September 2005

# DEFENSE LOGISTICS

# Better Strategic Planning Can Help Ensure DOD's Successful Implementation of Passive Radio Frequency Identification

**GAO**

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# DEFENSE LOGISTICS

# Better Strategic Planning Can Help Ensure DOD's Successful Implementation of Passive Radio Frequency Identification

## Why GAO Did This Study

The Department of Defense (DOD) has had problems with tracking and identifying inventory for many years, most recently in Operation Iraqi Freedom. One of several tools DOD is using to address these inventory problems is radio frequency identification (RFID). RFID technology consists of passive or active tags that are attached to equipment and supplies that are shipped from one location to another. Although DOD did not begin official implementation of passive RFID technology until January 1, 2005, DOD has been using active RFID technology since the early 1990s and began developing policy and pilot testing passive RFID in 2003. As of January 1, 2007, all commodities, excluding bulk commodities, are to have passive RFID tags. Full implementation of passive RFID is estimated to cost hundreds of millions of dollars. This report (1) provides information on the status of passive RFID implementation, (2) addresses the extent to which DOD has developed a strategic approach for implementing passive RFID, and (3) highlights challenges DOD recognizes it faces in implementing passive RFID and any plans developed by DOD to mitigate these challenges.

## What GAO Recommends

To ensure that passive RFID is effectively implemented, GAO is making three recommendations. DOD concurred with one and did not concur with two of our recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-05-345.

To view the full product, including the scope and methodology, click on the link above. For more information, contact William M. Solis at (202) 512-8365 or solisw@gao.gov.
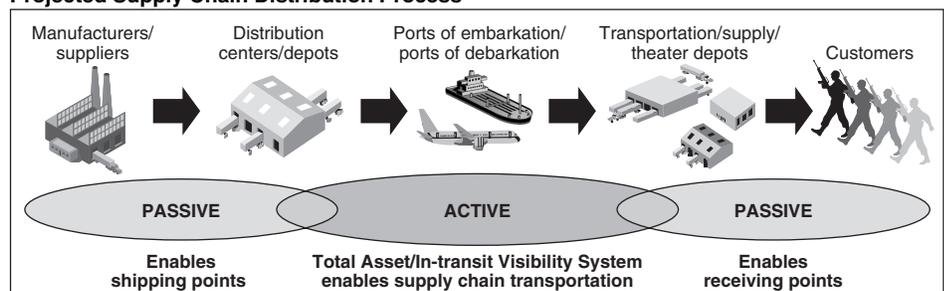
## What GAO Found

Since 2003, DOD and the components have taken actions to begin using a potentially promising technology, known as passive RFID, throughout their supply chain operations (see figure below). These actions include development of policy and guidance and the use of pilot projects and initial implementation to test the technology's application to their business processes. In addition, infrastructure and funding have been provided, but this has been minimal because implementation did not officially begin until January 2005. Future funding requirements are expected to increase sharply as full implementation proceeds—from $6.6 million as of January 2005 to about $472 million projected from fiscal years 2006 through 2011. This $472 million projection does not include the cost of system interoperability, which officials believe will be the most expensive element of implementation. Full implementation of passive RFID in supply operations is not anticipated until 2016 or beyond.

While DOD has taken a number of actions to direct the implementation of passive RFID, it has not yet developed a comprehensive strategic management approach that incorporates sound management principles. The planning by DOD and its components lacks or only partially incorporates several key management principles needed to effectively guide, monitor, and assess implementation. The development of a comprehensive strategic management approach that fully incorporates these principles could provide decision makers with a framework to guide RFID implementation efforts and the means to determine whether these efforts are achieving the desired results. This affects both DOD and its components because the components are developing implementation plans to support DOD's RFID policy.

DOD has identified several challenges that will need to be resolved before passive RFID can be fully implemented, but it has not yet developed a mitigation plan to address these challenges. Some challenges relate to the fact that passive RFID is a new and evolving technology, while other challenges derive from operational issues and obtaining adequate funding. Furthermore, certain regulatory and administrative obstacles remain. Until DOD and the components identify actions to mitigate these implementation challenges, their progress in resolving these challenges may be impeded.

**Projected Supply Chain Distribution Process**



Manufacturers/suppliers → Distribution centers/depots → Ports of embarkation/ports of debarkation → Transportation/supply/theater depots → Customers

PASSIVE · ACTIVE · PASSIVE

Enables shipping points | Total Asset/In-transit Visibility System enables supply chain transportation | Enables receiving points

Source: U.S. Army.

**United States Government Accountability Office**

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**United States Government Accountability Office**
**Washington, DC 20548**

September 12, 2005

Congressional Committees

The Department of Defense (DOD) has had problems with tracking and identifying inventory for many years. Since at least 1990, we have considered DOD's inventory management to be a high-risk area because inventory management systems and procedures are ineffective. Continued lack of visibility over inventory and equipment shipments increases vulnerability to undetected loss or theft and substantially heightens the risk that millions of dollars will be spent unnecessarily. Furthermore, it potentially compromises cargo security and the readiness of the warfighters. DOD has been using active radio frequency identification (RFID) technology for over a decade as a tool to help resolve this problem. More recently, DOD has also begun to use passive RFID technology. Both passive and active RFID technologies are part of a family of automatic information technologies used to enable hands-off identification of cargo and inventory. RFID technology consists of active or passive electronic tags that are attached to equipment and supplies that are shipped from one location to another. Full implementation of RFID technology into DOD's supply chain will require an investment estimated to cost hundreds of millions of dollars.

DOD's use of active and passive RFID technology is evolving.[1] DOD began using active RFID in the early 1990s as a tool to help resolve visibility problems experienced during Operations Desert Shield and Desert Storm. Active RFID technology is intended to provide nearly real-time, in-transit visibility of shipments. During Operation Iraqi Freedom, active technology was used to track parts and supplies shipped to and within theater, although not entirely successfully because some of the same visibility problems that occurred during Operations Desert Shield and Desert Storm

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[1] Additional information regarding governmentwide implementation of RFID technology is discussed in GAO, *Information Security: Radio Frequency Identification Technology in the Federal Government*, GAO-05-551 (Washington, D.C.: May 27, 2005).

were repeated, as we have previously reported and other DOD and military service after-action studies have documented.[2]

DOD has just begun implementing passive RFID, envisioned to ultimately work in conjunction with active RFID, to better enable inventory management and accountability. Passive RFID, which appears to be promising, is an emerging technology for both commercial and defense applications, and DOD logistics leadership views it as a key factor in transforming DOD logistics. Passive RFID is intended to facilitate accurate, efficient, hands-free data capture of shipping contents to improve item-level visibility. In October 2003, DOD developed initial RFID policy establishing business rules and requirements for implementing passive RFID technology in an integrated DOD supply chain enterprise. DOD's final RFID policy, dated July 30, 2004, directs the implementation of passive RFID technology for solicitations issued on or after October 1, 2004, for delivery of materiel on or after January 1, 2005. As part of this implementation process, DOD stipulated that its vendors and two of its distribution depots be required to use passive RFID technology as of January 1, 2005. DOD met the January 1, 2005, date through its initial implementation of passive RFID at the Defense Logistics Agency's (DLA) San Joaquin, California, and Susquehanna, Pennsylvania distribution depots.

This report addresses the status of DOD's passive RFID implementation and was prepared under the authority of the Comptroller General and is being addressed to the committees of jurisdiction. We focused on passive RFID because of its newness and potential high costs, and because it is just beginning to be implemented throughout DOD. We are providing you with this report because of your oversight responsibilities for defense issues. It addresses three key objectives: (1) to provide information on the

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[2] Department of Defense, *Conduct of the Persian Gulf War: Final Report to the Congress* (Washington, D.C.: April 1992); GAO, *Operation Desert Storm: Lack of Accountability Over Materiel During Redeployment*, GAO/NSIAD-92-258 (Washington, D.C.: Sept. 23, 1992); U.S. Army Materiel Command (USAMC), *Operation Iraqi Freedom (OIF)*, *Lessons Learned Conference* (Redstone Arsenal, Ala.: Sept. 10–11, 2003); GAO, *Defense Logistics: Preliminary Observations on the Effectiveness of Logistics Activities during Operation Iraqi Freedom*, GAO-04-305R (Washington, D.C.: Dec. 18, 2003); Department of Defense, *Objective Assessment of Logistics in Iraq: DUSD (L&MR) and Joint Staff (JSJ4) Sponsored Assessment to Review the Effectiveness and Efficiency of Selected Aspects of Logistics Operations During Operation Iraqi Freedom (OIF)* (Washington, D.C.: March 2004); GAO, *Defense Inventory: Actions Needed to Improve the Availability of Critical Items During Current and Future Operations*, GAO-05-275 (Washington, D.C.: Apr. 8, 2005).

status of passive RFID implementation in DOD, (2) to identify the extent to which DOD has developed a strategic approach for implementing passive RFID technology, and (3) to highlight a broad spectrum of challenges that DOD recognizes it faces with the ongoing implementation of passive RFID technology and any plans developed by DOD to mitigate these challenges.

For this report, we obtained and analyzed DOD's and various DOD military components' RFID guidance; readily available literature that describes the technology; funding, expenditures, and future projections data and requirements; and infrastructure being used and required for implementing the technology throughout DOD. We also reviewed studies initiated by DOD or its various military components. We interviewed knowledgeable officials from the Office of the Secretary of Defense, the four military services, DLA, the U.S. Transportation Command, the Joint Forces Command, and members of Joint Staff directorates. Additionally, we observed passive RFID technology being used at DLA's distribution depot in Susquehanna, Pennsylvania and at the Navy Ocean Terminal in Norfolk, Virginia. Because DOD is just beginning to implement passive RFID technology, we did not verify the data provided and considered the data sufficiently reliable for the purposes of this review. We conducted our work from July 2004 through August 2005 in accordance with generally accepted government auditing standards. Our scope and methodology are discussed in further detail in appendix I.

## Results in Brief

Since 2003, the Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics), the military services, DLA, and U.S. Transportation Command have taken actions to implement a potentially promising technology, known as passive RFID, into their operations. These actions include the development of overall policy and operational guidance, the use of pilot projects and initial implementation at several receiving and conveyor locations, and providing infrastructure and funding. The Under Secretary of Defense developed interim and final policy and operational guidance establishing requirements effective January 1, 2005, for the implementation of passive RFID technology in the DOD supply chain. This policy and guidance establishes requirements for tagging cases and pallets, contract requirements, technical specifications, architecture and integration, security, and funding. The military services, DLA, and U.S. Transportation Command have also developed respective operational plans to guide their implementation of DOD's overall policy. In addition, DOD has conducted several pilot projects to test the technology's application to their business processes and has implemented some passive

RFID capability at two DLA distribution depots and at one Navy ocean terminal. Additional passive RFID capability will be added to these locations as requirements are determined. Reports regarding the results of some of the completed pilot projects cite lessons learned that focus largely on the technical aspects of implementing the passive technology. Furthermore, minimal infrastructure and funding exists because passive RFID is an emerging technology and existing infrastructure and funding has primarily been in connection with the pilot projects and initial implementation. A sharp increase in expenditures—including costs for purchasing passive RFID equipment such as tags, readers, and writers, and costs associated with installation and maintenance—is expected as full implementation proceeds as directed by DOD's RFID policy and guidance. However, the cost projections made by DOD's military components, which reflect large increases in funding requirements, are probably lower than actual requirements will be because the services have had difficulty in determining cost estimates due to the evolving nature of the technology. Additionally, these cost projections do not include the cost of systems interoperability, which officials believe will be the most expensive element of implementation.

While DOD has taken a number of actions to guide and direct the implementation of passive RFID, it has not yet developed a comprehensive strategic management approach that incorporates sound management principles and could ensure that passive RFID is efficiently and effectively implemented. Existing passive RFID implementation policy and operational guidance for both DOD and its military components lack or only partially incorporate several key management principles, such as those used by leading organizations and embodied in the Government Performance and Results Act of 1993[3] (GPRA), that are needed to effectively guide, monitor, and assess implementation. Among the key management principles that are missing or are only partially present are (1) general and long-term goals and objectives, (2) a description of specific actions to support goals and objectives, (3) performance measures to evaluate specific actions, (4) schedules and milestones for meeting deadlines, (5) identification of total resources needed and annual cost estimates for passive RFID implementation into the supply chain, and (6) evaluation of the overall program with specific processes to allow for adjustments and changes. Inclusion of these elements in planning and guidance could better guide implementation efforts and provide DOD

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[3] Pub. L. No. 103-62 (1993).

decision makers with a means for determining whether their efforts achieve the desired results in implementing passive RFID into the DOD logistics supply chain. For example, detailed identification of resources needed could enable DOD and its military components to determine whether they are making the right investments, targeted to their needs, resulting in a sound return on investment. This affects both DOD and its military components, because the military components are developing implementation plans to support DOD's RFID policy. Without an improved strategic management approach that would incorporate these management principles, DOD and its military components cannot ensure that their implementation of passive technology into the DOD supply chain will be successful.

DOD has identified several challenges that will need to be resolved before passive RFID technology can be fully implemented in its supply chain processes, but the department has not yet developed a mitigation plan to resolve them. Some challenges relate to the fact that passive RFID is a new and evolving technology. For example, the electronic product code standards that identify specific information about items are being revised to provide increased capabilities, development of newer generation tags is creating uncertainty about upgrading and replacing equipment, concerns exist about the industrial base's ability to meet the demand for tags and equipment for both the private and public sectors, and training must be provided. Other challenges derive from operational issues associated with performance capabilities. For example, because the performance capabilities of passive RFID technology are still being determined, concerns exist about systems integration, which enables interoperability of automatic information systems among the military components to facilitate active and passive system interaction, and about the need for improvement in the accuracy of tag read rates. In addition, concerns exist about the availability of and permissions process for military use of authorized spectrum frequencies in foreign countries. Another challenge is obtaining adequate funding. Without the data needed to create business case analyses that demonstrate appropriate return rates on investment, the military services have been reluctant to provide funding for implementation. In addition to these challenges, certain regulatory and administrative obstacles remain, including the final approval of a proposed acquisition rule that will require vendors to contractually apply tags to products the government purchases, along with the approval of multivendor contracts for DOD-wide purchases of passive RFID equipment. Until the multivendor contracts are awarded, the DOD military components may be unable to leverage the purchasing power of the department to realize economy and efficiency benefits. Based on our

discussions with DOD officials, the underlying cause of these various challenges is the newness and evolving nature of the technology. However, officials noted that the current challenges they face will be resolved over time and are to be expected with the integration of any new technology. Without identifying the challenges that adversely impact passive RFID implementation and identifying the actions necessary to mitigate them, progress in resolving such challenges may be impeded.

We are recommending that the Secretary of Defense direct the Under Secretary of Defense (Acquisition, Technology, and Logistics) to develop a DOD-wide comprehensive strategic management approach that will ensure that passive RFID technology is efficiently and effectively implemented throughout the supply chain processes and will include an integrated strategy for fully implementing passive RFID, performance measures or metrics of progress, and a corrective action plan. We are also recommending that the Secretary of Defense direct the secretaries of each of the military services and other DOD military components to develop comprehensive strategic management approaches that support this DOD approach to fully implement passive RFID. As DOD and the military components develop these comprehensive strategic management approaches, we recommend that these approaches identify the specific challenges impeding passive RFID implementation and the actions needed to mitigate these challenges. In commenting on a draft of this report, DOD did not concur with our recommendation to expand its RFID planning efforts to include a comprehensive management approach that embodies key management principles used by leading organizations. The department asserted that it has already set forth the goals, objectives, performance measures, and milestones in its July 2004 RFID policy sufficient to guide the planning activities of the military services and other components. We disagree with the department's position because DOD's existing RFID policy lacks a number of key management principles necessary for good program management, and the lack of a comprehensive approach to guide the planning activities of the services and other components may impair DOD's ability to efficiently and effectively implement passive RFID technology. The department concurred with our recommendation for each of the military services and administrators of other DOD military components to develop individual comprehensive management approaches for implementing RFID. We believe that this approach will satisfy the intent of our recommendation if, prior to the military components developing their plans, the Under Secretary of Defense (Acquisition, Technology, and Logistics) takes additional actions to develop a DOD-wide comprehensive strategic management approach that would then be supported by the plans developed by the military

components. The department did not concur with our recommendation to develop a plan to identify challenges impeding passive RFID implementation and actions needed to mitigate those challenges. In essence, the department stated that the passive RFID challenges described in the draft report have basically been resolved. We do not believe this to be the case. We recognize that passive RFID is an evolving technology and that the department is continuing to address the challenges associated with implementing passive RFID technology. However, we believe that the challenges identified in the report continue to exist and that it is necessary for the department to identify specific challenges impeding passive RFID implementation and to develop a mitigation plan to address these challenges as RFID implementation proceeds. DOD's comments and our evaluation are discussed in detail at the end of this report.

## Background

RFID technology is one type of automatic identification technology. Automatic identification technology is a suite of commercial technologies—including bar codes, smart cards, magnetic stripes, and radio frequency identification—that provides a range of capabilities that enable the automatic capture of source data and enhance the ability to identify, track, document, and control deploying and redeploying forces, equipment, personnel, and sustainment cargo. Anticipated potential benefits of RFID include providing (1) near real-time, in-transit visibility for all classes of supplies and materiel; (2) "in the box" content-level detail for all classes of supplies and materiel; (3) quality, nonintrusive (hands-off) identification and data collection that enables enhanced inventory management; and (4) better item-level visibility. RFID tagging of DOD materiel is applicable to all items except bulk commodities such as bulk liquids, sand, and gravel.

At the most basic level, RFID is a data input system that consists of (1) a transponder, generally referred to as a tag; (2) a tag reader, also known as an interrogator, that reads the tag using a radio signal; (3) centralized data processing equipment; and (4) a method of communication between the reader and the computer. The reader sends a signal to the tag, which prompts the tag to respond with information about the container or item to which it is attached. The information is forwarded to central data processing equipment, which can then be used to get detailed information about the container or item, such as the shipping date or the date received. The information contained in the central data processing equipment can provide visibility over inventory items throughout the supply chain. DOD's final RFID policy, issued on July 30, 2004, includes business rules for implementing two types of RFID tags—active and passive.

Active RFID technology, which is more mature than passive technology, is used on containers or pieces of equipment for tracking shipments and their contents while in transit. Active RFID tags, which generally use a battery, have transmitters that transmit information when interrogated through radio signals that are read electronically. Active tags are more expensive than passive tags and are used for tracking major items and containers over long distances.

Passive RFID is the newer technology and its use in DOD is evolving. Ultimately, this technology, which appears to be promising, will be used to enable better inventory management and accountability. Passive RFID tags are applied to cases, pallets, and item packaging. Passive tags do not have batteries and store only a limited amount of information. To be activated, these tags require strong radio frequency signals from reader devices to enable the tags to send back the information stored on them. Once the radio signal is received, a small amount of the reader's signal power is temporarily stored and then used to generate the tag response. However, because of the tags' limited energy, the radio frequency signal strength emitted by them is at a low level, thus limiting the distance—generally 3 to 10 feet—from which the tags can be read. We reported in our May 2005 report that, under perfect conditions, the tags can be read from a range up to about 20 feet. Passive tags are much lighter and less expensive than active tags, ranging from about $0.20 to several dollars each, in comparison with about $100 each for active tags. DOD is testing the passive technology through pilot projects and initial implementation to assess its application to existing business processes. DOD's RFID policy, issued on July 30, 2004, requires (1) the department and its various military components to begin to implement passive RFID and immediately expand active RFID technology and capability within the DOD supply chain, and (2) suppliers to affix passive RFID tags on certain commodities for solicitations issued on or after October 1, 2004, for materiel delivered on or after January 1, 2005.

Passive and active RFID tags physically differ from one another, as figure 1 shows. Even though passive and active RFID technologies require similar types of equipment and function in a similar manner, the equipment is not interchangeable between the two technologies because they serve different purposes and use different radio frequencies. For more detail about the equipment necessary for passive and active RFID technology, see appendix II.

**Figure 1: Passive and Active RFID Tags**



Passive — UHF tags

Active — SaviTag 410 with bracket
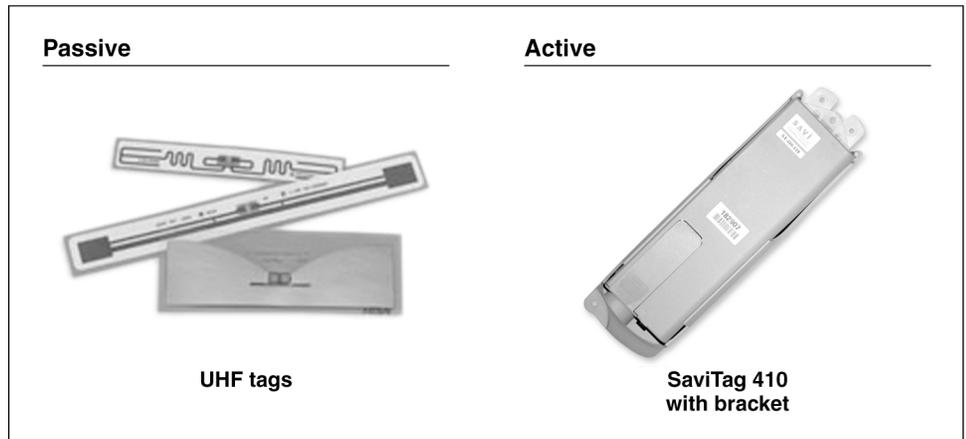
Sources: U.S. Army (left image) and DOD (right image).

Although passive RFID is an emerging technology for both commercial and defense applications, DOD logistics leadership views it as a key factor in transforming DOD logistics. DOD envisions using passive RFID technology to facilitate accurate, hands-off data capture in support of its logistics business processes in an integrated DOD supply chain enterprise. DOD anticipates that the application of passive RFID technology will provide efficient and accurate item/content visibility for better inventory management. DOD's goal for passive RFID is to provide nonintrusive identification of shipping contents to improve item-level visibility, and its goal for active RFID is to provide nearly real-time, in-transit visibility for most classes of supplies and materiel. Figure 2 depicts how DOD could use both passive and active RFID as items are physically moved from the manufacturers and suppliers to the warfighter.

**Figure 2: Projected Supply Chain Distribution Process**
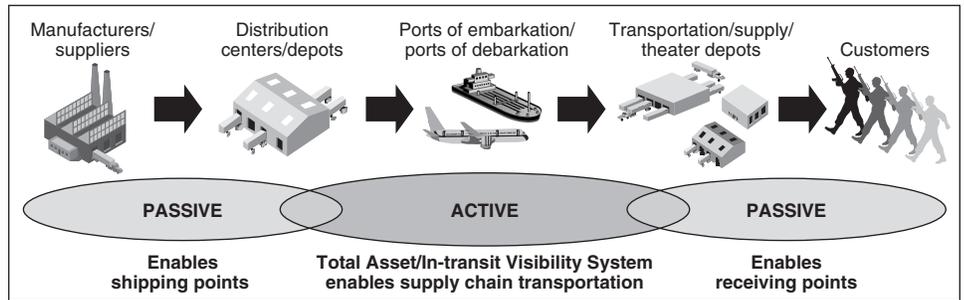


Source: U.S. Army.

As the defense logistics executive responsible for RFID implementation, the Under Secretary of Defense (Acquisition, Technology, and Logistics) issued DOD's final RFID policy on July 30, 2004. Certain other DOD military components also have specific responsibilities in the RFID implementation process. The DOD Logistics Automatic Identification Technology Office, for example, is the DOD focal point for coordinating overarching guidance for the use of automatic identification technology within the department. The Army Program Executive Office, Enterprise Information Systems, Product Manager Joint–Automatic Identification Technology Office is the DOD procurement activity for automatic identification technology equipment—including equipment and infrastructure—and it maintains a standing contract for equipment integration, installation, and maintenance. This office is also responsible for maintaining contracts for the purchase of passive RFID tags. DLA is the procurement activity and single manager for active RFID tags. Finally, the U.S. Transportation Command, as the distribution process owner, is responsible for directing and supervising execution of the strategic distribution system for moving and distributing supplies.

# DOD and Its Military Components Have Taken Actions to Implement Passive RFID Technology

DOD and its military components have developed RFID policy, and DOD has provided guidance to suppliers and military components for implementing passive RFID technology. DOD also is using pilot projects and has begun initial implementation at several receiving and conveyor locations to better understand this technology and test its application to their business processes. Although the military components have begun acquiring and funding the infrastructure needed for passive RFID implementation, existing infrastructure is minimal because implementation did not begin until January 1, 2005. Consequently, DOD is

just beginning to purchase equipment for passive RFID technology implementation, and it projects a sharp increase in expenditures as full implementation proceeds.

## DOD Has Developed Policy and Guidance and the Military Components Are Developing Plans to Implement Passive RFID Technology

Since 2003, the Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics) has developed policy and guidance to implement a potentially promising technology, known as passive RFID into their supply chain operations. The military services, DLA, and U.S. Transportation Command also have developed or are developing plans and guidance to support passive RFID implementation. DOD's RFID policy and the military components' implementation plans are evolving, and the department has taken several actions to provide additional guidance to suppliers and military components for implementing passive RFID. Figure 3 identifies the dates of several major policy and guidance actions that DOD has taken or plans to take to implement passive RFID into its supply chain processes. Although DOD plans to begin implementing the use of passive RFID to all classes of all commodities, excluding bulk commodities, shipped to all locations by January 1, 2007, it will be fiscal year 2016—and beyond for the Army—before passive RFID will be fully implemented into supply chain operations, according to Navy and Army funding projections.

**Figure 3: Timeline of Major DOD Actions to Implement Passive RFID**
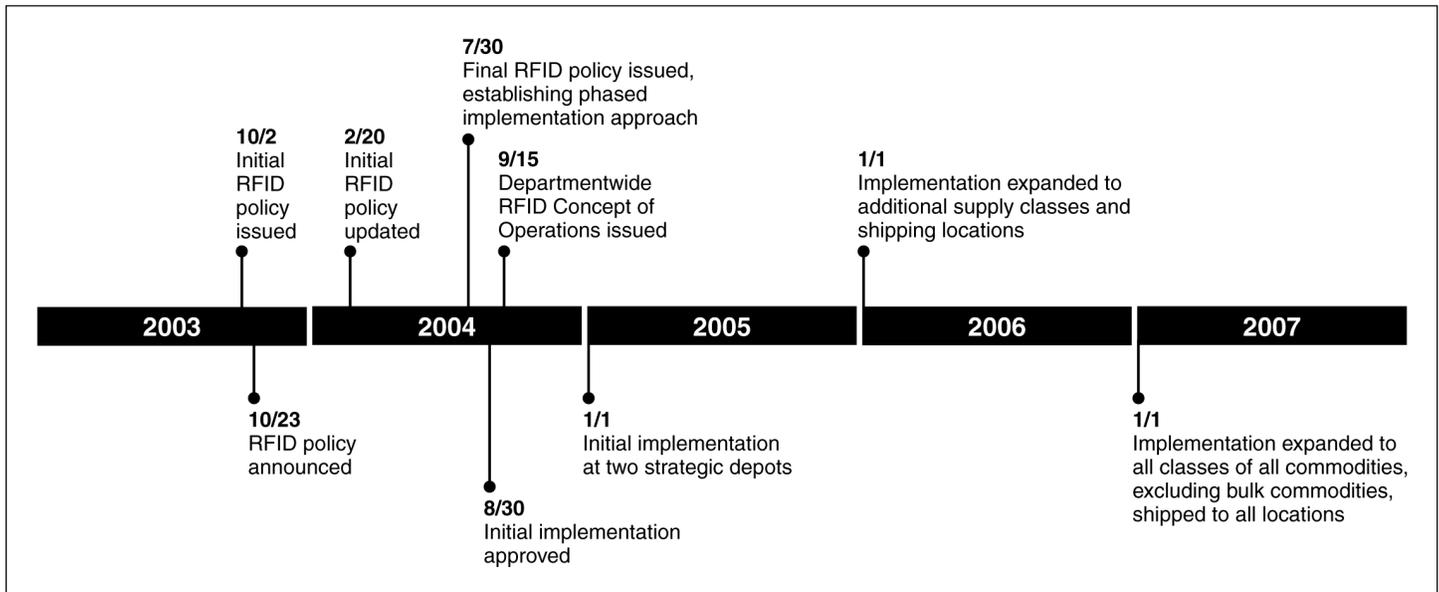


Source: GAO analysis of DOD data.

The initial RFID policy, issued by the Under Secretary of Defense (Acquisition, Technology, and Logistics), required suppliers to put passive RFID tags on pieces, parts, cases, or pallets by January 2005. A DOD news release officially announced the RFID policy in late October 2003. In early 2004, the initial RFID policy was updated. The updated policy provided an initial set of business rules for the implementation of passive RFID and laid out the requirement to plan for a January 1, 2005, implementation of the passive RFID business rules.

In late July 2004, the Under Secretary issued the final RFID policy. This policy finalized the business rules for the implementation of passive RFID and prescribed the implementation approach for DOD suppliers and vendors to use to apply passive RFID tags. The final policy establishes a mandatory requirement on solicitations issued on or after October 1, 2004, for suppliers to use passive RFID tags for deliveries that take place on or after January 1, 2005. This requirement applies to shipments of materiel in four supply classes that are delivered to two of DOD's distribution depots—San Joaquin, California, and Susquehanna, Pennsylvania—in accordance with the supplier implementation plan of the policy. In late August 2004, the Under Secretary of Defense (Acquisition, Technology,

and Logistics) issued a Logistics Decision Memorandum approving initial implementation of passive RFID at strategic distribution depots, strategic aerial ports, and maintenance depots. Starting January 1, 2006, the final RFID policy expands the requirement for suppliers to tag six additional supply classes and 32 additional shipping locations. Commencing January 1, 2007, all classes of all commodities, excluding bulk commodities, shipped to all locations are to be affixed with passive RFID tags.

According to the final policy, the Defense Logistics Board is to review the internal implementation plan, benefits, compliance requirements, and requisite budget requirements annually, based on an assessment of the implementation to date. As part of this review process, in late August 2004 the Under Secretary of Defense (Acquisition, Technology, and Logistics) met with the Defense Logistics Board to discuss DOD's strategy for RFID implementation and to obtain the board's agreement on future funding for both active and passive RFID. Additionally, a defense logistics executive decision memorandum issued in March 2005 stated that Defense Logistics Board members agreed that implementation of RFID across the department had the potential to greatly enhance visibility of the supply chain. The memorandum further stated that the business case analysis developed by DLA was compelling, and directed the secretaries of the military departments to move forward with passive and active RFID implementation. While we reviewed the contents of DOD's business case analysis, we did not assess its methodology and validity.

The final RFID policy also states that the Army's Program Executive Office Enterprise Information Systems continue development of a multivendor contract to support the purchase of passive RFID technology and to leverage the purchasing power of the department. Additionally, DOD's policy requires military components to prepare passive RFID implementation plans to support the DOD vision.

To meet the requirements of the final DOD RFID policy, in September 2004 DOD developed a departmentwide RFID Concept of Operations as an outline for the military services and other military components to follow in implementing RFID technology into DOD logistics and to articulate the specific uses of passive RFID throughout the DOD supply chain. The document outlines the scope, objectives and goals, assumptions and constraints, and project framework for DOD's implementation of RFID.

DOD has taken other actions to provide guidance and policy to DOD military components and external partners. For example, DOD has established Web sites such as www.dodait.com and www.dodrfid.org for

suppliers, DOD military components, and others to use to access RFID information, specifications, and updates to policy and guidance. DOD has also established Integrated Process Team Working Groups to discuss issues involving RFID and the implications of RFID for current business processes, new technology concerns, and strategic planning and implementation. DOD has hosted several conferences on RFID implementation instructions and training for suppliers and DOD military components.

In response to DOD's policy and concept of operations guidance, the military components are developing implementation plans to support DOD's policy and vision for passive RFID technology. As of January 2005, the Navy and DLA have completed passive RFID implementation plans. While the U.S. Transportation Command does not have a formal passive RFID implementation plan, its business process plan contains elements of DOD passive RFID guidance and requirements. The Army and Marine Corps have draft implementation plans, and the Air Force had just begun development of its plan at the time of this review.

## DOD Is Using Pilot Projects and Initial Implementations to Test the Application of Passive RFID Technology

DOD is using several pilot projects and has begun initial implementation at several receiving and distribution facilities to better understand passive RFID technology and test its application to their business processes. Examples of these pilot projects and initial implementations are listed in table 1 below. These pilot projects involve DLA and each military service and are small in scope, and generally have involved selected supply items, such as meals-ready-to-eat or individual protective clothing. One of these pilot projects, the Navy's ocean terminal project, which began in November 2003, successfully transitioned into an initial passive RFID implementation by May 2004. Since that time, the Navy's Fleet Industrial Supply Center, Ocean Terminal Division, has abandoned its legacy hand-held scanning processes in favor of the passive RFID documentation procedures, which document shipments by scanning RFID tags as they pass through reader devices. Furthermore, DOD's operational guidance required DLA to initially implement passive RFID by January 1, 2005, by enabling two of its distribution depots to receive selected passive RFID tagged items. As of late December 2004, DLA had completed this initial implementation at three receiving locations and one conveyor location in the Susquehanna, Pennsylvania depot and at three receiving and two conveyor locations in the San Joaquin, California depot. As of June 2005, a DLA official told us that surveys are being conducted to determine the number and location of future passive RFID infrastructure requirements. Reports regarding the results of some of the completed pilot projects cite

lessons learned that focus largely on the technical aspects of implementing the passive technology. For example, a meals-ready-to-eat pilot project, conducted in May 2004, was designed to simulate the process as products moved from vendor to depot to the delivery of the product to the unit level. This demonstration illustrated ways in which passive RFID could be implemented in the DLA supply chain. According to the reported results for this pilot, the most important benefit from the demonstration was the experience gained from the physical implementation of an RFID system within a DOD environment. Lessons learned centered on the technology's systems integration, application software, frequency coordination, and the immaturity of the passive RFID technology. Regarding the technology's immaturity, the report stated that the passive RFID hardware and software were currently too immature for many production operations.

Phase I of the protective equipment project tracked pallets and cases of Joint Service Lightweight Integrated Suit Technology (JSLIST) suits using passive RFID tags. The project evaluated the passive technology's implementation at three locations representing different functional areas of the JSLIST supply chain: vendor (shipping), DLA Distribution Center (receiving and shipping), and Army customer (receiving). The Phase I report stated that in March 2004 the first shipment of 29 pallets of RFID tagged suits was successfully distributed among the functional areas using a RFID-enabled receiving process. Lessons learned from the protective equipment project also indicated that passive RFID tag and reader technology is immature and that the receiving processes, data elements, and data entry procedures are not well known or documented at DLA distribution centers. We did not evaluate the results of these reports.

**Table 1: Examples of DOD's Ongoing, Completed, and Terminated Passive RFID Pilot Projects and Initial Implementations as of January 2005**

| Pilot project/initial implementation | Component | Location | Description |
|---|---|---|---|
| Pilot: DLA/Army MRE Shipments-ongoing | DLA/Army | Army National Training Center (interim test at Fort Lee) | Applying passive RFID tags to shipments of MREs from suppliers |
| Pilot: Individual Protective Equipment (IPE) completed 11/2004 | DLA/Army | San Joaquin, CA<br>Blue Grass Depot, KY<br>Fort Hood, TX | Receiving shipments of IPEs from San Joaquin to Blue Grass Army Depot tagged with passive RFID technology |
| Pilot: Military Shipping Label completed 12/2004 | Air Force | Spangdahlem AB, GE | Using passive RFID to replace active RFID tags for shipments to Spangdahlem AB, GE |

| Pilot project/initial implementation | Component | Location | Description |
|---|---|---|---|
| Pilot: Seabee RFID Pilot-terminated[a] 11/2004 | Navy | Fort Hunter-Liggett, CA | The integration of passive RFID into the Common Logistics Command and Control System - Joint Expeditionary Warfighter Logistics System |
| Initial implementation: Strategic distribution centers-ongoing | DLA | San Joaquin, CA<br><br>Susquehanna, PA | Centers capable of reading passive RFID tags attached to shipments received from suppliers and applying passive RFID tags on shipments to DOD activities and units |
| Initial Implementation: Norfolk/Lejeune Shipments-ongoing | Navy/Marine Corps | Norfolk Ocean Terminal/Camp Lejeune | Receiving shipments from DLA (Susquehanna, PA) tagged with passive RFID technology |

Source: GAO analysis of DOD data.

[a]This project was terminated because DLA was dissatisfied with the status and direction of the project, and its lack of DLA relevance.

## Existing Passive RFID Infrastructure Is Minimal, and Expenditures Are Projected to Increase Sharply as Full Implementation Proceeds

As of January 2005, the DOD military components owned and operated very little passive RFID infrastructure. DOD is just beginning to test and implement passive RFID technology for managing its inventory because passive RFID implementation did not officially begin until January 1, 2005. Passive RFID expenditures to date have largely been in connection with pilot projects, so DOD military components have spent a minimal amount of money on passive RFID technology. The passive RFID infrastructure owned by major DOD military components is shown in table 2. Future cost projections of implementing passive RFID in DOD's supply chain operations are estimated to be significantly higher than current expenditures as full passive RFID implementation proceeds. Additionally, the projected cost for passive RFID implementation—about $437 million from fiscal years 2006 through 2011—includes costs for purchasing passive RFID equipment such as tags, readers, and writers, and costs associated with installation and maintenance, but does not include the cost of system interoperability, which officials estimate to be the most expensive element of implementation.

**Table 2: Quantities of Passive RFID Infrastructure Items Reported by Major Department of Defense Component as of January 2005**

| DOD component | Tags | Readers | Handheld readers | Writers/ printers |
|---|---|---|---|---|
| DLA | 5,000 | 11 | 0 | 5 |
| U.S. Transportation Command | 0 | 0 | 0 | 0 |
| Army | 0 | 0 | 0 | 0 |
| Navy | 8,867 | 16 | 10 | 1 |
| Air Force | Yes[a] | 40 | 2 | 8 |
| Marine Corps | 0 | 4 | 0 | 0 |
| **Total** | **Unknown** | **71** | **12** | **14** |

Source: GAO analysis of data from the DLA, U.S. Transportation Command, Army, Navy, Air Force, and Marine Corps.

[a]The Air Force did not provide the quantity of passive tags owned.

DOD military components have spent a minimal amount of money on passive RFID technology because passive RFID technology is new and DOD is just beginning to implement this technology in its supply chain processes. Current expenditures have largely been in connection with pilot projects. As of January 2005, DOD and its military components had spent about $7.4 million on passive RFID technology. As shown in table 3, the Army and the Marine Corps had not spent any money on pilot testing passive RFID as of January 2005. The Marine Corps does possess some passive RFID infrastructure; however, according to Marine Corps officials, that infrastructure was acquired and paid for by the Office of the Secretary of Defense (OSD). As of January 2005, DLA had spent the most on passive RFID infrastructure in its pilot testing and initial implementation at two of its distribution depots, in San Joaquin, California, and Susquehanna, Pennsylvania.

**Table 3: Reported Passive RFID Expenditures by Major DOD Component as of January 2005**

| DOD component | Expenditures |
|---|---|
| OSD | $1,650,000[a] |
| DLA | $3,545,000[b] |
| U.S. Transportation Command | $503,000[c] |
| Army | $0[d] |
| Navy | $1,458,523[e] |
| Air Force | $276,761[f] |

| DOD component | Expenditures |
| --- | --- |
| Marine Corps | $0[g] |
| **Total** | **$7,433,284** |

Source: GAO analysis of reported expenditure data from OSD, DLA, U.S. Transportation Command, Army, Navy, Air Force, and Marine Corps.

[a] OSD estimate consists of funding for consulting services, tags, readers, software, etc. to support initial implementations.

[b] The DLA estimate consists of funding for six passive RFID pilot projects and initial implementation at two distribution depots—Susquehanna, PA, and San Joaquin, CA.

[c] The U.S. Transportation Command estimate consists of funding for one passive RFID pilot project.

[d] The Army has not spent any money on passive RFID.

[e] The Navy estimate consists of funding for five passive RFID pilot projects.

[f] The Air Force estimate consists of funding for one passive RFID pilot project.

[g] The Marine Corps does possess some passive RFID infrastructure; however, it was purchased by OSD.

Future cost projections of implementing passive RFID in DOD's supply chain operations are estimated to be significantly higher than current expenditures. In response to OSD's final RFID implementation policy, major DOD military components have projected significant increases in passive RFID funding for fiscal years 2006 through 2011. Although passive RFID testing and implementation in the DOD supply chain had cost $7.4 million as of January 2005, from fiscal years 2006 through 2011 the DOD military components project costs of about $437 million on passive RFID implementation, as shown in table 4. The figures provided by DLA represent actual budgeted amounts, while other component officials emphasized that the projections they provided were estimates and did not represent actual figures in the budget. The Marine Corps and Air Force did not provide any cost projections for passive RFID.

**Table 4: Passive RFID Projected Costs by Major DOD Component and Year for Fiscal Years 2006 through 2011**

Dollars in thousands

| DOD component | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | Total |
|---|---|---|---|---|---|---|---|
| DLA[a] | $25,706 | $23,191 | $20,747 | $18,516 | $18,553 | $18,098 | **$124,811** |
| U.S. Transportation Command[b] | $580 | $1,047 | $743 | $780 | $495 | $535 | **$4,180** |
| Army[b] | $5,600 | $8,030 | $12,040 | $17,713 | $26,110 | $39,660 | **$109,153** |
| Navy[b] | $3,000 | $16,400 | $38,700 | $43,000 | $48,300 | $49,900 | **$199,300** |
| Marine Corps[c] | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| Air Force[c] | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| **Total** | **$34,886** | **$48,668** | **$72,230** | **$80,009** | **$93,458** | **$108,193** | **$437,444** |

Source: GAO analysis of data from DLA, U.S. Transportation Command, Army, Navy, Air Force, and Marine Corps.

[a] The DLA figures are actual budgeted amounts.

[b] The U.S. Transportation Command, Army, and Navy figures are based on overall maintenance and procurement projections.

[c] The Marine Corps and Air Force did not provide us with any passive RFID cost projections.

Although the total projected cost for passive RFID implementation is estimated at about $437 million over fiscal years 2006 through 2011, this total does not include the cost of system interoperability. Officials estimate system interoperability to be the most expensive element of implementation because of the various systems that will need to be integrated to exchange automated shipping and receiving data from the use of passive RFID technology. According to DOD, system interoperability entails the ability of systems, units, or forces to provide data, information, materiel, and services and to accept the same from other systems, units, or forces and to use the data, information, materiel, and services so exchanged to enable them to operate effectively together. Interoperability includes both the technical exchange of information and the end-to-end operational effectiveness of that exchange of information as required for mission accomplishment. DOD envisions a seamless integration between passive and active RFID technology; however, such a seamless integration cannot take place unless the information captured by the RFID technology can flow though interoperable logistics information systems. According to Navy and Army projections, it will be fiscal year 2016—and beyond for the Army—before passive RFID will be fully implemented into supply chain operations. The Marine Corps and Air Force did not know their funding needs for implementing passive RFID. As of January 2005, there was no estimate as to how much full interoperability will cost. System interoperability is just one of many

challenges DOD must overcome before full implementation can occur throughout DOD's supply chain process.

# DOD's Implementation of Passive RFID Technology Lacks a Comprehensive Strategic Management Approach

While DOD has taken a number of actions to guide and direct the implementation of passive RFID into the supply chain process, passive RFID could be more efficiently and effectively implemented if DOD developed a comprehensive strategic management approach to ensure that implementation efforts are guided by sound management principles. Sound management principles, such as those used by leading organizations and embodied in GPRA, include identification of general and long-term goals and objectives, a description of specific actions, performance measures to evaluate actions, recognition of key external factors, comprehensive schedules and milestones, identification of resources and annual cost estimates, accountability for implementation, and evaluation of the overall program with specific processes to allow for adjustments and changes. Combined with effective leadership, these principles provide decision makers with a framework to guide program efforts and the means to determine if these efforts are achieving the desired results. We compared the contents of DOD's and available military components' implementation plans with these key management principles. Table 5 shows the results of the analysis for passive RFID.

**Table 5: Comparison of Key Management Principles to DOD's and Its Military Components' Passive RFID Policies and Implementation Plans**

| | Key management principles | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Component | General and 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 |
| U.S. Transportation Command | No | Partially | No | No | No | Partially | Partially | No |
| Army[a] | Partially | Partially | Partially | Yes | Partially | No | Yes | No |
| Navy | Partially | Partially | Partially | Yes | Yes | Yes | Yes | Partially |
| Air Force[b] | No | No | No | No | No | No | No | No |
| Marine Corps[c] | Partially | Partially | No | Yes | No | Partially | Yes | No |

Source: GAO analysis of DOD data.

[a] The Army's RFID plan was a draft document at the time of this analysis.

[b] The Air Force had not developed a plan at the time of this analysis.

As table 5 shows, many of these key management principles are missing or are only partially incorporated into existing passive RFID implementation policy and operational guidance for both DOD and its military components. While DOD has incorporated some of these key management principles—for example, by establishing business rules for passive RFID to explain how RFID will affect supply chain operations and processes— DOD has not fully incorporated all of these principles into a comprehensive strategic management approach to manage the implementation of passive RFID into the DOD logistics supply chain. In turn, the DOD military components are also unable to develop comprehensive plans to support DOD-wide passive RFID implementation due to the lack of an overarching DOD comprehensive strategic management plan. Among the key management elements that are missing or only partially present are (1) general and long-term goals and objectives, (2) a description of specific actions to support goals and objectives, (3) performance measures to evaluate specific actions, (4) schedules and milestones for meeting deadlines, (5) identification of total resources needed and annual cost estimates for passive RFID implementation into the supply chain, and (6) evaluation of the overall program with specific processes to allow for adjustments and changes.

The following discussion focuses on the key principles that are missing or only partially present in DOD's and its military components' planning and operational guidance for passive RFID.[4]

- **General and long-term goals and objectives**. Key management principles include having clearly defined general and long-term program goals and objectives with specific expected results and annual goals that relate back to the overall goals and objectives to guide implementation. OSD has identified general passive RFID broad and descriptive goals and objectives, such as to (1) implement knowledge-enabled logistics through fully automated visibility and management of assets in support of the warfighter; (2) ensure readiness for the forces and sustainability of the operations; (3) increase warfighter/customer confidence in the reliability of the DOD supply chain; (4) improve process efficiency of sourcing and delivery by improving shipping and receiving subprocesses; (5) improve

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[4] We did not perform a GPRA comparison for the Air Force because the Air Force had not developed its RFID implementation plan at the time of this analysis.

product lifecycle management (i.e., warranties/configuration management); (6) employ mature and emerging supply chain technologies to optimize effective in-transit and asset visibility within the DOD supply chain; (7) enable an adaptive supply chain with sense and respond capabilities; and (8) use RFID to facilitate accurate, hands-off data capture in support of business processes in an integrated DOD supply chain enterprise as an integral part of a comprehensive suite of automatic identification technology. The Army, Marine Corps, Navy, and DLA goals and objectives, included in their respective RFID implementation plans, are also general and descriptive in nature. The OSD and component general and descriptive goals and objectives do not define specific expected results, such as integration of automatic information systems, and no annual goals are identified, as suggested by the principle. A hierarchical relationship among and between OSD's and the military components' goals and objectives is also lacking. The U.S. Transportation Command's implementation plan for passive RFID did not contain any goals or objectives.

- **Description of specific actions to support goals and objectives**. Good management practices call for a description of specific actions to support goals and objectives. OSD has described, in some detail, specific actions related to operational processes where passive RFID technology is expected or mandated to be used. OSD's planning also includes an expectation for the automated information systems that support logistics activities to be RFID compatible. However, the following specific actions are not consistently present throughout OSD's policy or the military components' implementation plans: obtaining necessary workforce skills, considering human resource issues, identifying major capital resources (for example, RFID-specific equipment such as read stations and write stations), identifying major technological resources, and obtaining needed information resources. The presence of such specific actions is important for evaluating the achievement of organizational visions, missions, goals, and objectives, and could provide the basis for monitoring corrective actions that may be needed. Inclusion of such actions could assist DOD and the military components to better develop a strategic focus for passive RFID implementation and to ensure goals and objectives are achieved.

- **Performance measures to evaluate specific actions**. Successful organizations develop performance measures to evaluate specific actions for programs. OSD policy does not include performance measures to assess specific actions developed for passive RFID implementation. The Army and Navy implementation plans contain a basic set of measures designed to determine what progress the Army and Navy are making in achieving OSD's and their overall goal of improved logistics. For example, measures the Army identified include quantitative improvement for in-transit visibility, the read rate (accuracy) of tags, and the amount of

inventory reduced by the RFID technology. While these performance measures evaluate specific actions and support OSD goals and objectives, the planning does not include interim steps or specific details of how the measures will be taken or further identification of what targets the Army and Navy must achieve in order to be successful. Neither DLA, the U.S. Transportation Command, nor the Marine Corps included any performance measures in their respective passive RFID implementation plans.

- **Comprehensive schedules and milestones for meeting deadlines**. Leading organizations incorporate comprehensive schedules and milestones for meeting deadlines to monitor the progress of a program. For passive RFID, the Army, Navy, OSD, and DLA had short-term schedules, but these plans were only 2-year schedules based on supporting OSD guidance. Key management principles recommend that these schedules and milestones span a 5-year period. The Marine Corps and U.S. Transportation Command had no schedules and milestones listed for passive RFID in their implementation plans.

- **Identification of total resources needed and annual cost estimates**. Good management practices call for the identification of total resources needed and annual cost estimates. For passive RFID, OSD and its military components have established a framework for resource and annual cost estimation. For example, OSD states that the cost of implementing RFID into the DOD supply chain would be funded with Operations and Maintenance Fund or Working Capital Fund processes. The Navy's plan identifies annual and total resources needed; however, total resources needed—including annual cost estimates—are not present in OSD's plan or in the plans of the other military components. Without detailed resource planning, DOD and its military components cannot be certain that the passive RFID investments they are making are the right investments to meet their needs, and that implementing passive RFID would result in a sound return on their investments.

- **Evaluation of an overall program with specific processes to allow for adjustments and changes**. Successful organizations implement the evaluation of an overall program with specific processes to allow for adjustments and changes. For passive RFID, OSD identified evaluation methods to monitor progress toward achieving the general goals and objectives of DOD-wide RFID implementation. For example, OSD's final RFID policy states that the Defense Logistics Board is to review internal implementation plans, benefits, compliance requirements, and requisite budget requirements annually based on an assessment of the implementation to date. This review is to include an updated analysis of implementation success as well as to provide guidance for the expansion of RFID capabilities into additional applications and supply chain functional processes. Although OSD identified evaluation methods to

monitor progress towards achieving general goals and objectives, no specific process is in place to reexamine and revise the general goals and objectives themselves. The Navy also acknowledged the need for evaluation, but it did not explain how this evaluation would occur. DLA, the U.S. Transportation Command, the Army, and the Marine Corps did not include any evaluation methods in their passive RFID implementation plans. The U.S. Transportation Command's participation in passive RFID pilot programs is mentioned, but no process for evaluating RFID implementation is stated.

While DOD and its military components have made strides in developing policy and guidance to implement passive RFID, their early planning does not go far enough to protect the government's interest as investment in the technology continues. Because the military components are developing implementation plans to support DOD's RFID policy, the development of a comprehensive strategic management approach that fully incorporates these key management principles could provide decision makers in both DOD and the military components with a framework to guide RFID implementation efforts and the means to determine whether these efforts are achieving the desired results.

# DOD Has Identified Several Challenges for Passive RFID

DOD officials have identified a broad spectrum of challenges concerning passive RFID that remain to be resolved before passive RFID technology can be fully implemented into DOD operations, but their RFID implementation planning does not include any actions to mitigate these challenges. Among the challenges facing DOD as it implements passive RFID are those in four distinct categories. First, passive RFID technology is a new technology that is evolving. Consequently, electronic product code (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. Second, 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. Third, the return on investment from passive RFID has been difficult to determine and without the data needed to create a business case analysis, the military services have been reluctant to provide funding for implementation. Fourth, certain regulatory and administrative requirements remain, including the implementation of a Defense Federal Acquisition Regulation Supplement rule (acquisition rule) and the

approval of a multivendor contract for passive RFID purchases. In addition, although DOD and its military components have identified these passive RFID implementation challenges, they have not yet identified actions to mitigate these challenges.

## Technology Is Evolving

The EPC standards for passive RFID tags were being revised at the time of our review to provide increased capabilities,[5] and as of August 2005 these revised standards had been published and were awaiting approval from the International Standards Organization.[6] These new standards, designated EPC UHF GEN 2 (Generation 2), call for a radio frequency range of Ultra-High Frequency (UHF) 860-960 MHz, with a minimum read range of 3 meters—about 10 feet. The Generation 2 specifications were published in December 2004, but equipment and tags using these specifications were not available as of May 2005. DOD's RFID policy for placing tags on cases, pallets, and item packaging of shipped goods calls for the phasing out, over an anticipated 2-year period, of the tags currently in use once equipment operating under the new tag specifications is available. The current policy requiring the use of existing passive tags on items shipped after January 2005 has caused component officials to question the rationale for making an investment in tags and equipment, such as readers and printers, that will have to be replaced or upgraded in a short period of time to comply with the Generation 2 standards and tag format.

In our May 2005 report concerning governmentwide use of RFID technology, we identified a potential concern about whether the demand for passive RFID tags and equipment may eventually exceed the industrial base's ability to supply them.[7] Specifically, we stated that the increasing demand for passive RFID tags may eventually outstrip the supply and that the 30 percent damage rate during production will likely contribute to

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[5] The EPC standards provide a uniform format for encoding passive RFID tags to carry a sequence of digits that identifies the manufacturer, product, and version, followed by another sequence that is a serial number, which identifies each item uniquely.

[6] EPCglobal, Inc., is working with DOD to administer and develop the EPC standards. EPCglobal was formed in November 2003 as a joint venture between EAN Inc. and the Uniform Code Council. It is "a not-for-profit organization … to establish and support the Electronic Product Code (EPC) Network as the global standard for immediate, automatic, and accurate identification of any item in the supply chain of any company, in any industry, anywhere in the world."

[7] GAO-05-551.

future shortages. Army representatives expressed similar concerns about the industrial base's ability to supply passive tags and equipment in sufficient quantities to meet the implementation demand anticipated by both the military and commercial sectors. Thus, the infrastructure, such as RFID readers and write-stations, which are needed to support passive RFID technology, could be unavailable as implementation progresses. For example, DOD's and Wal-Mart's schedules for implementing passive RFID technology are similar, which could drive the near-term demand for tags and other equipment to exceed supply levels. Wal-Mart, the largest U.S. retailer, is requiring all of its suppliers to adopt RFID technology standards as of January 2006. As of January 18, 2005, according to Wal-Mart officials, 57 of the 100 suppliers scheduled to implement RFID in January 2005 were shipping tagged cases and pallets and that some of the 200 suppliers scheduled to begin shipping tagged cases and pallets in 2006 were already doing so. Army representatives also pointed out, however, that once Generation 2 standards are finalized, additional industrial base sources are expected to emerge to meet and surpass the public- and private-sector market demand.

Additionally, training is an ongoing challenge to passive RFID implementation. As in any new technology or operating system, the end users must be trained both to recognize RFID and to use it. Such training is especially important when dealing with inventory assets for DOD personnel operating in a combat setting. While the services have acknowledged this lack of training and are working to correct it, concerns remain about passive RFID training, as the following examples illustrate.

- The Air Force has provided passive RFID training to personnel in selected areas, associated with their pilot projects, but it has not institutionalized this training in its training curriculum.
- The Army has updated its training curriculum to include active RFID training into its business processes. In addition, its reserve forces get the same training as the active forces, and several reserve classes have already received training in active RFID technology. However, the Army is presently considering how to incorporate passive RFID training into its curriculum. At the time of our review, no official passive RFID training was in place.
- The Navy provides passive RFID technology training through contractor support in conjunction with its active RFID training on Early Entry Deployment System Kits; these kits provide the capabilities of writing/reading/uploading tags, access to regional servers, and printing labels.

- The Marine Corps anticipates using contractor support for passive RFID training in conjunction with its active RFID training on Early Entry Deployment System Kits, as well as including this training into its training center curriculum.
- U.S. Transportation Command officials pointed out that they are attempting to train all shippers, transportation consignees, and supply receivers to correctly use the single RFID format and data standard that DOD adopts. The requirements and standards for this are being developed and mandated by OSD/Joint Chiefs of Staff offices. As the distribution process owner, the U.S. Transportation Command is responsible for improving the overall efficiency and interoperability of distribution-related activities.

Overall, DOD and its military components acknowledged that passive RFID implementation will require significant training to ensure proper use throughout the military supply chain.

## Performance Capabilities of Passive RFID Technology Are Still Being Determined

Three performance capability issues also lead to challenges for DOD in implementing passive RFID technology. The first is that of systems integration, which enables interoperability of automatic information systems among the military components so these systems can work together and facilitate active and passive system interaction. Furthermore, common systems and standards for interoperability need to be established. For example, an Air Force official explained that because DLA and each of the services are developing their own plans to incorporate passive RFID into existing business processes, there is a possibility that implementation in each service could be different, leading to limited interoperability among the services. If passive RFID implementation is not interoperable among the services, this could lead to inefficiencies that could be avoided if interoperability had been built into the services' passive RFID implementation plans as these plans developed.

A second performance capability issue concerns the accuracy of passive RFID tag read rates. Army officials told us that within DOD and private industry there is a concern about the level of accuracy for reading tags. For example, results of some read-rate experiences within DOD and commercial industry have been reported at approximately 90 percent accuracy for passive RFID tags placed on individual cases and pallets. This is "not yet good enough" for Army-wide implementation, according to officials in the Army Program Executive Office, Enterprise Information Systems, Product Manager Joint–Automatic Identification Technology Office. The 10 percent tag misread rate could be attributed to the

placement of the tags on an item or to the quality of the tags. For instance, Navy tests have shown that inaccurate tag readings can occur when metals, packages containing liquids, or extremely dense material are tagged. In addition to the problems in reading individual tags, the technology is not yet sufficiently sophisticated to read all tagged items on fully loaded pallets within acceptable accuracy rates. For example, Navy officials found problems reading tags on items in the middle of a pallet versus those on the periphery. According to a Navy official, testing in October 2004 regarding the Navy ocean terminal pilot project identified an 85 percent accuracy read rate for tagged items on fully loaded pallets. The Air Force has experienced considerably lower accuracy read rates, ranging from 32 to 65 percent, according to a briefing presented by an Air Force official on February 10, 2005. Private industry has experienced this problem as well. According to Wal-Mart officials, as of January 18, 2005, the accuracy of its read rate for tagged items on fully loaded pallets was 66 percent and stated that reading all cases on a fully loaded pallet remains the biggest challenge. Our May 2005 report corroborates reliability problems with reading tags—and an inability to read tags in some instances—associated with conditions such as close proximity of multiple tagged items, environmental conditions, and reading tags at high speeds.[8] Furthermore, some tags have been found to be fragile, which could be a result of manufacturing and production techniques, according to an Army official. The fragility of passive RFID tags is further corroborated by a research group's survey of RFID tag vendors. We reported in May 2005 that this survey found that up to 30 percent of chips for passive RFID tags are damaged during production when they are attached to their antenna, and an additional 10 to 15 percent are damaged during the printing process.

A third area of performance capability involves spectrum frequency. Obtaining radio frequency spectrum permissions outside the continental United States is an implementation issue. Foreign governments can impose requirements on the type of RFID reader technology to be used, and must grant permission for use of spectrum frequencies in their countries. Army officials told us that the military does not use RFID technology in countries that do not grant frequency permission. Currently there is no worldwide frequency standard for passive RFID tags. For example, the allowed UHF frequency spectrum in the United States, Europe, and Japan ranges from 860 to 960. However, the International

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[8] GAO-05-551.

Organization for Standardization is considering possible worldwide frequency standards for passive RFID tags because of the impact an absence of standards could have on the commercial application of RFID tags. Furthermore, an Army official told us that Germany's frequency spectrum for active RFID will change in 2006. Consequently, radio-frequency-dependent equipment may have to be upgraded or replaced. Army officials are considering the use of region- or country-specific RFID readers operating with locally approved frequencies to address this issue.

## Concerns Exist about the Unknown Return on Investment for Passive RFID

The military services have expressed concern about the unknown return on investment for passive RFID, which has led to reluctance to provide funding for passive RFID. Studies have been conducted to determine a return on investment, although these studies have had mixed results. Without data to determine a business case analysis that would demonstrate a return on investment from using passive RFID technology, the military services have been reluctant to provide funding to support it. For example, in commenting on DOD's draft RFID policy, Air Force officials stated that DOD directed investment in passive RFID infrastructure without first building a business case to document the savings. Without seeing documented savings, the Air Force considered that it would face tremendous challenges in supporting the initial investment.

Navy officials commented similarly that without a compelling business case it is unable to proceed with investments and implementation as it needs to do. DOD's operational guidance states that the military components will plan for a January 1, 2005, implementation of passive RFID, although DOD's RFID policy does not require implementation by the military components to begin until January 1, 2006. Navy officials expressed their concern that this 2005 goal was not supportable because the Navy had not planned or budgeted for enabling passive RFID at its key supply system locations. Navy officials stated that a compelling business case was needed to help balance their total resource requirements against passive RFID's projected benefits. They also explained that ultimately they need a better understanding of the savings that investment in passive RFID can provide.

Furthermore, in commenting on DOD's draft RFID policy, the Office of the Army's Deputy Chief of Staff for Logistics pointed out several concerns impacting the Army's implementation of passive RFID technology. First, funding for passive RFID technology would be challenging because DOD's RFID policy was issued in the middle of a budget cycle and the schedule

for implementing RFID was not synchronized with the budget cycle process. Second, in order to justify funding necessary to implement passive RFID, the Army needed to conduct business process analyses, pilot projects, and site surveys, as well as to procure equipment and develop and conduct training to support RFID. Third, while DOD's RFID policy states that the cost of implementing and operating RFID technology is to be considered a normal cost of transportation and logistics, and it should be funded through routine operation and maintenance, working capital funds, or capital investment processes, such use of working capital funds would increase operating costs and surcharges until the potential RFID benefits offset them. Those costs would, in turn, be passed on to customers through higher prices that would have to be paid from appropriated funds. Finally, the Army is transitioning from its legacy Standard Automated Management Information System to a replacement system, the Single Army Logistics Enterprises System. Army officials have not determined if adopting passive RFID in its legacy systems is a sound investment strategy. They elaborated that because the Army is fielding its new Single Army Logistics Enterprises System, expensive and time-consuming changes to its legacy system may not be cost effective.

Regarding costs and benefits of implementing passive RFID, we reported in May 2005 that organizations need to determine whether the increased visibility provided by RFID technology will outweigh the costs associated with its implementation.[9] The military components and OSD have conducted some studies to develop a business case for use of RFID, although these studies have had mixed results. For example, the Center of Naval Analysis published a cost and benefits study in June 2004, but concluded that the option preferable to current full investment would be to wait until passive RFID technology is more mature because they had no hard data to use to estimate benefits.[10] However, according to a January 25, 2005, DLA briefing, the bottom-line results of a DOD business case analysis found that "there is a reasonable to good expectation that implementation of Passive RFID across DOD will provide an economic return on investment in the near term and an excellent expectation of economic returns in the long term." This DOD business case analysis was issued in April 2005 and was conducted pursuant to an August 30, 2004, logistics decision memorandum directing DLA to work with the Deputy

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[9] GAO-05-551.

[10] Center of Naval Analysis, *An Examination of Costs and Benefits of Navy RFID Adoption*, CRM D0010265.A2/Final (June 2004).

Under Secretary of Defense (Logistics and Materiel Readiness) to document the investment and cost benefits of implementing passive RFID. DOD recognized that this business case analysis is an initial and abbreviated analysis due to time constraints. The DOD business case analysis presented two results, which it characterized as optimistic and pessimistic. The optimistic result estimated savings of $1.781 billion, while the pessimistic result estimated savings of $70 million. In a March 10, 2005, Logistics Decision Memorandum, the Under Secretary of Defense (Acquisition, Technology, and Logistics) stated that this business case was compelling and directed the Secretaries of the military departments to move forward with passive and active RFID implementation as justified by the DOD business case. While we did not assess DOD's business case for implementing passive RFID because it was released after we completed our field work, we believe that it represents a step in the right direction. Lastly, Army officials informed us that the Army's Logistics Transformation Agency is conducting a business case analysis involving passive RFID, but this analysis was still being conducted as of May 2005.

## Regulatory and Administrative Requirements Need to Be Approved

DOD faces two additional challenges in implementing passive RFID as a result of regulatory and administrative processes. The regulatory challenge faced by DOD is one of ensuring consistency in the contractual requirements its vendors must follow in affixing or applying passive RFID tags on the products DOD purchases. DOD's July 30, 2004, RFID policy includes a requirement that passive RFID will be mandatory in solicitations issued on or after October 1, 2004, for delivery of materiel on or after January 1, 2005. To implement this action, DOD has proposed a rule to amend the Defense Federal Acquisition Regulation Supplement (DFARS)[11] for passive RFID. This proposed rule was published in the *Federal Register* on April 21, 2005, for a 60-day comment period.[12] The proposed rule is limited in scope, specifying that passive RFID tagging will be required on only four supply classes,[13] excluding bulk commodities, and

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[11] DFARS are published regulations DOD uses to establish and manage procurement business rules, policy, and guidance. The Director of Defense Procurement and Acquisition Policy is responsible for these regulations.

[12] 70 *Fed. Reg.* 20726 (Apr. 21, 2005). After further consideration following the 60-day comment period, DOD will determine if and when to finalize a proposed rule.

[13] These four classes are Subclass of Class I, packaged operational rations; Class II, clothing, individual equipment, tentage, organizational tool kits, hand tools, and administrative and housekeeping supplies and equipment; Class VI, personal demand items; and Class IX, repair parts and military components.

only applies to shipments of those classes of items that are delivered to two specific defense distribution depots—Susquehanna, Pennsylvania, and San Joaquin, California. As DOD continues implementation, it will need similar DFARS amendments that apply to its remaining supply classes and shipping locations. For example, DOD's RFID policy expands the requirement for passive RFID tagging as of January 1, 2006, to six additional supply classes and 32 additional shipping locations, and as of January 1, 2007, to all supply classes (except bulk commodities) shipped to all locations. Consequently, DFARS may need to be further amended to accommodate implementation of DOD's expanded policy requirements. Until additional DFARS amendments are in place, the contract language regarding vendors' placement of passive RFID tags on all products purchased by and shipped to DOD may not be standardized. Without additional DFARS rules, supply contracts could be subjected to individual contract clauses regarding passive RFID, which could result in inconsistencies among contracts across DOD and its military components.

The administrative challenge concerns establishing agreements with vendors to provide EPC-compliant technology through multivendor contract mechanisms, which can include the use of blanket purchase agreements, to leverage the purchasing power of the department for passive RFID infrastructure purchases. DOD designated the Army Program Executive Office, Enterprise Information Systems, Product Manager–Automatic Identification Technology Office as the DOD procurement agent for automatic identification technology equipment, including RFID equipment and infrastructure. As such, the office is to establish and maintain a multivendor contract for equipment, equipment integration, installation, and maintenance. While DOD policy requires that passive RFID implementation begin on January 1, 2005, the absence of a multivendor contract obligated the services and DLA to individually purchase passive RFID equipment in order to conduct the services' pilot projects and meet DLA's commitment to enable two of its depots—Susquehanna, Pennsylvania, and San Joaquin, California—to receive and process passive RFID-tagged shipments from vendors. In addition, according to an official in the Army Program Executive Office, a total of five blanket purchase agreements are to be established for passive RFID. As of April 12, 2005, the Automatic Identification Technology Office had established one blanket purchase agreement for passive RFID tags. It is still in the process of establishing the remaining four blanket purchase agreements for acquiring passive RFID equipment. According to Army officials, the delay in establishing the multivendor contract can be attributed to the fact that Army and DOD officials were working to define requirements and develop an Independent Government Cost Estimate, a

process that they consider to be part of the normal contracting process. Until other multivendor contracts are established, the DOD military components may be unable to leverage the purchasing power of the department to realize economy and efficiency benefits. In response to DOD's comments on a draft of this report, we were informed that as of August 11, 2005, three blanket purchase agreements have now been awarded, and only two agreements remain to be established and are expected to be established in the near future.

## DOD and Its Military Components Have Not Yet Identified Actions to Mitigate Passive RFID Implementation Challenges

Although the Marine Corps and Army draft passive RFID plans and the Navy and DLA passive RFID plans identify challenges and external factors affecting implementation, which is a key element of GPRA, most of these plans do not identify any actions for mitigating passive RFID implementation challenges. The OSD and U.S. Transportation Command plans do not identify passive RFID implementation challenges. Based on our discussions with DOD officials, the underlying cause of these various challenges is the newness and evolving nature of the technology. However, officials noted that the current challenges they face will be resolved in time and are to be expected with the integration of any new technology. We recognize that the identification of such challenges is a positive and essential step, but identification does not go far enough to ensure their resolution in an efficient and effective manner. Until DOD and the military components identify actions to mitigate these implementation challenges, their progress in resolving these challenges will be impeded.

## Conclusions

Although much more needs to be done, incorporating passive RFID technology into the DOD supply chain offers the promise of a technology that may begin to help address the long-standing problems of inadequate asset visibility throughout DOD and the military services. While DOD and its military components have made strides in developing policy and guidance to implement passive RFID, their early planning does not go far enough to ensure that Congress is sufficiently informed of the investments that will be required and that the department can achieve its goals with this technology. In particular, neither the department nor its military components have developed comprehensive strategic management approaches to ensure that implementation efforts fully incorporate key management principles, such as those used by leading organizations and contained in the Government Performance and Results Act. These principles can provide decision makers with a framework to guide program efforts and the means to determine if these efforts are achieving the desired results. Although DOD and its military components have

incorporated some of these key management principles in their RFID policy and guidance, many of these principles are missing or are only partially present. Without an improved management approach, DOD and its military components may, in the long term, continue to invest heavily in passive RFID without knowledge of which and how much infrastructure, and at what cost, will be needed to meet overall goals, objectives, and strategies. In addition, some key challenges slowing progress toward full implementation of RFID include (1) the newness and unproven state of passive RFID technology, (2) difficulty with demonstrating a sound business case and return on investment for passive RFID technology, and (3) lack of a DOD-wide needs assessment that identifies, by location, the infrastructure, maintenance support, and funding resources needed to fully implement passive RFID technology in the DOD supply chain processes. As the department and the military components continue to implement passive RFID without a comprehensive strategic management approach that identifies the challenges impeding implementation and ways to overcome those challenges, DOD and its military components will not have a means of measuring the progress of implementation and developing defensible budget requests, or of taking corrective actions as necessary in competitive budget environments.

# Recommendations for Executive Action

We recommend that the Secretary of Defense take the following three actions:

- Direct the Under Secretary of Defense (Acquisition, Technology, and Logistics) to expand its current RFID planning efforts to include a DOD-wide comprehensive strategic management approach that will ensure that RFID technology is efficiently and effectively implemented throughout the department. This strategic management approach should incorporate the following key management principles:
  - an integrated strategy with goals, objectives, and results for fully implementing RFID in the DOD supply chain process, to include the interoperability of automatic information systems;
  - a description of specific actions needed to meet goals and objectives;
  - performance measures or metrics to evaluate progress toward achieving the goals;
  - schedules and milestones for meeting deadlines;
  - identification of total RFID resources needed to achieve full implementation; and
  - an evaluation and corrective action plan.
- Direct the secretaries of each military service and administrators of other DOD military components to develop individual comprehensive strategic

management approaches that support the DOD-wide approach for fully implementing RFID into the supply chain processes.

- Direct the Under Secretary of Defense (Acquisition, Technology, and Logistics), the secretaries of each military service, and administrators of other military components to develop a plan that identifies the specific challenges impeding passive RFID implementation and the actions needed to mitigate these challenges. Such a plan could be included in the strategic management approach that we recommend they develop.

## Agency Comments and Our Evaluation

DOD provided written comments on a draft of this report. The department concurred with our recommendation for each of the military services and administrators of other DOD military components to develop individual comprehensive management approaches for implementing RFID, but did not concur with our other two recommendations.

DOD did not concur with our recommendation to expand its RFID planning efforts to include a comprehensive management approach to ensure efficient and effective implementation. The department commented that RFID is a critical transformational technology that will be implemented across the department over the next several years. The department stated that its approach is to build the rollout for passive RFID from the bottom up. The department asserted that it has already set forth the goals, objectives, performance measures, and milestones sufficient to guide the planning activities of the military services, DLA, and the U.S. Transportation Command, and that these activities have plans in development. The department stated that it will work with these activities to ensure that RFID is efficiently and effectively implemented throughout the department, to ensure implementation is funded, and to evaluate the benefits being achieved and report progress as part of the department's supply chain management improvement plan. We disagree. DOD's July 2004 RFID policy does not represent a sound strategic approach because it lacks a number of key management principles necessary for good program management. Specifically, we found that the policy (1) contains only general and descriptive goals and objectives that do not define specific expected results, and no annual goals are identified, as suggested by the principle; (2) describes specific actions related to operational processes but does not provide specific actions related to things such as obtaining necessary workforce skills, considering human resource issues, identifying major capital resources, identifying major technological resources, and obtaining needed information resources, which could provide the basis for monitoring corrective actions that may be needed; (3) does not include performance measures to assess the progress of implementation actions

for passive RFID; and (4) contains only short-term schedules rather than comprehensive schedules and milestones for meeting deadlines. Despite DOD's assertion in its comments that it already has sufficient guidance to ensure that RFID is efficiently and effectively implemented throughout the department, implementation of the technology is adequately funded, benefits are being achieved, and progress is being reported as part of the department's supply chain management improvement plan, we continue to believe that the incomplete incorporation of these key management principles in DOD's RFID policy may impede DOD's ability to achieve these things. The lack of clear, comprehensive, and integrated performance goals and measures has handicapped DOD efforts for several undertakings, including business management transformation,[14] critical spare parts shortages,[15] installation preparedness,[16] and depot maintenance.[17] We continue to believe that DOD needs to develop a more comprehensive strategic management approach to guide the implementation of RFID technology throughout the department.

The department concurred with our recommendation for each of the military services and other DOD military components to develop individual comprehensive management approaches for implementing RFID. In its comments, the department said that the services, DLA, and U.S. Transportation Command have RFID implementation plans in varying stages of development. The department stated that OSD will direct that these plans be completed by September 30, 2005, and that these plans will incorporate the key management principles cited in our report and will correct deficiencies cited in our report. The department noted that it would be premature to expect detailed implementation plans until RFID funding is solidified. We believe that this approach will satisfy the intent of our recommendation if, prior to the military components developing their

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[14] GAO, *Defense Management: Key Elements Needed to Successfully Transform DOD Business Operations*, GAO-05-629T (Washington, D.C.: Apr. 28, 2005).

[15] GAO, *Defense Inventory: The Department Needs a Focused Effort to Overcome Critical Spare Part Shortages*, GAO-03-707 (Washington, D.C.: June 27, 2003).

[16] GAO, *Combating Terrorism: DOD Efforts to Improve Installation Preparedness Can Be Enhanced with Clarified Responsibilities and Comprehensive Planning*, GAO-04-855 (Washington, D.C.: Aug. 12, 2004); and *Combating Terrorism: Actions Needed to Guide Services' Antiterrorism Efforts at Installations*, GAO-03-14 (Washington, D.C.: Nov. 1, 2002).

[17] GAO, *Depot Maintenance: Key Unresolved Issues Affect the Army Depot System's Viability*, GAO-03-682 (Washington, D.C.: July 7, 2003).

plans, the Under Secretary of Defense (Acquisition, Technology, and Logistics) takes additional actions to develop a DOD-wide comprehensive strategic management approach that would then be supported by the plans developed by the military components.

The department did not concur with our recommendation to develop a plan to identify challenges impeding passive RFID implementation and actions needed to mitigate those challenges. The department stated that the challenges outlined in our report have either already been mitigated or represented a misunderstanding on our part. In essence, the department's comments suggest that the passive RFID challenges identified in our draft report have been basically resolved. We do not believe this to be the case. We recognize that passive RFID is an evolving technology and that the department is continuing to address the challenges associated with implementing passive RFID technology. However, we continue to believe that the challenges identified in the report remain, and that the department needs to develop a mitigation plan to address these challenges. Specifically, our responses to DOD's comments about the individual challenges identified in the draft report are as follows.

- DOD stated that the audit incorrectly states that new standards are currently being developed to "meet DOD's RFID policy requirements." The department commented that the specification for the Electronic Product Code RFID tags being required by DOD is already published and products compliant to this specification are available on the market today. DOD also stated that the audit incorrectly states that the new standard will "define the DOD approved format for EPCs." The department said that the approved format for DOD was published in May 2005 and that the new Generation 2 standard, although already developed, is still awaiting International Standards Organization (ISO) approval. DOD stated that any concerns expressed in the audit to the contrary appear unfounded. We disagree with DOD's assertion that the concerns expressed in the report are unfounded. Nonetheless, we have clarified the language in the report to respond to DOD's technical concerns about our description of the development status of the new Generation 2 EPC standard. As discussed in the report, we found that the military components are reluctant to purchase passive RFID infrastructure knowing that the standard is going to change and that they might need to modify existing equipment or purchase new equipment to be compliant with the new EPC standard. Because the new Generation 2 EPC standard has not yet been approved and equipment and tags using the new standard were not available as of May 2005, we continue to believe that the military components' concern is valid and that it may not be the best use of scarce resources to fund

purchases of equipment necessary for implementing passive RFID until equipment operating under the new tag specifications is available.

- The department stated that the audit conjectures that the industrial base will not have the capacity to supply sufficient quantities of tags and equipment to meet requirements. The department stated that it had not found this to be the case. DOD further stated that the audit appeared to base this concern on some anecdotal comments made during some interviews. DOD also commented that it recognized that the department needed to consider lead times as new products come to the market. We concur that lead times are necessary for evolving technologies such as passive RFID, and we acknowledge in our report that these challenges will be resolved over time and are to be expected with the integration of any new technology. Nonetheless, we continue to believe that this is a valid concern that is not solely based on anecdotal comments made during some interviews. While this concern was expressed during some interviews conducted in the course of this audit, it was further corroborated in our May 2005 report,[18] in which we reported that the increasing demand for passive RFID tags may eventually outstrip the supply and that the 30 percent damage rate during production will likely contribute to future shortages.

- The department stated that the report identifies training as a challenge, and that DOD already has plans to address that challenge. DOD stated that the RFID implementation plans developed by the services, DLA, and U.S. Transportation Command will address training; that the Defense Acquisition University is developing computer-based training for internal stakeholders; and that training is being provided to DOD's Procurement Technical Assistance Centers. DOD commented that its training strategy will be refined and intensified as implementation continues. In our report, we recognize the planned efforts to provide training by the military components. We also believe that these actions cited by DOD recognize the necessity for passive RFID training throughout the department. However, until such training is formalized into the various training curriculums and personnel become proficient in the use of RFID technology and its capabilities, training remains a concern for passive RFID implementation. As recognized by DOD in identifying the need to refine and intensify its training strategy, we believe training will be a continuing challenge as DOD addresses the need to train new personnel and to refresh training of experienced personnel.

- The department states that systems interoperability is already being facilitated because the military components share a common approach,

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[18] GAO-05-551.

the Advance Shipment Notice (ASN), for passing RFID information. We continue to believe that interoperability is a challenge. An ASN is a notification issued by a supplier prior to shipment that provides the recipient with advance notice describing in detail what is being shipped. While the ASN provides helpful information, we do not believe that the ASN effectively addresses the interoperability concern. As we stated in our draft report, DOD identifies system interoperability as the ability of systems, units, or forces to provide data, information, materiel, and services and to accept the same from other systems, units, or forces and to use the data, information, materiel, and services so exchanged to enable them to operate effectively together. We also stated in our draft report that interoperability includes both the technical exchange of information and the end-to-end operational effectiveness of that exchange of information as required for mission accomplishment. DOD envisions a seamless integration between passive and active RFID technology; however, such a seamless integration cannot take place unless the information captured by the RFID technology can flow through interoperable logistics information systems. Effective implementation of passive RFID requires interoperability of automatic information systems among the military components so these systems can work together and facilitate active and passive system interaction. Common systems and standards for interoperability need to be established. If passive RFID implementation is not interoperable among the military components, this could lead to inefficiencies that could be avoided if interoperability had been built into the military components' passive RFID implementation plans as these plans developed.

- The department stated that the low read rates cited in our audit were based on older pilot projects reading all cases on a pallet. The comments noted that pallet and case tags on a conveyor are consistently read at 100 percent and stated that the audit does not mention this fact. The department stated that the draft report implied that the read rates were too low for implementation and responded that this simply was not true. The department stated that the use of the ASNs mitigated low read rates because the ASN contains the nested relationship of all cases on the pallet and that the reading of just one tag enables determining all other tags on the shipment. We continue to believe that for DOD to use passive RFID technology as intended, the accuracy of passive RFID read rates is critical to expeditiously verify that individual items were actually received. While read rates of tags on individual pallets and cases may be 100 percent, as stated by the department, our report focused on the technology not yet being sufficiently sophisticated to read all tagged items on fully loaded pallets with acceptable accuracy rates. As stated in our report, our audit found problems reading tags on items in the middle of a pallet versus those on the periphery as follows: the Navy experienced an 85 percent

accuracy read rate for tagged items on fully loaded pallets in its terminal pilot project, reported in October 2004; the Air Force has experienced 32 to 65 percent accuracy read rates for fully loaded pallets, reported on February 10, 2005; and even Wal-Mart reported that as of January 18, 2005, it has experienced only 66 percent accuracy of its read rate for tagged items on fully loaded pallets and stated that reading all cases on a fully loaded pallet remains the biggest challenge. These read rate figures were the most recent figures that were available to us at the time of our audit, and we believe that the dates of these data are sufficiently recent to demonstrate that this concern will continue for some time. Furthermore, while the ASN provides details pertaining to individual shipments—including a list of the contents of a shipment of goods as well as additional information relating to the shipment such as product description, physical characteristics, type of packaging, and configuration of goods within the transportation equipment—the ASN basically serves as a verification control mechanism to validate the contents of shipments received. The ASN is not a new type of control mechanism. In April 2005, the existing Material Inspection Receiving Report—which basically served the function of a packing slip—was expanded to contain RFID tag data. We believe that the ASN should continue to be used as a control to ensure that shipments sent by suppliers are actually received, but we believe that the ASN does not mitigate nor should it serve as a replacement for the need to read the passive RFID tags on all of the items received to ensure that what the ASN says was sent is what was actually received.

- DOD stated that one worldwide frequency standard is not required as recommended in the audit and will not occur. DOD stated that passive RFID technology as adopted can operate anywhere along the UHF band and a foreign country only needs to open up a portion of that band for RFID technology to be able to operate. The department also stated that readers are designed to operate at the country-approved spectrum. However, as discussed in our draft report, we did not advocate a worldwide standard. In our draft report, we noted that there was no worldwide frequency standard, and stated that a worldwide standard was being considered by the International Organization for Standardization, but we did not recommend that such a worldwide standard be developed. The concerns identified in the report were that the United States would need to obtain frequency spectrum permissions from foreign governments to be able to use RFID reader technology in their countries, and that foreign governments can impose requirements on the type of readers that can be used. We continue to believe that these are implementation issues because DOD will need to ensure that its procedures in place for requesting frequency spectrum permissions are followed, track any special requirements imposed by foreign governments, and identify and respond to changes in a country's spectrum. For example, in our draft report, we

pointed out that Germany's spectrum for active RFID will be changing in 2006, so radio frequency-dependent equipment operating under the old spectrum may need to be upgraded or replaced.

- The department stated that the concerns raised in the audit about unknown return on investment were dated because the DOD business case analysis has now been completed. DOD also stated that the Navy business case has been superseded by a more recent business case analysis that did find a return on investment. We believe that DOD's new business case analysis, issued in April 2005, is a step in the right direction, and we referred to the findings of this new business case analysis in our report. We continue to believe, however, that return on investment remains a strong concern among the military components and the DOD business case still needs to be adapted into the development of individual business case analyses by the military components that they can use to integrate the technology into their respective business processes. Our initial review of the department's business case analysis leads to reservations regarding the potential benefits it portrays because of the wide disparity between the optimistic and pessimistic results. As stated in our report, the DOD business case analysis presented two results, which it characterized as optimistic and pessimistic. The optimistic result estimated savings of $1.781 billion, while the pessimistic result estimated savings of $70 million. Although DOD recognized that this business case is an initial and abbreviated analysis due to time constraints, DOD stated that this business case was compelling and directed the secretaries of the military departments to move forward with passive and active RFID implementation as justified by the business case. In addition, DOD's business case is a departmentwide analysis and was developed to determine a gross benefit to the department. Until a return on investment can be demonstrated by the military components, the military components may continue to be reluctant to provide funds necessary for successful implementation. As stated in our report, we did not assess the methodology and validity of the DOD business case analysis, primarily because it was released after we concluded our field work.

- The department stated that the DFARS clause is nearing completion and will be followed by subsequent DFARS clauses as DOD phases in implementation. DOD also stated that the concern raised in the audit about "inconsistencies among contracts across DOD" is not an issue because very few contracts have been let in the interim. DOD explained that the purpose of the proposed DFARS clause was to standardize contract clauses across the department. We continue to believe that the development and approval of DFARS clauses remain a valid concern. As described in our draft report, the existing proposed rule is limited in scope, applying only to four supply classes delivered to two distribution depots. We stated in our draft report our concern that as DOD continues

passive RFID implementation, it will need additional DFARS amendments as RFID tagging requirements expand to DOD's remaining six supply classes and 32 additional shipping locations as of January 1, 2006, and to all supply classes (except bulk commodities) shipped to all locations as of January 1, 2007. DOD's comments acknowledge that they will need subsequent DFARS clauses as DOD phases in implementation. We concur with DOD that the purpose of the DFARS clause is to standardize contract clauses across the department; however, until additional DFARS amendments are in place, the contract language regarding vendors' placement of passive RFID tags on all products purchased by and shipped to DOD may not be standardized. Until DFARS clauses are approved for all supply classes and shipping locations, supply contracts could be subjected to individual contract clauses, which could result in inconsistencies among contracts across DOD and its military components. Just because few contracts have been awarded to date, as DOD stated in its comments, does not, in our opinion, mean that there will continue to be few contracts awarded until such time as additional DFARS amendments to cover the remaining supply classes and shipping locations are approved. The fact that the proposed DFARS clause covering only a portion of supply classes and locations still has not been completed but was anticipated to have been completed in October 2004 is indicative that the DFARS concern is likely to continue for some time.

- The department stated that the discussion of multivendor contracts was dated because since the audit, awards have been made for tag, reader, printer, and integration software/services. DOD also commented that blanket purchase agreements are not mandatory and are just one tool for procurement of RFID equipment, which can be and has been purchased without the use of such agreements. As stated in our draft report, the administrative challenge concerns establishing agreements with vendors to provide EPC-compliant technology to leverage the purchasing power of the department for passive RFID infrastructure purchases. As of August 11, 2005, we were informed by officials in the Army Program Executive Office, Enterprise Information Systems, Product Manager–Automatic Identification Technology Office that three of five blanket purchase agreements had been established. These agreements are for tags, fixed and transportable readers, and technical engineering services. The remaining two blanket purchase agreements, for printers and multiprotocol handheld readers, are anticipated to be established soon. However, until the remaining multivendor contracts are awarded, we continue to believe that the establishment and award of contract mechanisms such as blanket purchase agreements are administrative challenges and the DOD military components may be unable to leverage the purchasing power of the department to realize economy and efficiency benefits.

DOD's comments are printed in appendix III. DOD also provided technical comments, which we have incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees; the Secretary of Defense; the Secretaries of the Army, Air Force, and the Navy; the Commandant of the Marine Corps; the Commander, U.S. Transportation Command; and the Director, Defense Logistics Agency. We will also make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

Please contact me on (202) 512-8365 or solisw@gao.gov if you or your staff have any questions concerning this report. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix IV.

William M. Solis, Director
Defense Capabilities and Management

*List of Congressional Committees*

The Honorable John Warner
Chairman
The Honorable Carl Levin
Ranking Minority Member
Committee on Armed Services
United States Senate

The Honorable Ted Stevens
Chairman
The Honorable Daniel K. Inouye
Ranking Minority Member
Subcommittee on Defense
Committee on Appropriations
United States Senate

The Honorable Duncan L. Hunter
Chairman
The Honorable Ike Skelton
Ranking Minority Member
Committee on Armed Services
House of Representatives

The Honorable C.W. Bill Young
Chairman
The Honorable John P. Murtha
Ranking Minority Member
Subcommittee on Defense
Committee on Appropriations
House of Representatives

# Appendix I: Scope and Methodology

To determine the status of the Department of Defense's (DOD) implementation of passive Radio Frequency Identification (RFID) technology, we relied on information gathered through our visits and interviews with key personnel within the Office of the Secretary of Defense; the Defense Logistics Agency; the U.S. Transportation Command; the Joint Forces Command; the Logistics and Command, Control, Communications and Computer Systems Directorates within the Office of the Joint Chiefs of Staff; the Army Program Executive Office, Enterprise Information Systems, Product Manager–Automatic Identification Technology Office; and pertinent logistics offices within the Departments of the Air Force, Navy, and Marine Corps. We reviewed DOD's overall RFID implementation policy, its concept of operations guidance for DOD military components and suppliers and pertinent articles, and we obtained briefing documents to understand DOD's strategy for implementing RFID technology into its supply chain processes. We also obtained and reviewed historical RFID infrastructure and cost data and obtained, to the extent available, DOD military components' future infrastructure and funding requirements to fully implement the technology into the DOD supply chain operations. Because DOD is just beginning to implement passive RFID technology, we did not verify the data provided and considered the data sufficiently reliable for the purposes of this review. Additionally, we visited and observed the use of RFID technology at the Defense Logistics Agency's Defense Distribution Depot in Susquehanna, Pennsylvania, and the Norfolk Ocean Terminal pilot initiative at the Navy's Fleet and Industrial Supply Center in Norfolk, Virginia.

To identify the extent to which DOD has developed a strategic approach for implementing passive RFID technology, we obtained and analyzed DOD's and various DOD military components' passive RFID guidance. We assessed this guidance by comparing its content to key management principles, such as those used by leading organizations and contained in the Government Performance and Results Act of 1993, to determine whether DOD's planning contained key management attributes that are necessary to guide and monitor implementation of the technology.

To determine the broad spectrum of challenges DOD faces with implementation of RFID technology, we relied on analysis of data gathered through visits and interviews with and briefings provided by key personnel from the DOD organizations identified above. We also conducted a literature search to understand the RFID technology and the applications of it for commercial and defense purposes. We obtained and reviewed RFID technology studies initiated by DOD or its military components. We

also obtained and analyzed DOD military components' comments regarding DOD's overall RFID policy and concept of operations guidance.

We conducted our work from July 2004 through August 2005 in accordance with generally accepted government auditing standards.

# Appendix II: Examples of Passive and Active RFID Equipment

| Equipment | Equipment description | Equipment | Equipment description |
|---|---|---|---|
| **RFID Writing Station** | Creates a tag number, which it then burns onto a RFID chip. | **Antennae** | Transmits and receives signals to/from RFID tags. |
| **UHF Tag** | Contains a tag number that can be used to link to a data base record that tracks customers' orders. | | |
| **Passive RFID Printer** | Prints, reads, and in some cases writes Passive RFID embedded labels. | **RFID Matrics AR 400 Reader** | Takes read information from antenna and passes it over network to an Automated Information System. |

Sources: GAO and DOD.

**Active**

| Equipment | Equipment description | Equipment | Equipment description |
|---|---|---|---|
| **SAVI Interrogator** | Provides the user with the ability to collect tags and perform read/write operations to multiple tags. | **STR 7200 Combined Handheld Reader Module Kit** | Reads, locates, and queries tag data; used to collect receipt, shipment, storage, and inventory data. |
| **SAVI Docking Station, battery, and charger** | Perform read/write operations to a single tag. | **RF Relay** | Enables communications between interrogators and a host computer at distances up to 7500 feet. |
| **SAVI 412 and 410 Tags, SAVI Seal RF Tag** | Contain data about shipment contents. | **Pocket Personal Computer 8146** | Read, write, locate tag, and query tag data. |

Source: U.S. Army.

# Appendix III: Comments from the Department of Defense

AUG 0 5 2005

Mr. William Solis
Director, Defense Capabilities and Management
U.S. Government Accountability Office
441 G Street, N.W.
Washington, DC 20548

Dear Mr. Solis:

This is the Department of Defense (DoD) response to the GAO draft report, GAO-05-345, "DEFENSE LOGISTICS: Better Strategic Planning Can Help Ensure DoD's Successful Implementation of Passive Radio Frequency Identification" dated June 29, 2005 (GAO-05-345). The Department nonconcurs with Recommendations 1 and 3 and concurs with Recommendation 2. Attachment 1 contains our detailed response. Technical comments have been provided under separate cover.

Radio Frequency Identification (RFID) is a critical transformational technology that will be deployed across the Department over the next several years. It is a crucial part of our plan to improve Supply Chain Management (SCM) and is included as a key component of our Focused Logistics Roadmap. The Office of the Secretary of Defense (OSD) has established a definitive RFID policy and is working with the Combatant Commands, Military Services and Defense Agencies on implementation plans and funding issues. OSD has already set forth the goals/objectives, performance measures and the milestones sufficient to guide the planning activities of the Military Services/Defense Logistics Agency (DLA) and U.S. Transportation Command (USTRANSCOM). In addition, OSD is not acting as a program office for RFID implementation, which will occur within the Military Services/DLA/USTRANSCOM. Therefore, the Department nonconcurs with Recommendation 1.

Each of the Military Services/DLA/USTRANSCOM has plans in development. The Department concurs with the recommendation that these plans be completed and should incorporate the key management principles cited in the audit. We will direct completion of those plans by September 30, 2005. OSD will continue to work with the Services/DLA/TRANSCOM to evaluate the benefits being achieved and will report progress as part of our Supply Chain High Risk improvement plan.

Lastly, the Department nonconcurs with the recommendation to develop a plan to address specific challenges outlined in the audit. The challenges outlined have either already been mitigated or represent a misunderstanding of the technology and its implementation in the Department.

The Department appreciates the opportunity to comment on this audit. Should additional information be required, Mrs. Kathy Smith of my staff is the point of contact. She may be reached at (703) 604-0098x135.

Sincerely,
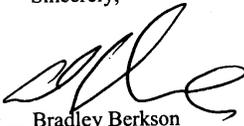
Bradley Berkson
Principal Assistant Deputy Under Secretary of
Defense (Logistics and Materiel Readiness)

Attachments:
As Stated

GAO DRAFT REPORT – DATED JUNE 29, 2005
GAO CODE 350561/GAO-05-345

"DEFENSE LOGISTICS: Better Strategic Planning Can Help Ensure DoD's Successful
Implementation of Passive Radio Frequency Identification"

DEPARTMENT OF DEFENSE COMMENTS
TO THE RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommended that the Secretary of the Defense direct the
Under Secretary of Defense (Acquisition, Technology, and Logistics) to expand its current Radio
Frequency Identification (RFID) planning efforts to include a DoD-wide comprehensive strategic
management approach that will ensure that RFID technology is efficiently and effectively
implemented throughout the department. This strategic management approach should
incorporate the following key management principles:

- An integrated strategy with goals, objectives, and results for fully implementing RFID in
  the DoD supply chain process, to include the interoperability of automatic information
  systems;

- A description of specific actions needed to meet goals and objectives;

- Performance measures or metrics to evaluate progress toward achieving the goals;

- Schedules and milestones for meeting deadlines;

- Identification of total RFID resources needed to achieve full implementation; and

- An evaluation of corrective action plan. (page. 38/GAO Draft Report)

DOD RESPONSE: Nonconcur. RFID is a critical transformational technology that will be
deployed across the Department over the next several years. It is a crucial part of our plan to
improve Supply Chain Management (SCM) and is included as a key component of our Focused
Logistics Roadmap.

The Office of the Secretary of Defense is not acting as a program office in managing the
implementation of RFID. Our approach is to build the Department rollout for passive RFID
from the bottom up. The Office of the Secretary has already set forth the goals/objectives,
performance measures and the milestones sufficient to guide the planning activities of the
Military Services/DLA and USTRANSCOM. Each of the Military Services, Defense Logistics
Agency (DLA) and USTRANSCOM has plans in various stages of development. They are also
doing analyses now to determine the best place to start in implementing passive RFID. We will
direct completion of those plans by September 30, 2005 and will work with the Components to
ensure that RFID is efficiently and effectively implemented throughout the Department.
In addition, we continue to work with the Military Services and USTRANSCOM to ensure
implementation is funded. Until funding is solidified, it is premature to expected detailed

implementation plans. The Office of the Secretary will continue to work with the Military Services/DLA/USTRANSCOM to evaluate the benefits being achieved and will report progress as part of our SCM improvement plan.

RECOMMENDATION 2: The GAO recommended that the Secretary of the Defense direct the secretaries of each military service and administrators of other DoD components to develop individual comprehensive strategic management approaches that support the DoD-wide approach for fully implementing RFID into the supply chain processes. (page 38/GAO Draft Report)

DOD RESPONSE: Concur. The Military Services, DLA and USTRANSCOM have implementation plans in various stages of development. The Office of the Secretary of Defense will direct completion of these plans by September 30, 2005. The plans will incorporate the key management principles cited in the audit and will correct deficiencies pointed out in the audit. Until funding is solidified, it is premature to expected detailed implementation plans.

RECOMMENDATION 3: The GAO recommended that the Secretary of the Defense direct the Under Secretary of Defense (Acquisition, Technology, and Logistics), the secretaries of each military service and administrators of other components to develop a plan that identifies the specific challenges impeding passive RFID implementation and the actions needed to mitigate these challenges. Such a plan could be included in the strategic management approach that we recommend they develop. (page 39/GAO Draft Report)

DOD RESPONSE: Nonconcur. The "challenges" outlined in the audit have either already been mitigated or represent a misunderstanding of the technology and its implementation in the Department.

The audit incorrectly states that new standards are currently being developed to "...meet DoD's RFID policy requirements..." The specification for the Electronic Product Code (EPC) RFID tags being required by DoD is already published and products compliant to this specification are available on the market today. In addition, the audit incorrectly states that the new standard will "...define DoD approved format for EPCs." The approved format for DoD is already published as part of the Tag Data Specifications 1.27 published May 27, 2005. The "new standard" referred to in the audit is apparently what is commonly referred to as EPC Generation 2 (Gen 2). This standard has already been developed and is now going through International Standards Organization (ISO) approval. However, this standard is not necessary to "meet the DoD RFID policy requirements." The Generation 1 products are sufficient for this purpose. Moreover, the design of the Gen 2 standard is intended to minimize changes necessary to upgrade to Gen 2 from the Generation 1 products, and early products have born that out. Any concerns expressed in the audit to the contrary appear unfounded.

The audit also conjectures that the industrial base will not have the capacity to supply tags and equipment in sufficient quantities to meet the requirement. The audit appears to base this concern on some anecdotal comments made during some interviews. The Department has not found this to be the case. The Department does recognize that lead times need to be considered as new products come to market.

The audit cites training as a challenge, but the Department already has plans to address this challenge. The format for the Military Service/DLA/USTRANSCOM implementation plans will address training as a key part of the format. In addition, the Defense Acquisition University is

developing RFID computer-based training for our internal stakeholders and "train-the-trainer" training is being provided to the Procurement Technical Assistance Centers so that they can educate our small business suppliers on RFID. As the technology is implemented, our training strategy will be refined and intensified.

The audit cites systems "interoperability," as a challenge. Despite the fact that each component is developing their own plan for implementation, they all share a common approach to the data for passing RFID information, e.g. Advanced Shipping Notice (ASN). These standards have already been developed, thus facilitating systems "interoperability."

The tag read rates are also cited as a challenge. The low read rates cited are based on older pilots reading all cases on a pallet. Pallet tags and case tags on a conveyor are consistently read at 100% although the audit does not mention this fact. The implication is that the rates are too low for implementation. This is simply not true. The requirement for an Advanced Shipping Notice (ASN) mitigates any low read rates of cases on pallets through a dock door. The ASN will have the nested relationship of all cases on the pallet. Therefore, by reading just one of the tags, you are able to determine all the other tags on the shipment…100% read rate of all cases on the pallet are not needed. Radio Frequency enabled conveyors also mitigate the read rates in the receiving process.

Another challenge in the audit is frequency spectrum. One worldwide frequency standard is not required as recommended in the audit and will not occur. The passive RFID technology that DoD has adopted is designed to operate anywhere along the entire Ultra-High Frequency (UHF) band (860-960 mHz). Therefore, one single frequency is not required. A country need only open a portion of the UHF band for this technology to be able to operate. For example, the same EPC tag can be read in the US at 915 mHz and also read in Australia at 920-925mHz. The vast majority of countries in which we operate have already opened portions of the UHF band for this technology and efforts continue to get the last few (Italy, Spain, etc). Readers are designed to operate at the country-approved spectrum.

Concerns about unknown return on investment were also mentioned in the audit. These concerns are largely dated as the DoD business case has now been completed in addition to a Navy business case. The audit cites a Navy business case that was superceded by a more detailed one that is now complete and does find a return on investment.

Finally, the audit posits concerns about the Defense Federal Acquisition Regulation (DFAR) clause and the multivendor contracts. The DFAR clause is nearing completion and will be followed by subsequent DFAR clauses as we phase in our implementation. At this phase of the implementation, the concern about "…inconsistencies among contracts across the DoD" is not an issue. Very few individual contracts have been let in the interim. The purpose of the proposed DFAR clause to implement RFID with our suppliers was, in fact, to standardize contract clauses across the Department.

The discussion on the multivendor contracts is also dated. Since the audit began, the tag, reader, printer and integration software/services awards have been made. In addition, the Blanket Purchase Agreements (BPAs) are just one tool for procurement of RFID and are not mandatory. Equipment can and has been purchased without the use of the BPAs.

# Appendix IV: GAO Contact and Staff Acknowledgments