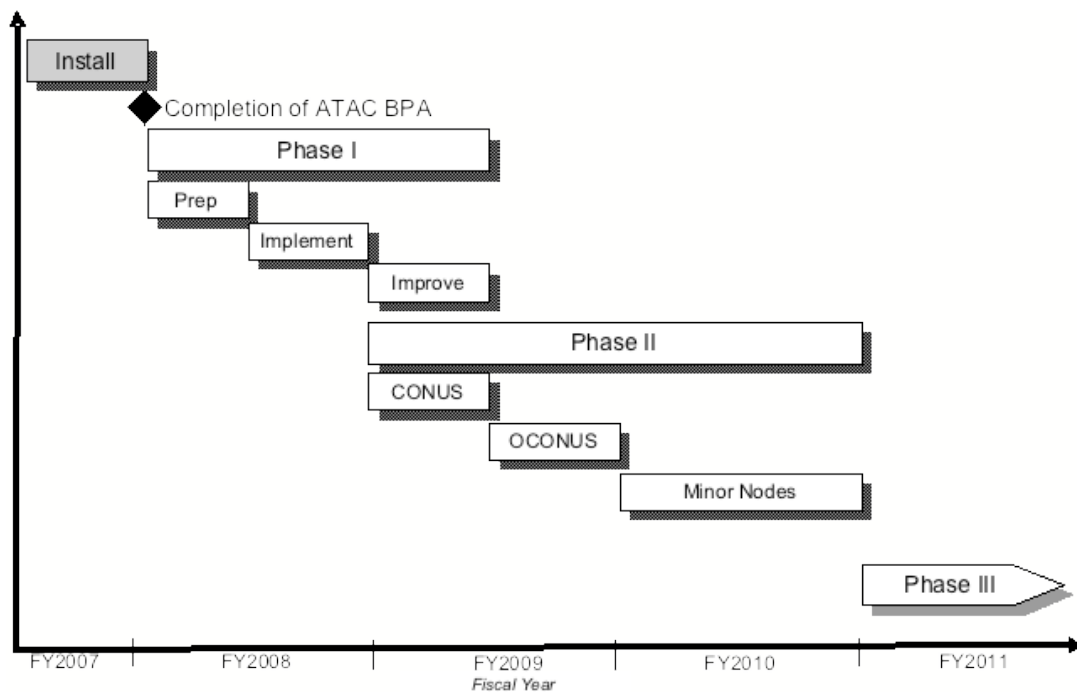


Figure 3: Notional Implementation Plan

Phase I – ATAC Hub

The initial phase of implementation, and in many ways the most difficult. This phase of work requires that the pRFID portals and printers be installed and configured within the ATAC Hub, along with the RFID Middleware edge server. This phase also requires the detailed development of RFID and operational performance metrics development (appendix A).

The benefits of this implementation phase are:

- › Improved Manifest Accuracy. RF Reads of the loaded materials will simultaneously eliminate exceptions and provide the ePOT information required to ensure materials are appropriately shipped by the ATAC.



- › Reduced Outbound SIT. RFID reads of the delivered materials will identify materials not delivered or materials delivered incorrectly at destinations. Again, this will simultaneously eliminate exceptions and provide the ePOD information.
- › Metrics Development. RFID and operational metrics development will provide the ATAC Program Manager with the requisite information to evaluate the performance of the implemented RFID system.

Major challenges and long-lead items of this phase include:

- › eRMS Changes. Development and testing of the changes within eRMS required to support the process. In addition to the integration of the RFID Middleware data integration for Advance Shipping Notice (ASN) and RFID read data are critical changes.
- › Navy-Marine Corps Internet (NMCI) Certification - All new equipment and modified programs will require NMCI review and approval to operate within the ATAC.
- › Partner RFID Reads. DLA Depots and Overhaul destinations must be equipped with RFID readers to support the process. In addition, RFID read data must be provided back to the ATAC to complete the exception processing.

Due to the time required for system development and certification, this phase is expected to last at least 12 months, and may be expected to take 18 months for startup. Careful monitoring and tuning of the RFID and business process operations is required for an additional 6 months.

Phase II – eRMS Nodes

The second phase of the implementation entails installation of RFID enabled printers at nodes, with little impact to the business processes. There are minor process changes required at the Hubs.

The benefits of this implementation phase are:

1. Reduced Inbound SIT
 - a. Real-time delivery confirmation (ePOD)
 - b. Exception reports for processing
2. Visibility
 - a. eRMS node tagging can enable tracking of material shipments by carriers and intermediate points.

The challenge for this phase is how to structure the implementation across the large number of nodes. It is recommended that the major nodes (by volume) be prioritized, starting with CONUS and then OCONUS locations. There is little dependency between implementations, which adds a great deal of flexibility in the schedule. However, this phase will dramatically increase the number and range of users and will require additional technical support.

This phase should be expected to span several years, based upon the number of locations.



Phase III – ATAC Process Improvement

The final phase of implementation is very loosely defined and really represents the ongoing efforts at continuous process improvements, leveraging the information and investment of the RFID infrastructure.

This phase should be expected to span up to 12 months.

6 Appendix A – Metrics Definitions

Metrics

A key element of success for the RFID enablement is establishing appropriate business and technical metrics. This section outlines suggested metrics for both the overall business process as well as specific technical measures. Data requirements and calculation methods are suggested as well. In some instances, these metrics are geared towards initial implementation, focusing on startup issues, where others are geared towards ongoing operations.

Although not discussed, it must be noted that development of metrics is not sufficient by itself. Review of the operational metrics on a daily or routine basis must become ingrained within the organization, along with the necessary research into observed deviations. By establishing these continuous improvement behaviors, real change and business process improvement can be managed.

Business Metrics

pRFID enablement must do more than support high read rates of tags and other technical measures. Metrics that measure the overall performance of the business process are essential to understanding the benefits of enablement. These metrics include:

Stock In Transit (SIT)

A measurement of number of items and/or dollar value of material either inbound to the ATAC hub or outbound from the hub to a depot or overhaul destination. This metric is calculated from eRMS transactional data. RFID is expected to significantly reduce SIT by eliminating missed receipt transactions.

Disputes

Closely related to the SIT metric above, the Dispute metric tracks the number and dollar value of open disputes over transactions. This should be monitored for both inbound and outbound shipments. This metric is also calculated from eRMS transactional data.

Manifest Accuracy

A measure of the effectiveness of the manifesting and staging processes within the ATAC. Calculated from eRMS and RFID data, showing the count of correctly manifested items from pRFID reads as a percentage of the total number of manifested items from eRMS. RFID Enablement is expected to increase the accuracy of the manifests leaving the ATAC.

Average Processing Time at ATAC

A measure of the total elapsed time for processing materials at the ATAC. This metric is calculated from the eRMS timestamps and should be reported in several segments, including the Overall Processing Time, Receiving



(from receipt to processing) and Shipment (from processing to shipment). RFID enablement should reduce the average processing time.

Data Entry Costs

The final business metric, data entry costs are developed from the total personnel costs attributed to data entry. It is expected to be reduced after RFID enablement and business process improvements.

RFID Metrics

There are a large number of possible RFID metrics that report the technical performance of the implementation. The more important metrics are listed below:

RFID Read Rate

A measure of the technical performance of the reader in its environment, this metric is calculated from the total number of tags read as a percentage of the total number of tags presented to the reader. This information is collected from both RFID and eRMS data, matching specific shipments to determine the correct rate. The read rate metric should be determined at each portal, including delivery, staging and shipment portals.

Also, the read rate alone is not sufficient to understanding the performance of the system. By identifying unique shipments that failed to read, research into the cause of the missed read is needed during implementation, to identify the root cause such as improperly applied tags, RF resistant material, packaging issues, commodity, orientation or other causes.

RFID Tagging Accuracy

A measure of the performance in the generation and application of tags to materials. This metric requires manual intervention and is best performed as intermittent surveys or random sample inspections during implementation. This metric is calculated using the number of correctly tagged (and readable) items as a percentage of the total number of items processed.

As with the read rate, this metric must be followed up with root cause analysis to determine the sources of failure.

ASN Received

A measure of the data transmission process for ASN information. This is calculated as the number of ASN's received on time for processing as a percentage of the number of ASN's sent. This information must come from the destination system.

ASN Accuracy/Completeness

Similar to the RFID Tagging Accuracy Metric, this is determined by survey or random sampling of the accuracy and completeness of the ASN data. This information must come from the destination system.

ASN Match

This measure is calculated from the number of ASN's correctly matched at the destination during the receiving process. It is a function of the successful ASN transmission and RFID reads. This information must come from the destination system.



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RFID Receipts

A measure of the number of fully processed transactions using RFID at the destination as a percentage of the number of items processed. It is a function of nearly all other activities and represents the final performance outcome for RFID. This information must come from the destination system.

Equipment performance/reliability

This metric measures the availability of the RFID equipment and is generally reflected as a percentage of the time available.

Exceptions

A final measure that is not specifically RFID based is the count of the number of exception conditions triggered. This metric is more closely related to the business process improvement, by tracking the number



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