Final Regulatory Flexibility Analysis of Passive Radio Frequency Identification (RFID)

Version 1.0

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1 EXECUTIVE SUMMARY

1.1 Background

The Department of Defense (DoD) is amending the Defense Federal Acquisition Regulation Supplement (DFARS) to add requirements for DoD suppliers to affix Radio Frequency Identification (RFID) tags, at the case and palletized unit load levels, for specific items to be delivered to specific DoD locations. DoD considers the implementation of RFID to be a strategic imperative, necessary to deliver supplies to the warfighter more quickly, while increasing visibility of materiel throughout the supply chain. To create an automated and sophisticated end-to-end supply chain, the DoD is dependent upon initiating the technology at the point of origin, the DoD commercial suppliers. Without the assistance of DoD supplier base to begin populating the DoD supply chain with passive RFID tags, a fully integrated, highly visible, automated end-to-end supply chain is untenable.

The Department of Defense (DoD) is already a globally sophisticated user of active RFID, with over a decade of experience in this technology and the most extensive network in the world. Now, the DoD is moving to standardize the use of active RFID and is moving ahead with the application of passive RFID technologies. On July 30, 2004, the Acting Under Secretary of Defense for Acquisition, Technology, and Logistics issued policy requiring the implementation of Radio Frequency Identification across the DoD. The Department of Defense is taking a leadership role in passive RFID, both as an early adopter of the technology and by driving the development of the technology and standards.

1.2 Modified Economic Analysis

The Department of Defense undertook a detailed analysis of its supply chain to determine how to roll-out the use of passive RFID within its logistics operations. To determine the appropriate strategy, the DoD:

1. Analyzed current supply chain operations and baselined key costs and performance metrics.

2. Analyzed alternative implementation strategies to include:

   a. The market adopts passive RFID without DoD involvement,

   b. The market adopts passive RFID with DoD involvement according to a phased implementation plan, for DoD Suppliers

   c. The market adopts passive RFID with DoD involvement immediately with no phased implementation, for DoD Suppliers

3. Conducted costs and benefits analysis with emphasis on impact to small business and recycling industry.

1.3 The Need to Transform the DoD Supply Chain

The effectiveness of today's Defense logistics system is diminished primarily because of its inability to rapidly adapt to warfighting advancements, technology advancements, commercial practices, and modern information requirements. The DoD logistics environment is comprised of multiple logistics nodes and segments. This logistics environment places a heavy burden on the warfighter, as they must operate where there is incomplete information and limited visibility of critical materiel. This environment also creates unnecessary workloads for logistics planners, materiel receipt operations, in-theater transportation activities, and front-line military logisticians.

It is by no means an easy transition from a legacy system designed to move mass to an agile system capable of delivering power, speed, and information. The legacy logistics system is not as quick to adapt to today's flexible force, resulting in:

- Lack of end-to-end visibility
- Unnecessary warfighter workload
- Inefficient materiel configuration
- Unnecessary nodal delays
- Inefficient use of transportation assets
- Improper packaging and markings of shipments

Tomorrow's Defense logistics system must be capable of delivering more responsive combat power. It must be coordinated, synchronized, and harmonized. It should be streamlined, efficient, simple to manipulate, and pinpointed to deliver full response across the global spectrum of warfare. It must be optimized from end-to-end and operational on day one. RFID will facilitate this transformation.

As stated before, RFID is part of a family of Automatic Identification Technology (AIT) devices that includes but is not limited to: barcodes, optical memory cards, contact memory buttons, and satellite tracking systems. RFID and barcodes will co-exist for several years as both technologies have their merits, yet RFID brings several positive benefits over barcodes:

- Reduces human error
- Improves data accuracy/asset visibility
- Performs in rugged, harsh environments
- Allows for dynamic multi-block read/write capability
- Facilitates source data collection
- Allows for simultaneous reading and identification of multiple tags
- Provides for unique reads for individual items

The employment of RFID provides several benefits to the overall DoD supply chain. Figure 1 identifies these potential benefits and the respective nodes.

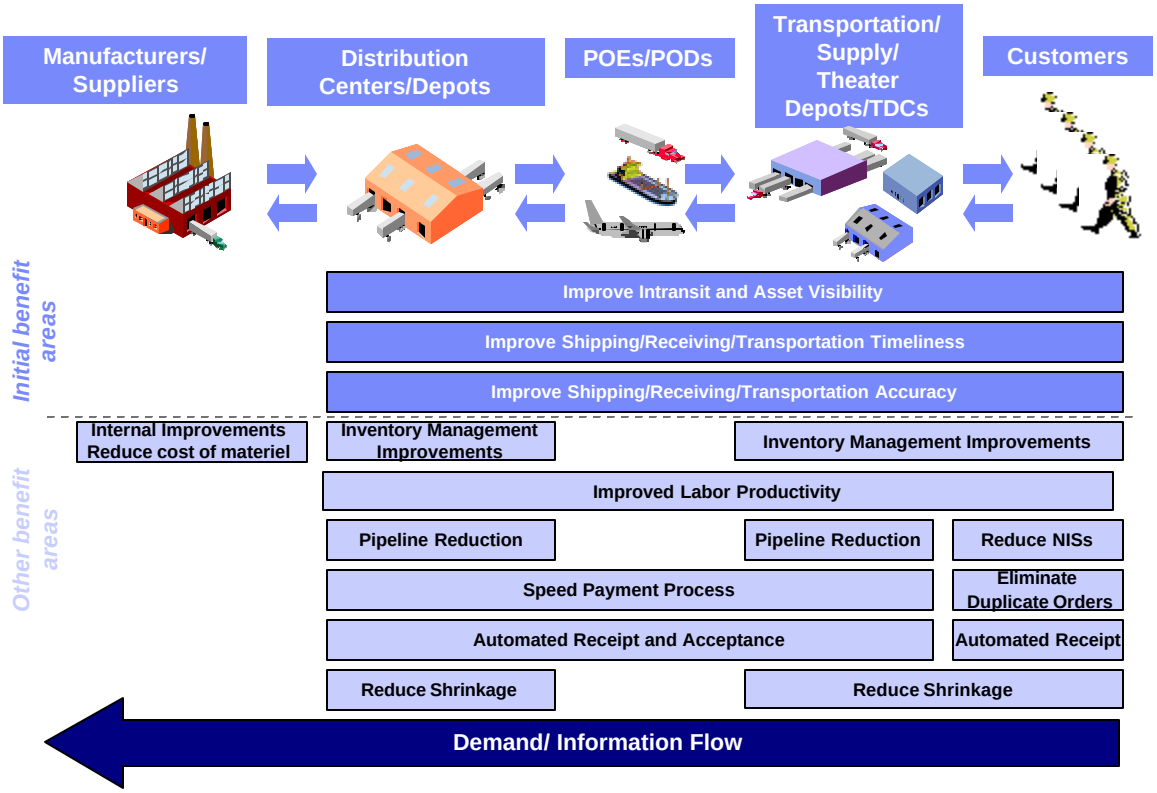


Figure 1 High Level Illustration of the Benefits from RFID Across the DoD Supply Chain

It is envisioned that each military service and defense agency will review its internal business processes to further refine the most appropriate employment of RFID. The widespread integration of RFID into the DoD business processes should be managed with the same level of attention as a major system fielding. Although this technology enables accuracy and timeliness of data within current and future systems of record, introducing RFID will require significant planning, equipment fielding, Automated Information System (AIS) changes, and training.

The end state for the DoD supply chain is to be a fully integrated adaptive entity that leverages state-of-the-art enabling technologies and advanced management information systems to automate routine functions and achieve accurate, timely in-transit, in-storage, and in-repair asset visibility with the least human intervention. In addition, this end state should provide continuous effective information for logistics decision making in support of logistics requirements to military operations in austere environments. In short, a single, seamless, responsive enterprise system linked to the source of supply and capable of responding to exigent requirements at best speed and using the most efficient means.

Passive RFID offers the most practical, efficient, and effective means to deliver real logistics transformation opportunities to DoD. Building on the successes of barcoding and active RFID, DoD is prepared to drive forward with this emerging technology and further enhance the capabilities of our warfighting customers.

1.4 The RFID Enabled Supply Chain

Figure 2 depicts a DoD RFID enabled supply chain. This high level process view provides a visual representation of how DoD foresees using RFID, as materiel is physically moved from the manufacturers/suppliers to the warfighter.

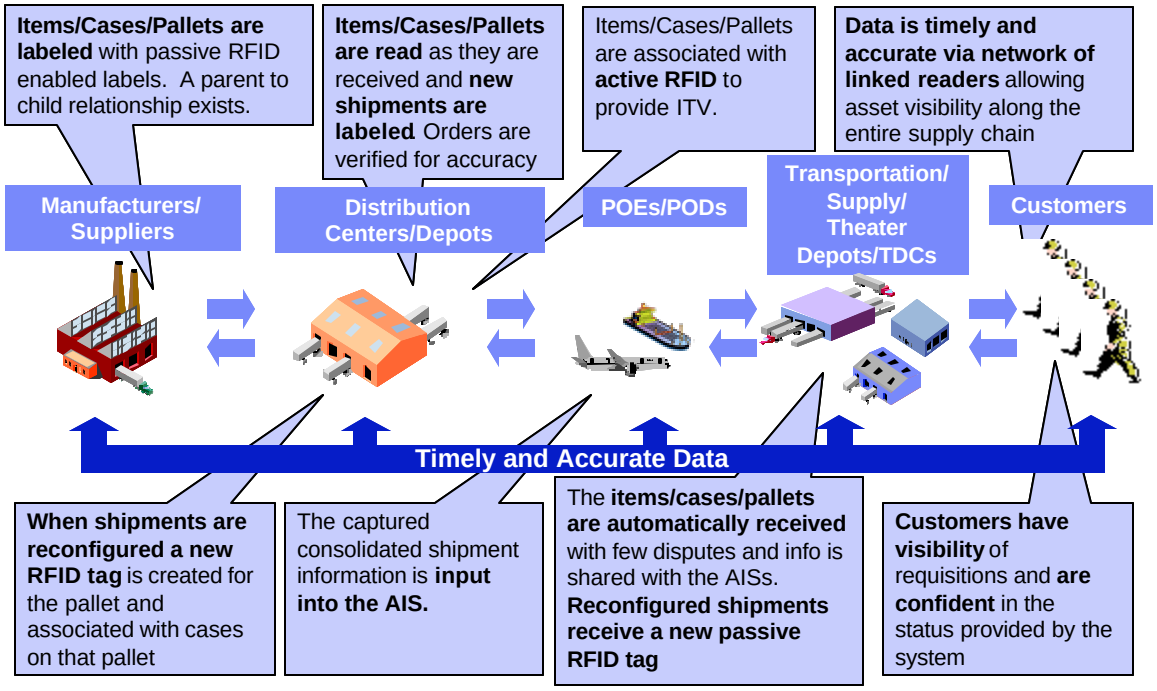


Figure 2 DoD RFID Enabled Supply Chain

1.5 Active and Passive RFID

Active and passive RFID will continue to complement one another as passive RFID technology is implemented throughout the DoD. Consolidated shipments moving outside the Continental United States (OCONUS) through the Defense Transportation System (DTS) are currently tracked using active RFID. Non-consolidated shipments moving both within the Continental United States (CONUS) and OCONUS carry barcoded Military Shipping Labels (MSL). The implementation of passive RFID will complement the current successes of active RFID for OCONUS shipments. Section 3.1 explains the differences between active and passive RFID. Figure 3 illustrates the CONUS/OCONUS passive–active–passive relationship.

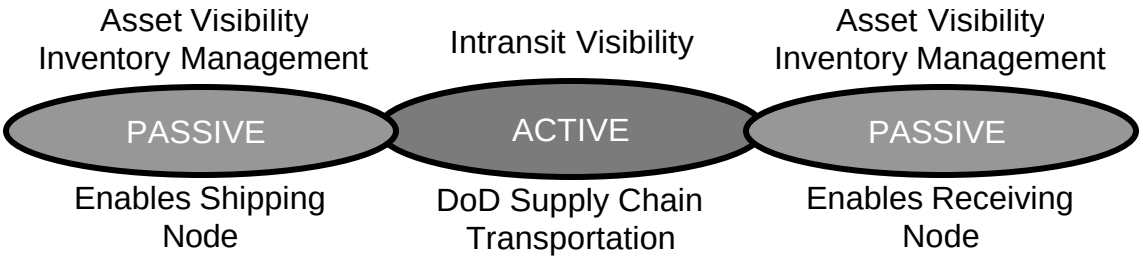


Figure 3 CONUS/OCONUS Passive-Active-Passive

The association of a passive tag to an active tag will provide improved container stuffing and un-stuffing time and accuracy to facilitate "inside the box/pallet/container" visibility. This passive and active association is created by building a "nested" structure of passive tags (Unique Identification (UID) item packaging, case and pallet tags) that are subordinate to the active tag (container and 463L pallet level tags). Historically, active RFID has been excellent at providing nodal visibility. The implementation of passive tags provides efficient and accurate item and detailed content visibility. The marriage of active RFID with passive RFID will facilitate more accurate and timely automatic capture and reporting of data within the multiple layers of information required in DoD's dynamic environment.

Figure 4 depicts how the passive–active–passive relationship could look across the DoD supply chain (CONUS/OCONUS).

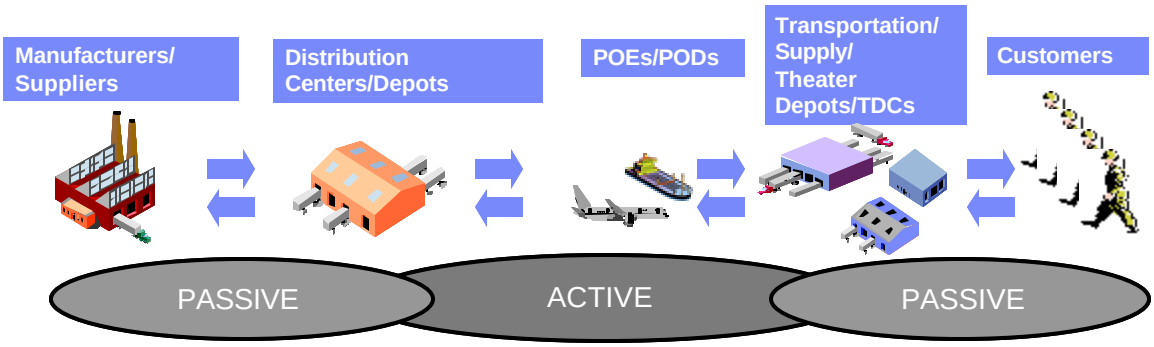


Figure 4 View of Passive-Active-Passive Across the DoD Supply Chain

1.6 Alternatives Analyzed

1.6.1 The Market Adopts Passive RFID without DoD Involvement

Over the past year, several leading companies (Wal-Mart, Michelin, Proctor & Gamble, Target, International Paper, Best Buy, etc.) have announced plans to adopt and implement passive RFID to improve their supply chain and operations. The growth of RFID continues to move forward at a fast pace and the composition of the supplier base shows that it will continue to grow towards a

global trend. In 2004, the Meta Group estimated that approximately 30% of manufactured capital goods would be RFID enabled by 2008 and grow to 80% by 2013.

Numerous market analysts' reports continue to assess the overall impact of the recent mandates on spending and the adoption of RFID but several key findings can be made from all of these reports:

1) **The global RFID market is growing**
2) **Costs are coming down and the technology is maturing**
3) **Adoption rates are increasing**
4) **Standards are developing at a rapid pace for a technology recently described as nascent**
5) **Early market adopters will shape the development of this technology**

In summary, the adoption of RFID is moving at a rapid pace and companies that embrace RFID as early adopters will be in a key position to shape the design, standards development and employment of this technology. The exclusion of DoD from the overall RFID landscape would not cause much of an impact to the overall adoption of RFID on a global scale but would result in higher costs and potential barriers for DoD when they reentered the market at a later time. It would also place suppliers in a potential conflicting standards situation as DoD may have unique needs for the employment of RFID. The most critical potential impact would be on the warfighter on the ground by reducing the effectiveness and efficiency of the DoD supply chain.

1.6.2 The Market Adopts Passive RFID with DoD Involvement According to a Phased Implementation Plan

The DoD undertook a detailed examination of the components of its supply chain in order to determine an appropriate implementation schedule for the introduction of passive RFID into the supply chain. The DoD has approximately 60,000 suppliers that ship materiel to it in a given year. As such, the DoD wants to carefully manage the way it places the RFID requirement on its suppliers to ensure that it can closely monitor progress and proactively deal with any supplier issues/concerns that arise during the implementation. In order to develop the implementation plan, the DoD looked at three key elements: classes of supply (i.e. materiel delivered to the DoD), DoD receiving locations, and levels of packaging (i.e. case vs. pallet, etc). By examining each of these factors, the DoD has been able to develop a plan that targets critical items at key distribution locations.

This phased implementation (located at http://www.dodrfid.org/supplierimplementationplan.htm) approach benefits both the DoD and the DoD supplier community. By limiting the number of suppliers immediately impacted by this program, the DoD is allowing itself time to effectively manage the introduction of this new technology into its supply chain. DoD will have more time to work with the smaller number of impacted vendors in order to ensure their understanding and to help fix any problems that arise. It also allows DoD to make any necessary modifications to the program through the analysis of the initial implementation. DoD is targeting the commodities whose supply chains are most ready to immediately inject the use of RFID. These

commodities also represent types of supply that are key to ensuring the readiness of our militaries' warfighters.

1.6.3 The Market Adopts Passive RFID with DoD Involvement According to an Immediate Implementation Plan (No Phasing)

The benefits of the market adopting passive RFID with DoD involvement are detailed above in Section 1.6.2. However, immediate DoD implementation of passive RFID without phasing the implementation would require that all classes of supply be tagged at the case and pallet level that were shipped to any DoD location worldwide. DoD has identified a variety of benefits that it will achieve through the use of RFID. While DoD would certainly realize benefit from this approach, it would only achieve a marginal level of benefit based on the introduction of more classes of materiel being tagged. Inherent in DoD receiving these benefits is the fact that locations receiving these tagged shipments have infrastructure in place that allows them to read RFID tags and associate those reads to data residing in the logistics systems in order to derive a business benefit. As a result, the DoD would only receive these increased benefits in locations that are outfitted with passive RFID capabilities. In 2005, this is limited to the Defense Distribution Center Susquehanna, PA (DDSP) and the Defense Distribution Center San Joaquin, CA (DDJC). Therefore materiel being tagged and shipped to all other locations would arrive without being read by any RFID equipment thus depriving the DoD of gaining the value of that tag. The costs would therefore outweigh the benefits as the DoD would be paying for the suppliers' RFID costs (in the contract cost) and not receiving the expected benefits.

In terms of sheer volume, the immediate implementation of passive RFID would be nearly impossible. From the supplier perspective, there would simply not be enough RFID equipment (tags, readers, printers) available in the marketplace to support all 60,000+ suppliers. The RFID market is not prepared to support such a volume in such an immediate timeframe. From the DoD perspective, this would also simply be too great of a change to handle. As mentioned previously, DoD will not have infrastructure in place at every DoD location immediately. DoD is faced with the same marketplace limitations as the supplier community – they would not be able to fulfill their demand for all of the RFID equipment necessary to have an immediate implementation.

1.7 Summary

Passive RFID is an emerging technology that holds tremendous promise to help improve supply chain operations in both the commercial sector and within DoD. DoD has chosen this technology as an enabling tool to develop an integrated, end-to-end supply chain designed to relieve burdensome logistics processes for the DoD's warfighting community.

The evaluated option that is the most pragmatic is for the market to adopt passive RFID with DoD's involvement according to a phased implementation approach. DoD's participation in the initial phase of this technology development will ensure that its requirements are recognized and reflected in the standards that are currently being developed. DoD will also be able to shape the requirement for future generations of passive RFID tags, readers, and software. The phased implementation allows the DoD to establish passive RFID infrastructure at key locations, thus ensuring that tagged materiel from suppliers can be read at the important receiving locations.

The phased approach also allows DoD to work more closely with the impacted suppliers to ensure compliance and to develop solutions to any problems that arise during the initial stages of the implementation. This would be impossible if DoD had to deal with all 60,000+ suppliers trying to comply at the same time. Finally, and perhaps most importantly, it will allow the DoD to continually identify areas for business process improvement throughout the implementation. Business process reengineering is where DoD will reap the true benefits of passive RFID, enabling the DoD to transform its logistics operations in an economical fashion that continues to equip the DoD and its warfighters with everything necessary to accomplish their mission(s).

In order to facilitate rapid adoption of this technology, DoD decided to pursue a change to the Defense Federal Acquisition Regulation Supplement. This change institutionalizes the requirement with a standard DFARS clause that will be included in all future materiel acquisition contracts. In accordance with Executive Order 12866, DoD is submitting a modified Economic Analysis that outlines three implementation approaches. The associated benefits, costs, and industry impact are included in this analysis.

2 INTRODUCTION

Today's U.S. military is a dynamic, rapidly moving force designed to be effective in an asynchronous battlespace. The enhanced mobility and speed of today's combat force, capable of performing in austere theaters with limited infrastructure, creates a new class of challenges for military logisticians. The performance of logistics during the combat phase of Operation Iraqi Freedom created a compelling case for change to meet this challenge. The contemporary military logistician must meet the challenge of supporting the transformed combat force with fast, accurate, flexible, and mobile sustainment support.

Historically, military logisticians supported the warfighter with limited information on assets, particularly in theater. This obstacle led to less effective inventory management, inefficiency, and delay across the supply chain. Ultimately, these shortfalls impacted the warfighter's overall materiel readiness, ability to close the force, and operational availability of weapons systems. The lack of synthesized end-to-end real time theater information on assets, including both at-rest and in-transit items, across all Components, undercuts the Combatant Commander's (COCOM) ability to exercise directive authority for logistics.

Today's forces require improved visibility, but visibility is not an end in itself. Visibility is a tool to achieve specific outcomes, in support of the following objectives:

- Ensure reliable delivery of the required item to the right location in the correct quantity in the right condition at the time required and from the most appropriate source.
- Make tools and information available for decision makers to exercise effects-based management of the logistics network.
- Manage end-to-end capacities and available assets across the end-to-end chain to best support the warfighter requirements.
- Promote the ability of the supported COCOM to effectively exercise directive authority over logistics.

Radio Frequency Identification (RFID) is an enabling technology that will allow military logisticians to create synthesized and integrated end-to-end information on assets. The end state for the DoD supply chain is to be a fully integrated adaptive entity that leverages state-of-the-art enabling technologies and advanced management information systems to automate routine functions and achieve accurate, timely in-transit, in-storage, and in-repair asset visibility with the least human intervention. RFID is a foundational technology on the path to achieving this vision. Ultimately, DoD will operate a single, seamless, responsive enterprise visibility network, accessible across the enterprise and usable by both people and systems across the end-to-end supply chain. As a starting point, the DoD vision for RFID is to utilize RFID to facilitate accurate, hands free 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 (AIT) technologies. DoD will leverage all of these technologies, where appropriate in the supply chain, to improve the ability to support the warfighter.

The Department of Defense is already a globally sophisticated user of active RFID, with over a decade of experience in this technology and the most extensive network in the world. Now, the

DoD is moving to standardize the use of active RFID and is moving ahead with the application of passive RFID technologies. On July 30, 2004, the Acting Under Secretary of Defense for Acquisition, Technology, and Logistics issued policy requiring the implementation of Radio Frequency Identification across the DoD. The Department of Defense is taking a leadership role in passive RFID, both as an early adopter of the technology and by driving the development of the technology and standards for its application.

The July 2004 policy directs military services and defense agencies to immediately expand the use of high data capacity active RFID currently employed in the DoD operational environment. The policy also directs the phased application of passive RFID by DoD suppliers who will be required to put passive RFID tags on the cases and pallets of materiel shipped to DoD, as well as the packaging of all items requiring a Unique Identification (UID). Beginning in 2005, DoD suppliers will be required to apply passive RFID on shipments of selected classes of supply going to the Defense Distribution Center San Joaquin, CA (DDJC) and the Defense Distribution Center Susquehanna, PA (DDSP). Additional classes of supply and nodes will be added over the next several years, with full implementation expected by 2008. Complete address and DoDAAC information for these locations can be found at http://www.dodrfid.org.

Figure 5 depicts a DoD RFID enabled supply chain. This high level process view provides a visual representation of how DoD foresees using RFID, as materiel is physically moved from the manufacturers/suppliers to the warfighter.

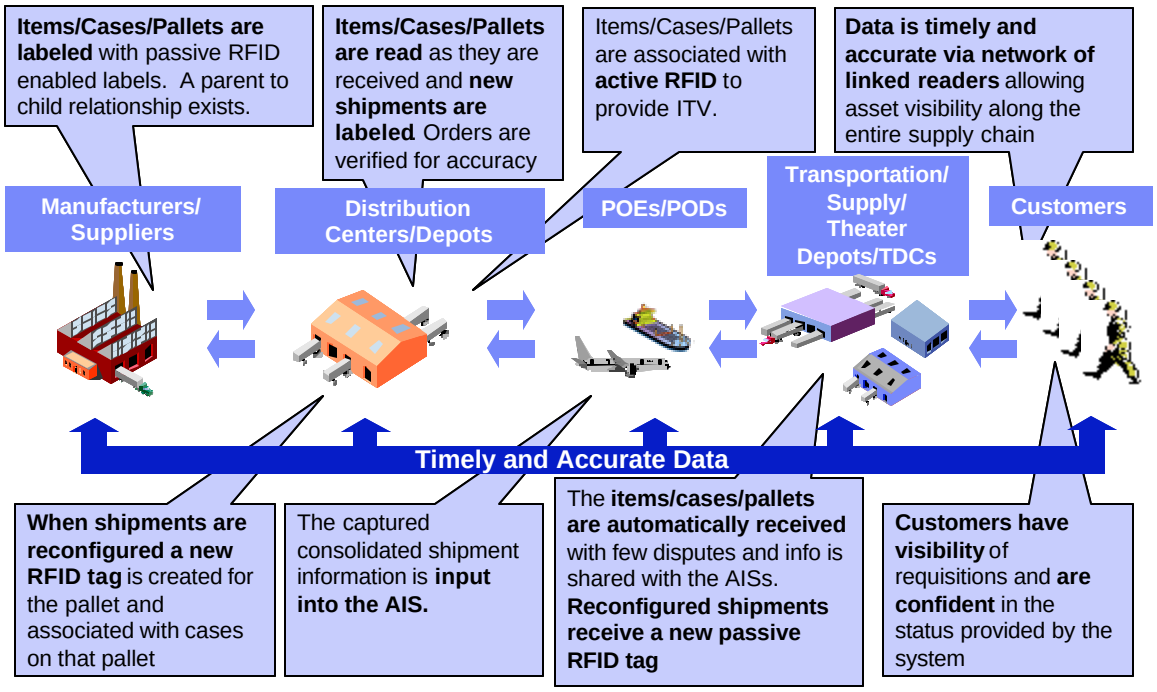


Figure 5 DoD RFID Enabled Supply Chain

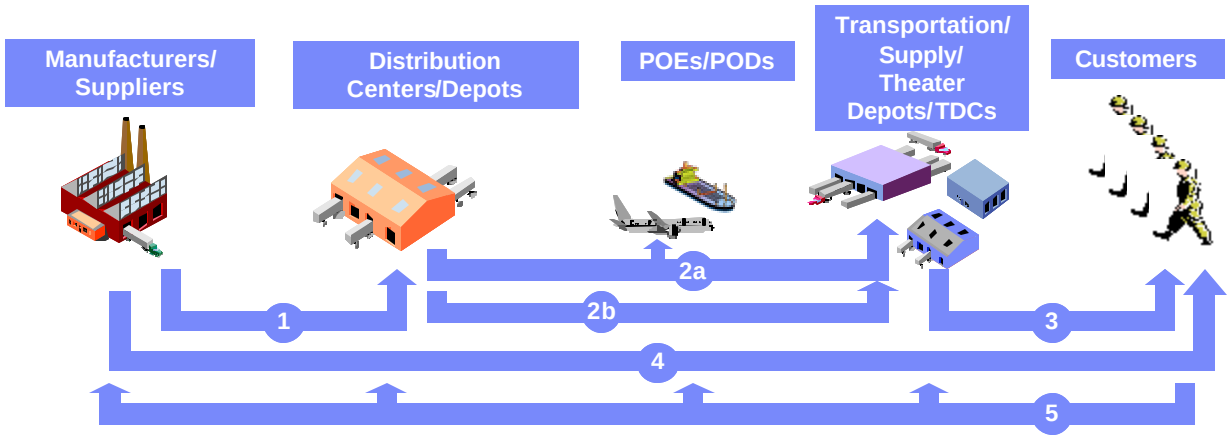
Clearly not all operations within the DoD logistics supply chain are captured in this picture. However, the primary actions performed by the physical nodes to move materiel through the logistics chain are the shipping/receiving/transportation processes. Figure 5 shows materiel movement that physically "touches" each node throughout the logistics path. Yet, materiel can

start, end and move through different paths between logistics nodes. Figure 6 gives other examples of how materiel can move, in various segments, through the logistics chain. All of the segments depicted in Figure 6 are impacted by RFID. Materiel movement includes moving retrograde back through the supply chain. Again, the direct impact of RFID on the retrograde & return process corresponds to the basic shipping, receiving, and transportation processes. A more complete discussion of the DoD supply chain is addressed in Section 4 of this document. Additionally, the impact upon Logistics Information Systems is addressed in Section 4.6.8.

With passive RFID, DoD will capture more data hands-free, injecting advanced technology at the transactional level. This foundation will streamline the movement of materiel through warehouses and depots; increase inventory accuracy and asset visibility; and generate productivity improvements. Active RFID is a cargo tracking capability and provides the ability to manage consolidated shipments. With the addition of passive RFID to the technology portfolio, the military is developing an end-to-end capability, relying on complementary active and passive technologies, delivering an RFID suite applicable to all inventory, in-transit, in-process, or on the shelf.

Historically, information across the supply chain has only been captured at the pre-defined nodal touch points, as illustrated in Figure 5 and Figure 6. This data capture has generally been used to update systems of record and, in some situations, generate status notifications. To speed the adoption and implementation of passive RFID technologies and accelerate the learning curve, DoD Components are initially using passive capabilities for transaction sets similar to, and sometimes identical to, legacy transactions. However, once the foundational implementations are established, the true promise of passive RFID may be realized. RFID delivers near real-time status, enables better inventory control (particularly in deployed or combat environments) and can make track and trace around the world a reality. The key benefit of RFID technology is that it eliminates the need for human intervention as RFID tag reads can occur automatically.

No longer will the DoD be constrained to capturing information on at-rest and in-transit inventories at fixed locations. As RFID tagging becomes more and more ubiquitous, and RFID technology more portable, real-time information can be captured wherever required supporting the requirements of the COCOM. Just as important, the adoption of passive RFID standards will serve to enhance the visibility of information flow across and among the Components that has historically been a challenge for the DoD. The military logistician will be able to deploy and move a logistics infrastructure and visibility capability as rapidly as the COCOM can deploy and engage the combat force.



1 Manufacturers/Suppliers to Defense Distribution Center for stock replenishment

2a Defense Distribution Center to Supply Depots/Theater Distribution Center for stock replenishment outside the continental United States (OCONUS)

2b Defense Distribution Center to Supply Depots for stock replenishment in the continental United States (CONUS)

3 Supply Department/Theater Distribution Center to Customer

4 Direct Vendor Delivery (DVD)

5 Return/Retrograde – RF (active and passive) read and write capabilities will be required at the furthest most point in the supply chain delivery system to support retrograde. The Return/Retrograde process is the same as the shipping process.

Figure 6 Alternative Examples of DoD Logistics Supply Chain Segments

As mentioned previously, RFID is part of a larger suite of AIT technologies and the DoD will leverage all of these technologies, where appropriate in the supply chain, to improve support to the warfighter. To take full advantage of this enabling technology, RFID data must be available to the Automated Information Systems (AISs). Managers of all major logistics systems modernization programs will update appropriate program documentation to include the requirement for RFID capabilities as part of the system operational deployment in conformance with the business rules and initial timeline set forth in the DoD RFID Policy. Managers of major acquisition programs will update programs as required, including the requirement for RFID capabilities where applicable.

Active and passive RFID will continue to complement one another as passive RFID technology is implemented throughout the DoD. Consolidated shipments moving OCONUS through the Defense Transportation System (DTS) are currently tracked using active RFID. Non-consolidated shipments moving both CONUS and OCONUS carry barcoded Military Shipping Labels (MSL). The implementation of passive RFID will complement the current successes of active RFID for OCONUS shipments. Figure 7 illustrates the CONUS/OCONUS passive–active–passive relationship.

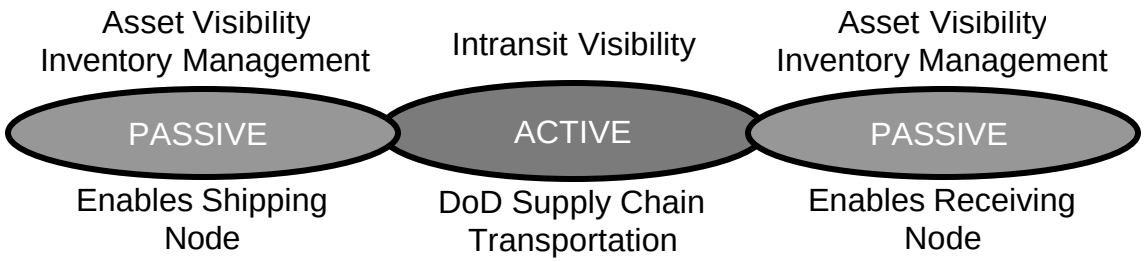


Figure 7 CONUS/OCONUS Passive-Active-Passive

The association of a passive tag to an active tag will provide improved container stuffing and un-stuffing time and accuracy to facilitate "inside the box/pallet/container" visibility. This passive and active association is created by building a "nested" structure of passive tags (UID item packaging, case and pallet tags) that are subordinate to the active tag (container and 463L pallet level tags). Historically, active RFID has been excellent at providing nodal visibility. The implementation of passive tags provides efficient and accurate item and detailed content visibility. The marriage of active RFID with passive RFID will facilitate more accurate and timely automatic capture and reporting of data within the multiple layers of information required in DoD's dynamic environment.

RFID deployment also complements the ongoing unique identification (UID) initiative. The UID initiative requires that an unambiguous, globally unique identifier (data) be permanently marked on an item. The AIT media that is used to convey the UID is a 2D data matrix symbol.

The RFID initiative requires the use of an AIT media (RFID) as a hands-free means of data collection. In 2007, the requirements for the use of UID and RFID will intersect. DOD will require that RFID devices be attached to the exterior packaging of an item marked with a UID. This insures that an item identified by a UID will be visible throughout the supply chain. In order to identify the UID item using RFID, the RFID tag data on the unit packs, shipping containers, exterior containers, and palletized unit loads must be associated to the UID information in a logistics system. Using RFID tags as a means of data collection and associating the tag data with UID information will help to maintain precise UID asset/in-transit visibility and improve data quality, item management, and maintenance of UID materiel throughout the DoD supply chain. The combination of 2D barcode and RFID technologies incorporated into AIT equipment will facilitate the UID and RFID relationship. Figure 8 depicts the "nested" structure of active RFID, passive RFID, and UID items.

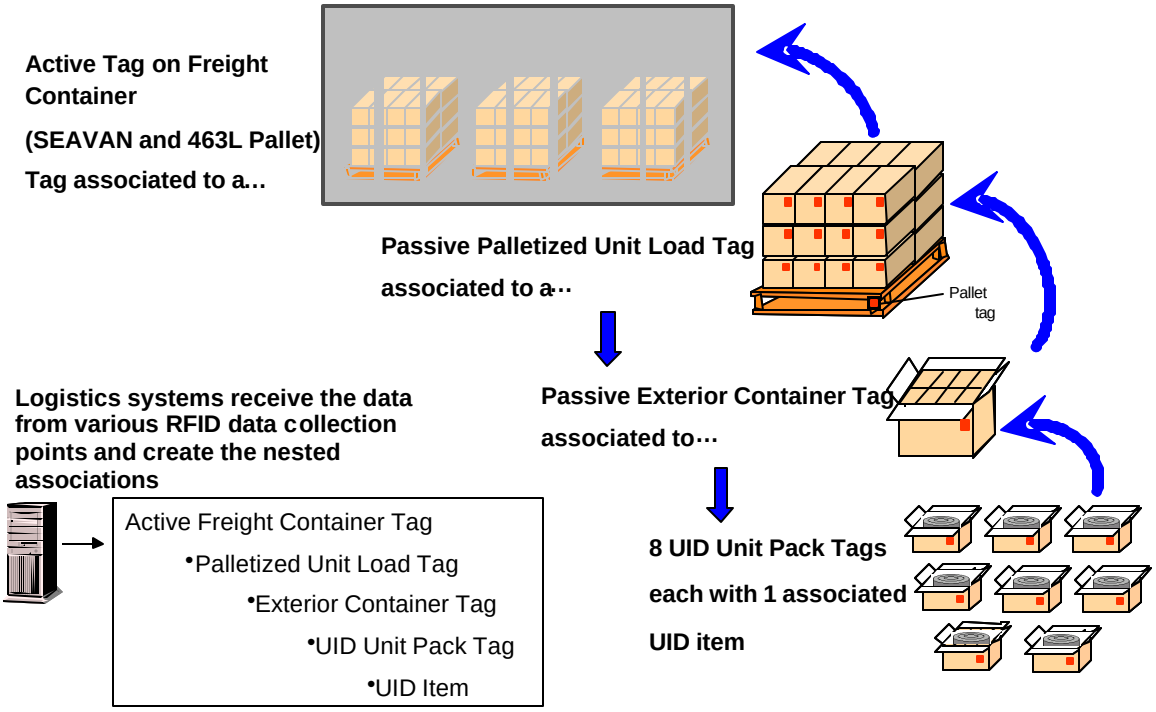


Figure 8 Nested Structure of Active RFID, Passive RFID and UID Items

Due to the "nested" structural relationship, it is envisioned that passive RFID will be used to verify contents, track physical movement, and virtually build the contents of a 463L pallet or SEAVAN container. Passive RFID will accurately verify in real-time and communicate to the local AIS (and personnel physically loading the pallet/container) the contents of the 463L pallet or SEAVAN container. Once the pallet/container is properly configured, an active tag is attached to the 463L pallet or SEAVAN container to track and trace the supply and transportation. At the final destination, when the pallet/container is unloaded, passive RFID will again verify the contents and track the physical movement of the materiel within the destination node. Additionally, this nested data will be used to create a transaction of record and close the supply and transportation transactions, without the need for manual data/intervention. Figure 9 depicts how the passive–active–passive relationship could look across the DoD supply chain (CONUS/OCONUS).

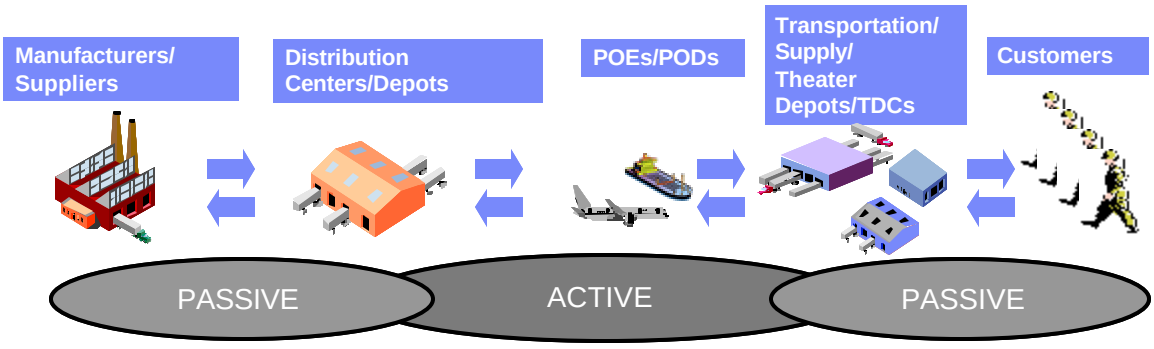


Figure 9 View of Passive-Active-Passive Across the DoD Supply Chain

In summary, the capabilities RFID creates are quickly being realized as a valuable component of the suite of Automatic Identification Technology (AIT) technologies. Active RFID has already improved the ability to track, trace, and locate on demand materiel for overseas shipments. Combining the passive RFID technology with the active RFID technology currently in place will create greater efficiencies and data accuracy in the DoD supply chain. Leveraging RFID to the fullest extent possible will improve the ability to get the warfighter the right materiel, at the right place, at the right time, and in the right condition.

The real value of RFID lies not in what we know it can do today, but in uncovering what it will do in the future. DoD is in the midst of the most fundamental transformation of logistics capability ever attempted, and RFID is a foundational element of this transformation. Through RFID deployment, DoD is laying a foundation that allows military logisticians to see an exciting capability, net-centric logistical control, riding on new applications able to see and manage end-to-end. With RFID, we can imagine controlling the supply chain from factory to foxhole, managing from end-to-end, able to deliver the right item to the right place at the right time, even in the face of rapidly evolving conditions in the battlespace.

In order to rapidly incorporate the benefits of this emerging technology, the Office of the Under Secretary of Defense (Acquisition, Technology and Logistics) has developed a Defense Federal Acquisition Regulation Supplement (DFARS) clause. Once this requirement is standardized within the DFARS, future materiel acquisition contracts will include this clause and speed the use of this technology within the DoD manufacturing and supplier base.

2.1 Organization of Report

This report is organized as follows: Following the Executive Summary and Introduction, Section 3 provides an overview of Radio Frequency Identification (RFID), a description of passive RFID and describes the role of EPCglobal, the international standards body for RFID.

Section 4 provides a detailed explanation of the DoD Supply Chain, including physical logistics nodes and associated logistics information systems. Section 4 also attempts to quantify the total costs to the taxpayer of the DoD supply chain operating inefficiently with less than optimal AIT enabling technology. Likewise, Section 4 will describe how RFID will enhance the DoD supply chain and alleviate the major pain points associated with DoD's inefficient processes.

Section 5 of this report will develop the baseline case for allowing the market to evolve without the rule.

Sections 6 and 7 lists the alternatives to allowing the market to evolve independently of DoD regulation.

Section 8 provides an analysis of the alternatives.

2.2 Problems Addressed by Regulation

The Department of Defense (DoD) is amending the Defense Federal Acquisition Regulation Supplement (DFARS) to add requirements for DoD contractors to affix Radio Frequency Identification (RFID) tags, at the case and palletized unit load levels, for specific items to be delivered to specific DoD locations. DoD considers the implementation of RFID to be a strategic imperative, necessary to deliver supplies to the warfighter more quickly, while increasing visibility of materiel throughout the supply chain. To create an automated and sophisticated end-to-end supply chain, the DoD is dependent upon initiating the technology at the point of origin, the DoD commercial suppliers. Without the assistance of DoD supplier base to begin populating the DoD supply chain with passive RFID tags, a fully integrated, highly visible, automated end-to-end supply chain is untenable.

2.3 Current DoD AIT Regulations

The passive RFID DFARS rule has no direct conflicts with other current DoD AIT regulations. The rule does not duplicate, overlap, or conflict with any other Federal rules.

2.4 Regulation

The purpose of the rule is to improve visibility of DoD assets in the supply chain, increase the accuracy of shipments and receipts, and reduce the number of logistic "touch points" to decrease the amount of time it takes to deliver materiel to the warfighter. RFID is the most efficient medium through which this important logistics information can be captured and fed to various information systems to realize these objectives. To reach these objectives, the DoD needs a common direction and standard contract language to ensure compliance with the rule. There is no specific statutory requirement for the rule.

Comments on the rule from the public comment period focused on four main areas: MIL-STD-129 definitions, recycling, Consumer Packaged Goods (CPG) and the Advance Shipping Notice (ASN). The comments on MIL-STD-129 centered on the use of MIL-STD-129 as the source of definitions vice the use of commercially accepted definitions or other sources. The DoD uses MIL-STD-129 for packaging and labeling guidance/regulations for its suppliers. As such, and in order to provide a consistent approach across all suppliers, the definitions used throughout the clause are taken verbatim from the MIL-STD-129. The recycling comments voice possible concern over the metals from the RFID tag antennas being incorporated into recycled materials. Additionally, some of those who commented on recycling cited the results of studies done by industry associations, more of which is discussed in detail in Section 5.6. There was limited data available concerning the effects of RFID tags on the recycling industry/process when the first version of this regulatory flexibility analysis was completed. The DoD is appreciative of the information that was provided during the public comment period and has updated this document to include the relevant information that was provided. The DoD also welcomes additional information and will utilize any relevant information as it continues to expand its RFID program. The comments concerning CPG items focused on items being delivered to DeCA with recommendations that DoD should wait until the grocery industry as a whole moves forward with passive RFID. DoD appreciates the input from those concerned with the tagging of CPG

material. However, it is important to note that, for the most part, CPG items are not shipped to DDSP and DDJC and therefore are not included within the scope of the current DFARS rule. As DoD continues with implementation, the Department will carefully review future requirements for tagging of CPG goods. Lastly, the comments on the Advance Shipping Notice (ASN) centered on requests to delay implementation of the ASN requirement and concerns about the ability to fulfill the data requirements in the ASN. The benefit of an ASN lies in the positioning of shipment data into a receiving information system prior to the actual arrival of the corresponding shipment – thus providing the receiving organization with "actionable information" to make delivery changes or other key business decisions. RFID is a technology that improves the ability of users in supply chains to rapidly identify, record, and process items, shipments, or both. The use of an ASN with RFID technology facilitates the positioning of shipment data into a receiving information system and allows the immediate "hands off" receipt, via RFID, of that item into inventory upon the arrival of the actual shipment – thus speeding up product availability for the customer as well as invoice close-out and payment."

Suppliers are presently required to print and affix military shipping labels or the commercial equivalent to every package delivered to DoD. To comply with the requirements of the rule, suppliers have several implementation options. The first is to simply buy pre-programmed tags (with the appropriate tag data construct), affix the tags to the packages, and submit the advance shipment notice (ASN) via Wide Area Workflow (WAWF). The second option expands on the first by adding a reader with which the supplier can verify the readability of the pre-programmed tags, and possibly write tags depending on the type of reader that is purchased. The third option involves the supplier purchasing a RFID-enabled printer that can print the appropriate data constructs to the blank tags. The fourth option expands on the third by suppliers upgrading/replacing their existing printers to include RFID printing capabilities, thus allowing the supplier to embed the RFID tag within their military shipping label. The final option would be the establishment of a full RFID infrastructure throughout the entire business process of the supplier. An example of the cost of the third option follows. The approximate price range for RFID-enabled printers is $2,500 to $4,000, and the price is expected to drop significantly as volume of sales increases over the next few years. The only other cost would be the price of the tags. In this example, the supplier could enter their ASN information through Wide Area Workflow (WAWF) via the web interface at no additional cost. No separate reading devices are required, since the printers themselves will be able to verify the accuracy of the RFID tag and assure compliance with EPCglobal specifications. Conversely, with the emergence of Third Party Logistics (3PL) providers, some suppliers may desire to take advantage of these 3PL services to maintain a low cost compliance capability.

The rule also requires suppliers to provide an advance shipment notice through use of the existing WAWF receipt and acceptance electronic system, to associate RFID tag data with the corresponding shipment. The combination of hands-free data capture with DoD's new workflow procedures offers a powerful value proposition that is, to finally integrate supply, transportation, and financial information into a seamless logistics information system.

3 WHAT IS RADIO FREQUENCY IDENTIFICATION?

3.1 RFID Background – Active Vs. Passive

Radio frequency identification technology provides a means to remotely identify, categorize, and locate materiel automatically within relatively short distances. In its simplest form, an RFID system consists of tags that store and emit data through radio waves, and the interrogators that intercept these waves and turn the information back into data. The data is digitally stored on RFID transponder devices, such as tags or labels. Fixed or handheld interrogators electronically retrieve the data via electromagnetic energy and send the data to a database. That data is then used to determine anything from the location of the package to a variety of its content information. The technology is divided into two categories—passive and active—of data storage and retrieval systems.

Active RFID technology includes a battery driven tag that transmits radio frequency (RF) energy up to 300 feet and has high data capacity. Active RFID is not the subject of this analysis and is not subject to the DFARS clause. Passive RFID does not include a battery and therefore, requires a much stronger signal to activate the tag. Consequently, the tag must be read from a much shorter range (no greater than 10 meters – and typically between 12 inches and three meters). The tag on a package is activated by a signal from the reader/interrogator and it reflects energy back to the reader/interrogator. Further, passive RFID is significantly less expensive than active RFID. Passive tags currently cost about $0.40 - $0.60 whereas currently used DoD active tags cost between $70-$100.

Passive RFID technology continues to improve over time. Initially, there was concern that the RFID tag defect rate of passive RFID tags would significantly impact cost estimates. RFID tag manufacturers test each tag before sending the tags to a customer. The manufacturer marks those defective tags as such, and ensures that each order is filled with the correct number of working tags. Furthermore, this issue has not significantly impacted any of the DoD initial implementations to date.

Passive RFID is gaining acceptance in the global marketplace. Passive RFID tags may be cheaper than active RFID tags, but have significantly less performance and data capacity. Passive RFID is best suited for applications where the ability to read hundreds of tags simultaneously from a short distance is the requirement.

3.2 Evaluating Alternative Technologies

Potential alternative technologies are extremely limited as the discussion is not a simple compare/contrast analysis and the functionality does not compare. Figure 10 shows the different technologies that the commercial sector employs besides RFID.

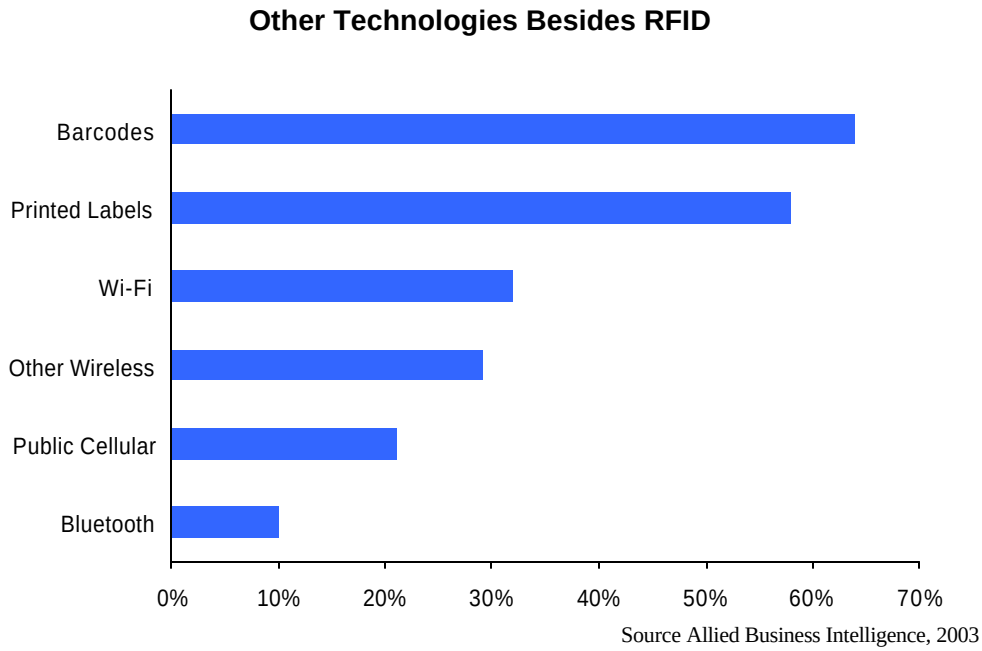


Figure 10 Besides RFID, What Other Technologies Does Your Firm Employ for Supply Chain Management and/or Asset Management?

Although the figure above provides an overview of the other technologies employed by the commercial sector, the DoD has adopted the below listed technologies over the years to improve the effectiveness and efficiency of their supply chain:

1) **Barcodes:**
    a. **Linear Barcodes**: Linear barcodes are one-dimensional—the information is carried in only one direction (left-to-right)—and represents a limited group of characters. Linear barcode applications require an external database to support business processes and require line-of sight. DoD selected the general purpose Code 39 barcodes as its first standard linear symbology. It is the principal DoD barcode and its effective capacity is about 20 characters.
    b. **Two-Dimensional Barcodes**: Two-dimensional barcodes store data in two directions: left-to-right and top-to-bottom. They store significantly more data than linear barcodes and facilitate more complex applications, but also require line-of sight. While most linear barcode applications require an external database to support business processes, 2D barcodes can function as a portable data file that travels with a shipment. They have error detection and can include error correction features. The portable data file (PDF) 417 is the most commonly used 2D barcode within DoD. Every PDF 417 symbol is composed of a stack of barcoded rows, ranging from three rows to a maximum of 90. It can encode up to 1850 characters.

2) **Active RFID:** Active RFID technology employs battery powered tags or transponders that respond to reader/interrogators. Active tags support applications requiring large

amounts of data and long read ranges. Additionally, the tags do not require a line of sight to the interrogator to function properly. Active RFID use in DoD includes in-transit visibility (ITV) of consolidated shipments in the supply chain and Real Time Locating System (RTLS) in maintenance depots. In DoD ITV applications, the active RFID tags have a memory capacity of 128k and may contain up to 1150 lines of content level data. These tags can be read by interrogators at distances of up to 300 feet.

3) **Optical Memory Card (OMC):** An OMC uses the technology popularized by audio compact disks (CDs) and audio-visual CD-ROM (read only memory) products. Data are etched to the card with a high-intensity laser and recovered by a low-power light beam. Most uses require a "write-once and read-many times" application. The OMC technology differs from barcode technology in that data are sequentially written to a card on several occasions until all available memory has been used.

4) **Contact Memory Buttons:** Contact memory technology is based on a contact memory button—a very small, fast, read-write data storage device, impervious in most harsh operating environments—with capacity up to 8 megabytes. Analogous to small, "ruggedized" computer diskettes, contact memory buttons are capable of storing any digital data, including text, graphics, sounds, and color photographs. The button does not require a battery to retain its memory and has a life expectancy of 100 years or 1 million read-write cycles. Buttons work with portable button readers or serial links that provide interfaces with personal computers. Touching a reader-writer to the button accesses the chip's memory. Memory button tags are similar to RFID transponders in that they are completely sealed and do not have exposed contacts to transmit data. They are extremely resistant to temperature extremes and environmental hazards (e.g., electromagnetic interference, electromagnetic pulse, radiation, and corrosive atmospheres). Contact memory technology can be used interchangeably with barcode media and interfaced with Radio Frequency Data Capture (RFDC). It is considered a low-cost alternative to the RFID tag offering additional features, such as larger memory capacity and faster data transfer rates. Memory button tags are especially useful in applications where space is limited; however, they cannot be read remotely.

5) **Satellite Tracking Systems:** Satellite tracking systems provide near real-time tracking of vehicles, materiel, and convoys, and may offer digital communication for drivers. Typically, tracking systems require five components—a transceiver unit, satellite, earth station, network control center, and a military satellite-tracking operations center. A transceiver unit is installed on the vehicle or container being tracked. This unit exchanges data with an earth station via satellite communications. The earth station passes it to a network control center. These first four elements can be operated commercially. The military unit receiving the data establishes a satellite-tracking operations center. Its AIS accesses tracking data continuously and monitors movement.

3.3 Analysis of Other Technologies

When DoD began looking for a new technology to improve the effectiveness and efficiency of their supply chain regarding cases, pallets, and items, it was an easy analysis to narrow down the field based upon the key requirements that are important to DoD.

	Cost	Durability	Human Intervention	Data Rich
Satellite Tracking Systems	High	High	No	No
Active RFID	Medium	High	No	Yes
Optical Memory Cards	Low	High	Yes	Yes
Contact Memory Button	Low	High	Yes	Yes
Passive RFID	Low	Medium/ High	No	Yes/No
Barcodes	Low	Low/ Medium	Yes	Yes/No

Source: DoD AIT/OSD SCI 2005

Figure 11 Comparison of Other Technologies for DoD Use on Cases, Pallets, and Items

The DoD has identified a need to be able to track materiel at the lowest piece part throughout the supply chain. Gathering this level of data in a timely and accurate manner will help the DoD realize its goal of supply chain transformation. However, this transformation will not occur unless the DoD uses a cost effective technology to track this materiel. As Figure 11 shows, the selection of passive RFID and barcodes are the two most logical choices regarding identification of cases, pallets, and items. As these were the two primary choices, the ensuing analysis will focus on passive RFID and barcodes.

3.3.1 Passive RFID Vs. Barcodes

RFID and barcodes are two technologies that sometimes overlap, but have very different applications. EPCglobal, a leader in RFID technology standardization, sees both RFID technology and barcodes co-existing for years.

The main difference between the two technologies is that barcode technology requires a line-of-sight for capturing data. In order to read a barcode, a scanner has to be able to see it, which usually requires individuals to orient the barcode and/or scanner in order to get a read. On the other hand, RFID technology is a dynamic read-write capability that does not require as much human intervention in the process.

The differences in the capabilities of the two technologies are well documented and recapped below, which shows advantages of passive RFID tags over barcodes:

- **No Physical Contact or Line of Sight Required** – RFID does not require physical contact or line of sight.

- **Tags Can Withstand Harsh Conditions** – In order to function properly, barcode readers must have clean and clear optics, and the label must be clear and free of abrasions. RFID tags can be read from a distance and in challenging environments.

- **Ability to Scan Multiple Products at Once** – Opposed to barcode systems where labels need to be scanned one at a time.

- **Ability for Reuse**- Tags can be reused as they allow for read/write capability and could be embedded into the shipping package.

In summary, benefits of using passive RFID outweigh the current state of effectiveness through barcoding. As noted before, several initial implementations were run in 2004 to begin evaluating RFID. Operations at the Navy Ocean Terminal, Norfolk, VA have been running the longest of any Initial Implementation and they noted a shipping accuracy improvement of approximately 3% and an overall time savings of approximately 37% using passive RFID over the combination of manual processing and barcodes. Read rates for the passive tags are about 96% for boxes on a pallet and 100% for single boxes on a conveyor. In addition, a major retailer has recently experienced 99% read rate on over 50,000 pallet tags. It is understood that these figures are just a small part of a representative sample, but even the limited employment of this technology has shown benefit when used properly to improve the business processes.

3.4 Why Passive RFID?

The DoD vision is to utilize passive RFID to facilitate accurate, hands-free 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 (AIT) technologies. DoD has leveraged most of these technologies, with the exception of passive RFID, where appropriate in the supply chain, to improve the ability to support the warfighter. Likewise, commercial industry has extensive experience with AIT in its supply chains and has begun incorporating passive RFID technology into its business processes.

DoD has taken a bold step to radically transform its supply chain operations and business processes. DoD carefully evaluated all applicable AIT technologies and decided passive RFID offers the greatest opportunities for future logistics enhancements.

3.5 EPCglobal: The Governing Standards Body

EPCglobal is a joint venture between European Article Numbering International (EAN) and the Uniform Code Council (UCC). This industry driven organization is leading an effort to create global standards for RFID use. The goal of the organization is to increase efficiency, visibility and the quality of information flow through the supply chain. They plan to accomplish this through global adoption of the EPCglobal Network. This network contains technologies, including RFID, that make immediate and automatic identification of supply chain items and the sharing of this information a possibility. Through their establishment and support of this network, EPCglobal is determined to set a global standard for immediate, accurate and automatic identification of any item in any supply chain, located anywhere in the world. The Electronic Product Code (EPC) is a next generation product identification blueprint. It is a "license plate" assigned to every product that uniquely identifies that item in the supply chain. EPCglobal grew out of the initial passive RFID work being done at the Massachusetts Institute of Technology (MIT) Auto-ID Center. DoD participated in the work at the Auto-ID Center in order to ensure that the standards and technology being developed met the needs of the Department of Defense.

4 THE DOD SUPPLY CHAIN

4.1 Size and Scope

The size and complexity of DoD's logistics mission dwarfs even the largest commercial logistics networks. DoD logistics is big business and represents a significant portion of the annual defense budget. Military logistics cost $131 billion in both 2003 and 2004, in part due to current operations. This figure is expected to decline beginning in 2005. Over 100,000 containers or 5.1 million M/T (measurement tons) of sealift and more than 1.75 million air shipments are required annually to keep the vast logistics pipeline full. This annual pipeline value exceeds 9 million line items and represents more than $27.3 billion dollars in materiel and supplies (secondary items only). The infrastructure supporting the Defense logistics system requires over 73 million square feet of storage space and hundreds of information systems, materiel management systems, and financial systems. This logistics system currently results in an average customer wait time to receive materiel of 16 days. This metric applies to all requisitions worldwide and includes backorder time and receipt notification delays.

4.2 Warfighter Support

A primary goal of this passive RFID effort is to enable the DoD logistics systems to improve complete total asset visibility to our military logisticians and the warfighters they support in theater. The COCOMs have mandated materiel destined for their Areas of Responsibility to be visible throughout the supply chain. RFID will enable the Defense Transportation System and Defense supply chain operations to comply with the COCOMs' requirement. The amount of materiel that flowed from the Defense Logistics Agency to warfighting customers during 2004 was staggering. More than 1.67 million air shipments flowed to COCOMs while the Military Sealift Command delivered in excess of 338,000 surface shipments.

4.3 Current DoD Supply Chain Issues

The current Department of Defense supply chain presents extreme challenges for military logisticians. It served the Department of Defense well throughout the Cold War and performed admirably each time it was tasked to support major engagements or contingency operations around the globe. However, during Operation Iraqi Freedom and earlier in Operations Desert Shield and Desert Storm, the Department of Defense exercised the logistics system in ways never before experienced. Rapid build up of personnel, weapon systems, materiel and supplies pushed the logistics system to its breaking point and resulted in extreme cargo backlogs at Container Consolidation Points (CCPs), Aerial Ports of Embarkation (APOEs), Aerial Ports of Debarkation (APODs), Surface Ports of Embarkation (SPOEs), Surface Ports of Debarkation (SPODs), and Theater Distribution Centers (TDCs). The quantity of materiel and supplies being pushed through the logistics system was staggering. The logistics capability had never before been exercised with such speed and volume.

Today, in a world where asymmetrical warfare is testing the current military strategy and contingency and peacekeeping operations are forcing military units into unexpected locations throughout the world, we find ourselves encumbered with a logistics system that can no longer provide timely, reliable, or responsive support to the Combatant Commanders in their Areas of Responsibility. The same logistics system that was pushed to its limit during Operations Desert Storm and Iraqi Freedom continues to be challenged in current operations.

The Department of Defense has created a vast capability. The establishment of the United States Transportation Command (TRANSCOM) with its Operational Commands; Air Mobility Command (AMC), Military Sealift Command (MSC), and Military Surface Deployment and Distribution Command (SDDC), affords the American warfighter a tremendous power projection capability. The Defense Logistics Agency and military services' supply chain operations are capable of delivering weapons systems, materiel and services, through well-established requirements planning and execution processes that are configured for worldwide support. However, the challenge for military logisticians is to coordinate combat logistics support operations with TRANSCOM's power projection capability to deliver fast, reliable, and affordable service to our Combatant Commanders.

The DoD logistics environment is comprised of multiple logistics nodes and segments. This logistics environment places a heavy burden on the warfighters, as they must operate where there is incomplete information and limited visibility of critical materiel. This environment also creates unnecessary workloads for logistics planners, materiel receipt operations, in-theater transportation activities, and front-line military logisticians.

Tomorrow's Defense logistics system must be capable of delivering combat power quickly. It must be coordinated, synchronized, and harmonized. It should be streamlined, efficient, simple to manipulate, and pinpointed to deliver full response across the global spectrum of warfare. It must be optimized from end-to-end and operational on day one. RFID will facilitate this transformation.

It is by no means an easy transition from a legacy system designed to move mass to an agile system capable of delivering power, speed and information. The legacy logistics system is not as quick to adapt to today's flexible force, resulting in:

- Lack of end-to-end visibility
- Unnecessary war fighter workload
- Inefficient materiel configuration
- Unnecessary nodal delays
- Inefficient use of transportation assets
- Improper packaging and marking of shipments

It is envisioned that the insertion of RFID into DoD's logistics and distribution systems will begin to repair the negative attributes associated with its massive supply chain operations.

4.4 How can Passive RFID Address these Issues?

As stated before, RFID is part of a suite of AIT devices that includes, but is not limited to bar codes, optical memory cards, contact memory buttons and satellite tracking systems. RFID and barcodes will co-exist for several years as both technologies have their merits. Yet, RFID brings several positive benefits:

- Eliminates Need for Human Intervention
- Reduces human error
- Improves data accuracy/asset visibility
- Performs in rugged, harsh environments
- Allows for dynamic multi-block read/write capability
- Facilitates source data collection
- Allows for simultaneous reading and identification of multiple tags
- Provides for unique reads for individual items

The employment of RFID provides several benefits to the overall DoD supply chain. Figure 12 identifies these potential benefits and the respective nodes.

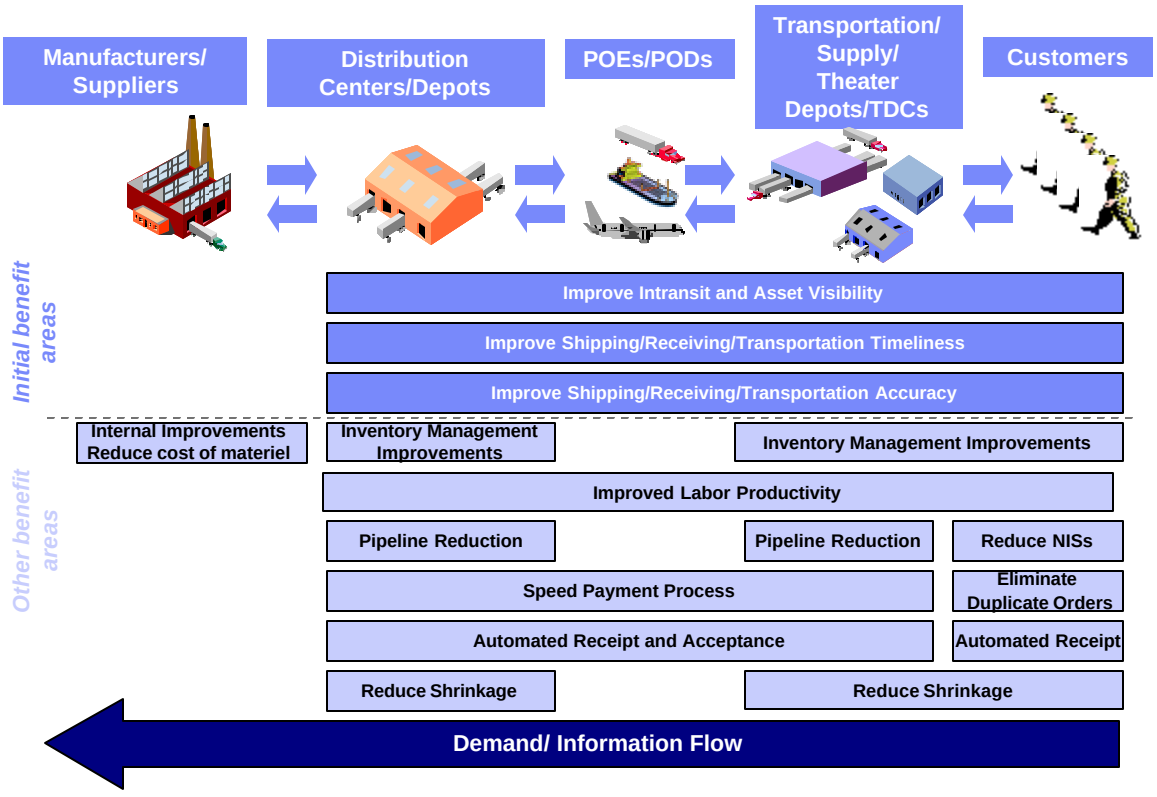


Figure 12 High Level Illustration of the Benefits from RFID Across the DoD Supply Chain

It is envisioned that each military service and defense agency will review its internal business processes to further refine the most appropriate employment of RFID. The widespread

integration of RFID into the DoD business processes should be managed with the same level of attention as a major system fielding. Although this technology enables accuracy and timeliness of data within current and future systems of record, introducing RFID will require significant planning, equipment fielding, AIS changes, and training.

4.5 The Future RFID Enabled Supply Chain

The DoD logistics supply chain is made up of physical logistics nodes (Defense Distribution Centers, Ports of Embarkation/Ports of Debarkation (POEs/PODs), Theater Distribution Centers, Transportation Offices, Supply Activities) through which the movement of materiel is processed. To improve in-transit and asset visibility, these physical logistics nodes must have an appropriate RFID infrastructure and connections to existing AIS's established.

Figure 13 lists types of DoD logistics nodes and gives a description of each node.

Node Type	Node Functions
Manufacturers/Suppliers	Commercial providers who produce/supply materiel to the DoD.
Transportation/Supply Office	Military activities that place/fill orders, receive materiel, maintain/monitor inventory, arrange transportation, and Distribute materiel to the end customer.
Distribution Centers/Depots (Sustainment and Repair)	Military/Commercial activities for the receipt, classification, storage, accounting, issue, maintenance, repair, procurement, manufacture, assembly, research, salvage, or disposal of materiel.
Port of Embarkation (POE)	Military/Commercial activities that consolidate materiel, lift/transport materiel, and deliver materiel according to the terms of service. The activities are a geographic point in a routing scheme from which cargo or personnel depart. This may be a seaport or aerial port from which personnel and equipment flow to a port of debarkation.
Port of Debarkation (POD)	Military/Commercial activities that consolidate materiel, lift/transport materiel, and deliver materiel according to the terms of service. The activities are a geographic point at which cargo or personnel are discharged. This may be a seaport or aerial port of debarkation.
Theater Distribution Centers	Military activities that receive materiel in consolidated form and reconfigure shipments in smaller and/or direct packaging for delivery to the end customer.
Theater Depots (Sustainment and Repair)	Military/Commercial activities that place/fill orders, receive materiel, maintain/repair/monitor inventory, arrange transportation, and distribute materiel to the end customer.
Customers	Military personnel/activities that place orders, receive materiel for either replenishment inventory or immediate consumption/use, return items, and deploy/redeploy.

Figure 13 DoD Logistics Nodes

Figure 15 is a high-level pictorial representation of the DoD supply chain.

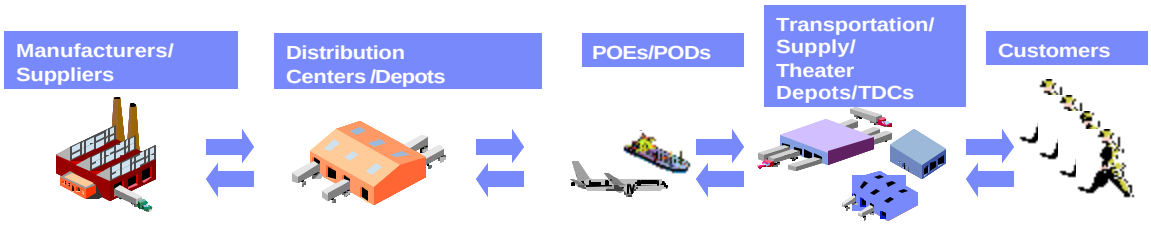


Figure 14 DoD Supply Chain Nodes

4.6 Supply Chain Nodes

The following sections provide a brief description of the business processes performed at each node in the supply chain and a pictorial and written representation of the potential use of RFID within each logistical node in the DoD supply chain.

4.6.1 Manufacturers and Suppliers

It is envisioned that RFID could operate in the following manner at the manufacturer/supplier:

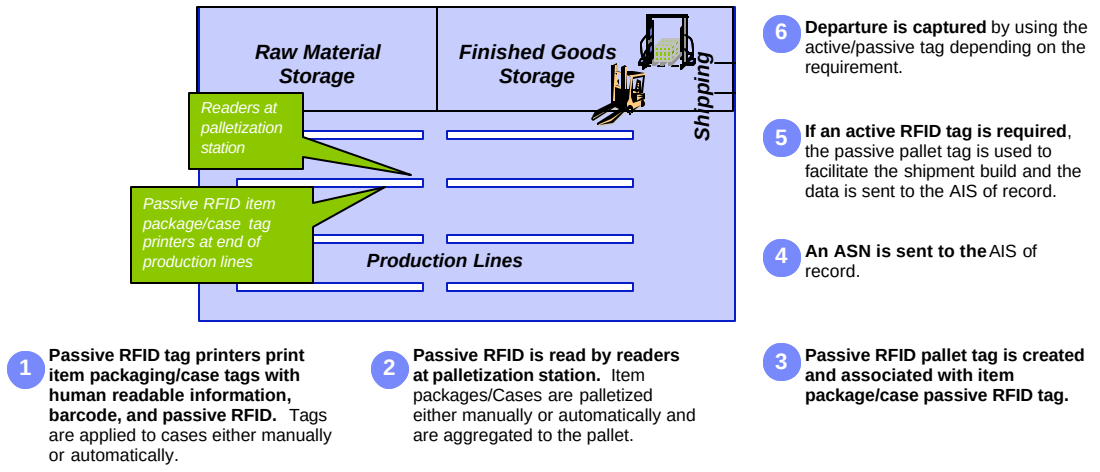


Figure 15 Manufacturers/Suppliers

A potential scenario of using passive RFID at the manufacturers/suppliers level is as follows: Passive RFID tags are printed for the item package/cases. This tag includes human readable information, a barcode and the passive RFID tag. The tags are then applied at the appropriate level. As the item packages/cases are palletized (either manually or automatically), the passive RFID tags are read by the readers at the palletization stations. Once the pallet is constructed, the passive RFID pallet tag is created and associated with the item package/case passive RFID tags on that pallet. From there an ASN is sent to the AIS of record. If an active tag is required, the passive pallet tag is used to help build the shipment information for the active tag and the data is sent to the AIS of record. When the shipment leaves the manufacturer/supplier, the data is captured with either an active or passive RFID scan depending on the requirements.

4.6.2 Transportation/Supply Offices

It is envisioned that RFID could operate in the following manner at the Transportation/Supply Office:

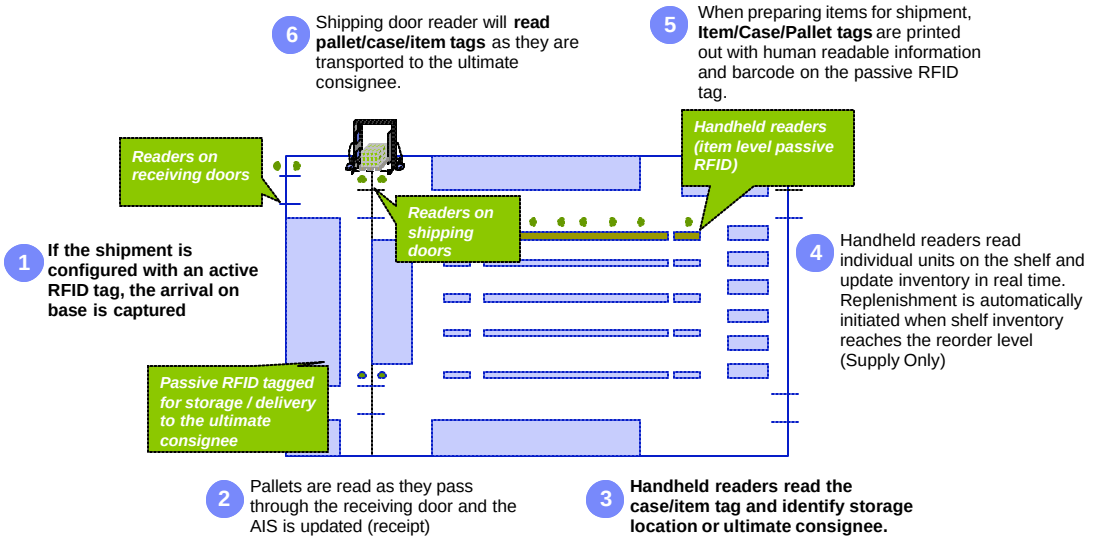


Figure 16 Transportation/Supply Offices

A potential scenario of RFID use within a Transportation/Supply Office is as follows: when a shipment with an active RFID tag arrives at the Transportation Supply/Office, the arrival is captured through an active RFID read at the receiving door and the AIS is updated accordingly. Next, handheld readers are used to scan the item package/case tags and identify the appropriate storage locations or the ultimate consignees. Handheld readers are also used in the Transportation/Supply Offices to update inventory on the shelves in real-time. This facilitates automatic replenishment which is triggered when inventory on the shelf reaches a predetermined reorder level. When the Transportation/Supply Office prepares items for shipment, item package/case/pallet tags are printed with human readable information, barcodes and include the passive RFID tag. These are then applied at the appropriate level of packaging. When the

shipments leave the Transportation/Supply Office for the ultimate consignees, the readers at the shipping doors will read the departing RFID tags.

4.6.3 Distribution Centers and Depots

It is envisioned that RFID could operate in the following manner at the Distribution Center/Depot (Sustainment):

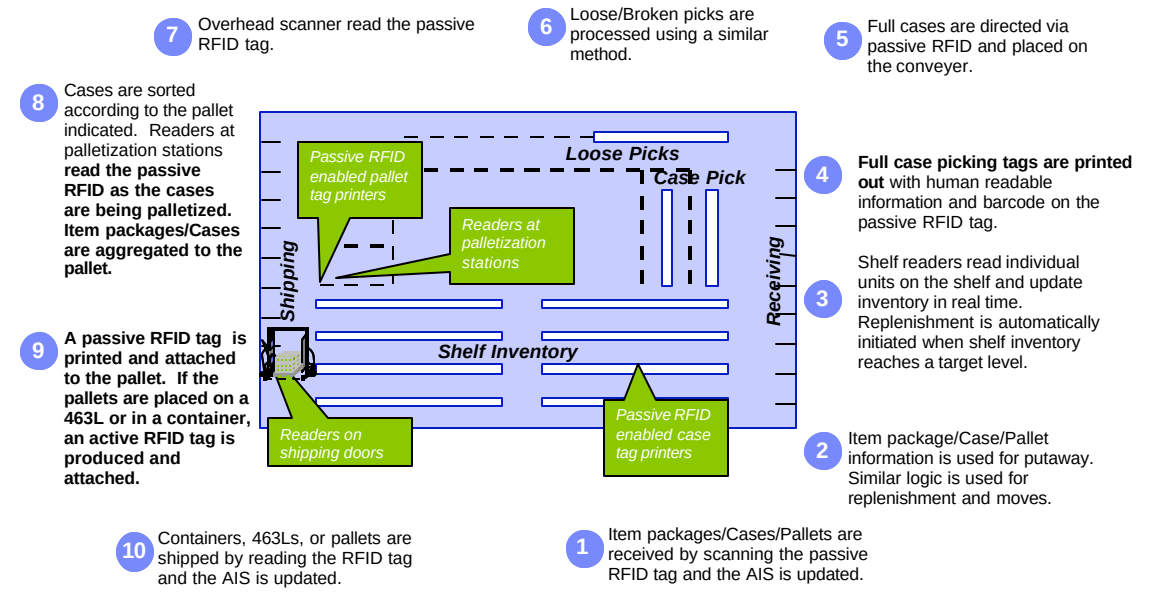


Figure 17 Distribution Centers/Depots (Sustainment)

A potential use of passive RFID at the Distribution center and Depot level is as follows: as passive RFID tagged items are received, the item package/case/pallet tags are scanned and the appropriate AIS is updated. The information contained on the tags is used to place the items in the appropriate storage location. Shelf readers are used in the Distribution Centers and Depots to update inventory on the shelves in real-time. This facilitates automatic replenishment which is triggered when inventory on the shelf reaches a predetermined reorder level. When picking items for shipment, those items which are picked in full cases have passive RFID tags made for them to include human readable information, barcodes, and the RFID tag. The picked cases are placed on the conveyor and directed via passive RFID scans, which occur from a reader placed above the conveyor. Loose or broken picks are processed in a similar manner. The cases are then sorted according to the pallet specified and readers at the palletization stations read the passive RFID tags as the items are being palletized. Once items are palletized, a passive RFID tag is attached to the pallet. If a 463L pallet or container is used, an active RFID tag is produced and attached. The pallets, containers, or 463L pallets are then shipped by scanning the RFID tag and the AIS is updated.

It is envisioned that RFID could operate in the following manner at the Repair Depot:

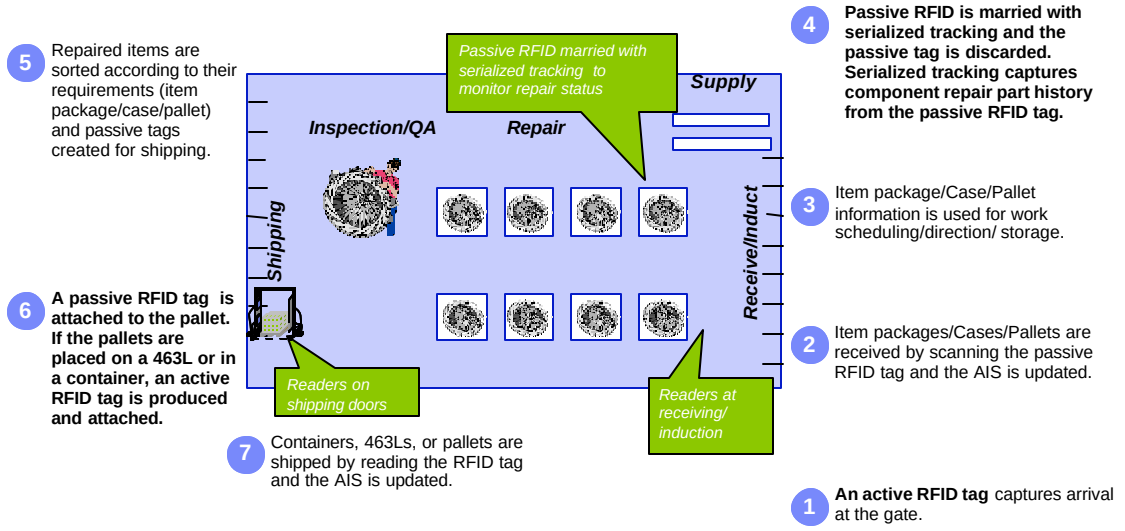


Figure 18 Repair Depots

At a repair depot, it is envisioned that passive RFID could be employed in the following manner: an active RFID tag is scanned at the arrival gate. Next, the item packages/cases/pallets are received by scanning the passive RFID tag. The appropriate AIS is then updated as a result of the scan. The information on the item package/case/pallet tags are used for scheduling, direction and storage of items. The passive RFID information is married with the serialized tracking and the passive tag is then discarded. The serialized tracking enables the depot to capture the component repair part history from the passive tag. After repair, the items are sorted according to requirements of item packaging, case or pallet, and the appropriate passive tag is created and applied for shipment. Once palletized, the passive RFID tag is attached to the pallet. If a 463L pallet or container is used, an active RFID tag is produced and attached. The pallets, containers, or 463L pallets are then shipped by scanning the RFID tag and the AIS is updated.

4.6.4 POE/PODs

It is envisioned that RFID could operate in the following manner at the POEs/PODs:

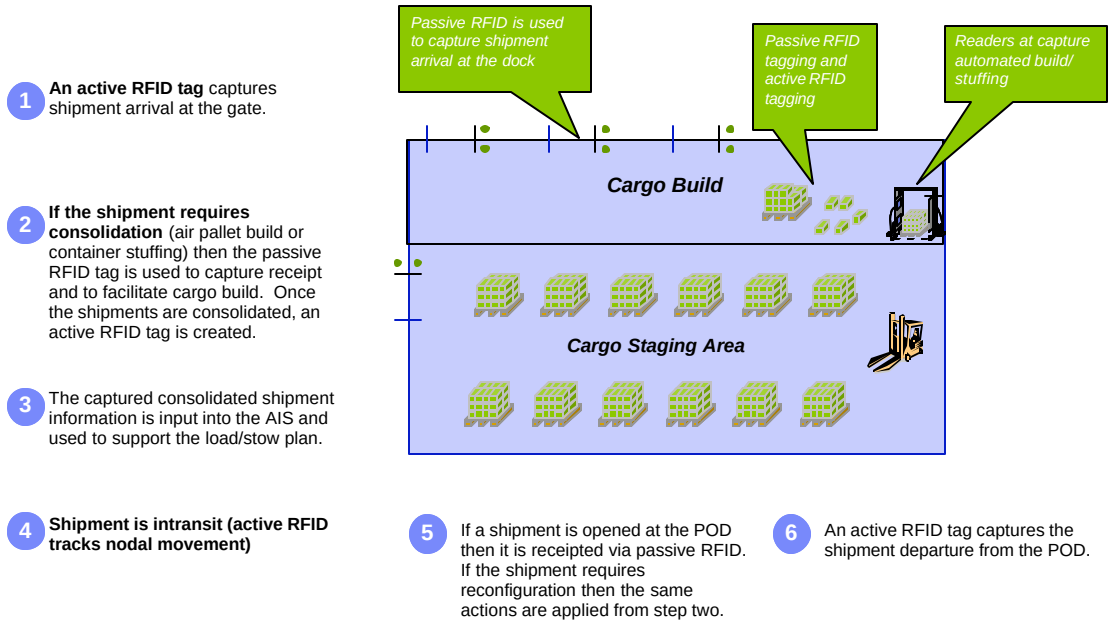


Figure 19 POEs/PODs

It is envisioned that passive RFID could have the potential applications within a POE or POD in the following manner: when a shipment arrives tagged with active RFID, the shipment is scanned at the gate. If this shipment requires consolidation, either air pallet build or container stuffing, the passive RFID tag is used for receipt and also to facilitate the build. Once the shipments are consolidated, a corresponding active RFID tag is created and the shipment information is inputted into the AIS. In addition, this information supports the creation of the load/stow plan. Once the shipment is in-transit, active RFID tracks the nodal movements. Upon arrival at the POD, the shipment may be opened for reconfiguration. If this occurs, the shipment is receipted for via passive RFID. The shipment then goes through the same process of consolidation as it did at the POE- the passive RFID tag is used for receipt and to also facilitate the build. Once the shipments are consolidated, a corresponding active RFID tag is created and the shipment information is inputted into the AIS. When the reconfigured shipment leaves the POD, an active RFID tag captures the shipment's departure.

4.6.5 Theater Distribution Centers

It is envisioned that RFID could operate in the following manner at the Theater Distribution Centers:

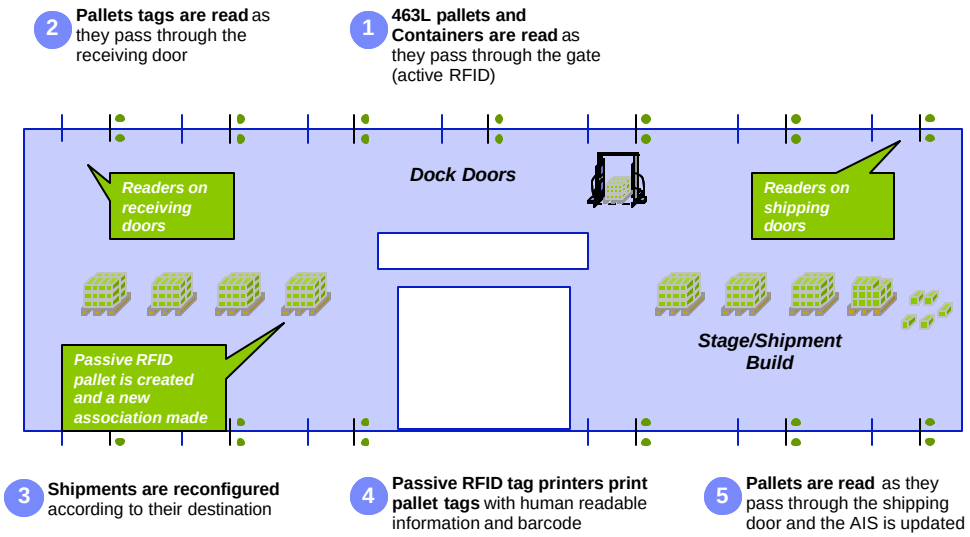


Figure 20 Theater Distribution Centers

A potential application of passive RFID within the Theater Distribution Centers is as follows: active RFID tags are read from 463L pallets and containers as they pass through the gate on arrival. Passive RFID tags are read from the pallets as they pass through the receiving door. Shipments are then reconfigured within the Theater Distribution Center for shipment. New passive RFID tags are printed and applied to the corresponding pallets. These tags include human readable information and barcodes. The pallet tags are read as they move through the shipping door for departure and the AIS is then updated.

4.6.6 Theater Depots

It is envisioned that RFID could operate in the following manner at the Theater Depots (Sustainment):

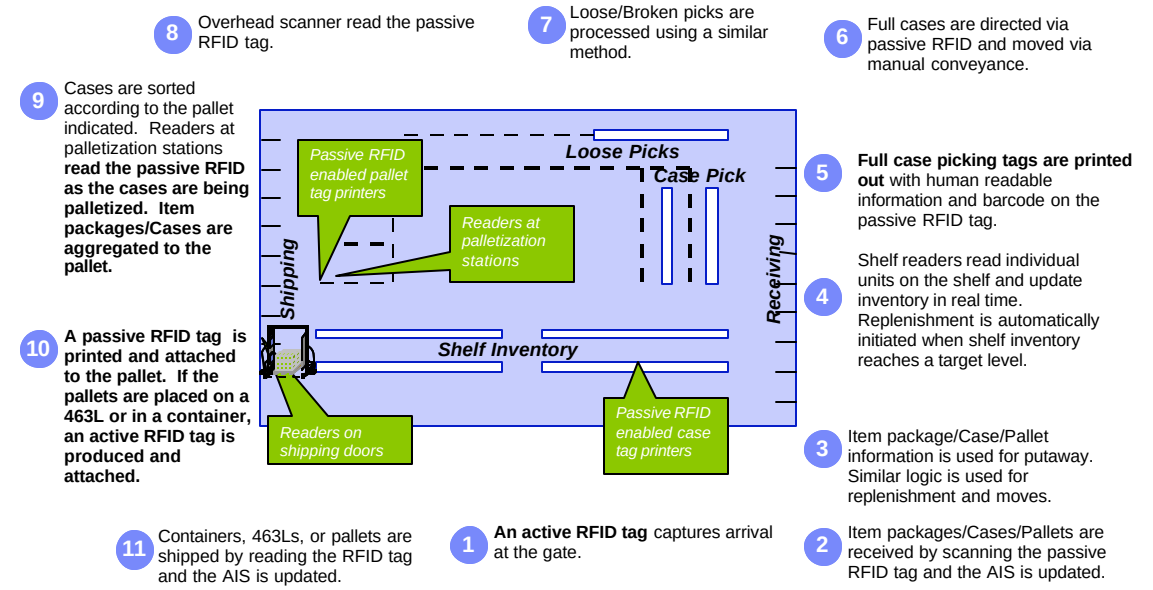


Figure 21 Theater Depots (Sustainment)

A potential application of passive RFID within the Theater Depots (Sustainment) is as follows: an active RFID tag captures a shipment's arrival at the gate. Item packages/cases/pallets are received by a passive RFID scan and the AIS is updated. The passive tag information on the item package/case/pallet is used to store the items, as well as for replenishment and movement of the items. Shelf readers are used in the Theater Depots (Sustainment) to update inventory on the shelves in real time. This facilitates automatic replenishment, which is triggered when inventory on the shelf reaches a predetermined reorder level. Those items which are picked in full cases have passive RFID tags printed, which include human readable information, barcodes, and the passive RFID tag itself. The passive RFID tag is applied to the case. The picked full cases are placed on the conveyor and directed via passive RFID scans, which occur from a reader placed above the conveyor belt. Loose or broken picks are processed in a similar manner. The cases are then sorted according to the pallet specified and readers at the palletization stations read the RFID tags as the items are being palletized. Once items are palletized, a passive RFID tag is attached to the pallet. If a 463L pallet or container is used, an active RFID tag is produced and attached. The pallets, containers, or 463L pallets are then shipped by scanning the active RFID tag and the AIS is updated.

It is envisioned that RFID could operate in the following manner at the Theater Repair Depots:

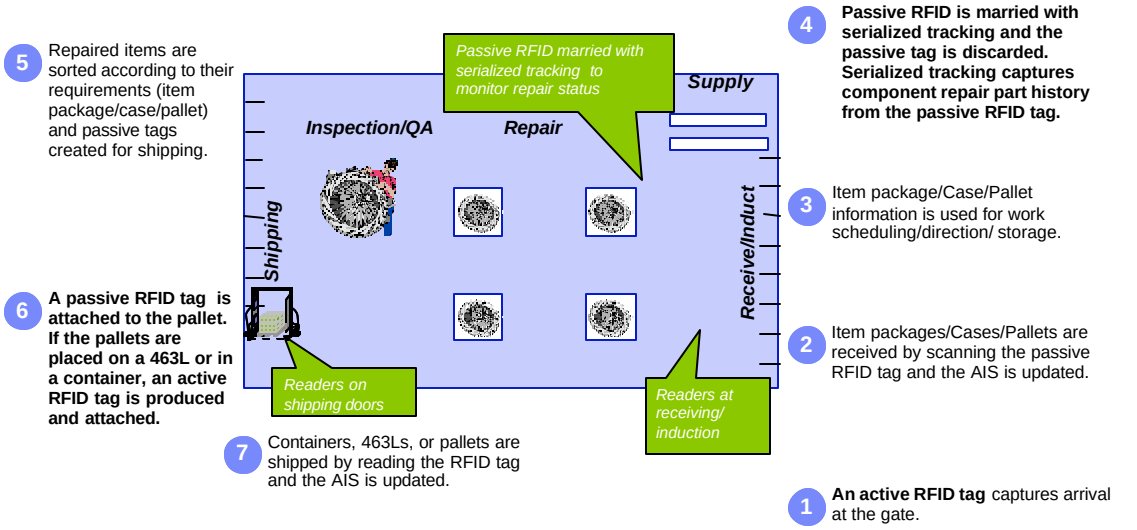


Figure 22 Theater Repair Depots

At the Theater Repair Depot node, it is envisioned that passive RFID could be implemented in the following manner: an active RFID tag is scanned at the arrival gate. Next, the item packages/cases/pallets are received by scanning the passive RFID tag and the appropriate AIS is updated with information from the scan. The information on the item package/case/pallet tags are used for scheduling, direction, and storage of items. The passive RFID tag information is married with the serialized tracking and the passive tag is then discarded. The serialized tracking enables the depot to capture the component repair part history from the passive tag. After repair, the items are sorted according to requirements of item packaging, case or pallet, and the appropriate passive tag is created and applied for shipment. Once items are palletized, a passive RFID pallet tag is created and attached to the pallet. If a 463L pallet or container is used an active RFID tag is produced and attached. The pallets, containers, or 463L pallets are then shipped by scanning the active RFID tag and the AIS is updated.

4.6.7 Customers (Units)

It is envisioned that RFID could operate in the following manner at the customer location:

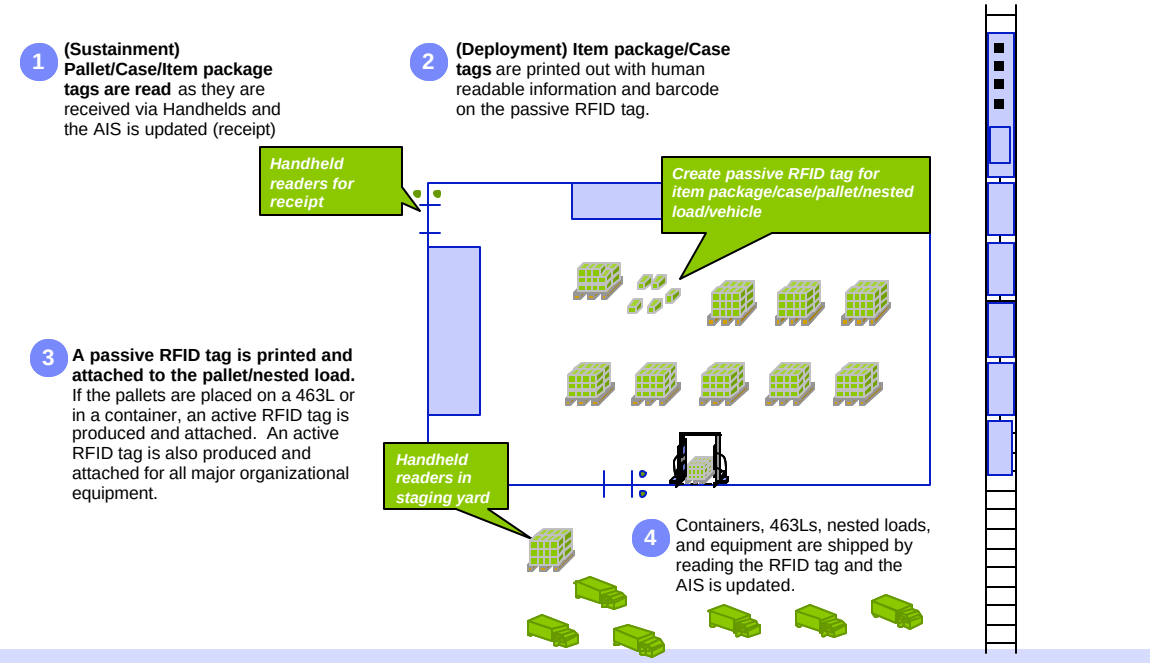


Figure 23 Customers

At the customer level, it is envisioned that passive RFID can be implemented in the following manner: sustainment pallet/case/item package RFID tags are read as they are received via a handheld RFID reader. The AIS is updated to reflect receipt. At deployment, item package and case passive RFID tags are printed with human readable information and a barcode on the RFID tag. Once items are palletized, a passive RFID pallet tag is printed and applied to the pallet or nested load. If the pallets are placed on a 463L pallet or in a container, an active RFID tag is created and attached. Additionally, active RFID tags are produced and attached for all major organizational equipment. Containers, 463L pallets, nested loads, and equipment are shipped by reading the active RFID tag. Once the RFID tag is read, the AIS is updated.

4.6.8 Logistics Information Systems

Aside from the previously defined logistics nodes within the DoD supply chain, there are myriad logistics information systems that operate independently and in an unsynchronized manner, resulting in major gaps throughout the supply chain. RFID is a key component for military logisticians in developing a streamlined, synchronized, efficient end-to-end supply chain. RFID will not only connect physical logistics nodes, but will also harmonize the disparate information systems into a highly capable network, which will provide visibility, responsiveness, and effectiveness to the warfighting community. Figure 24 shows the key systems and organizations impacted by RFID within the DoD supply chain. A description of their roles and responsibilities

follows: the physical nodes in the DoD supply chain have been identified and defined previously. They are provided again in association with affected information systems in order to clarify and bring into context the association between physical nodes and information systems within the RFID enabled supply chain. Each node is defined after Figure 25.

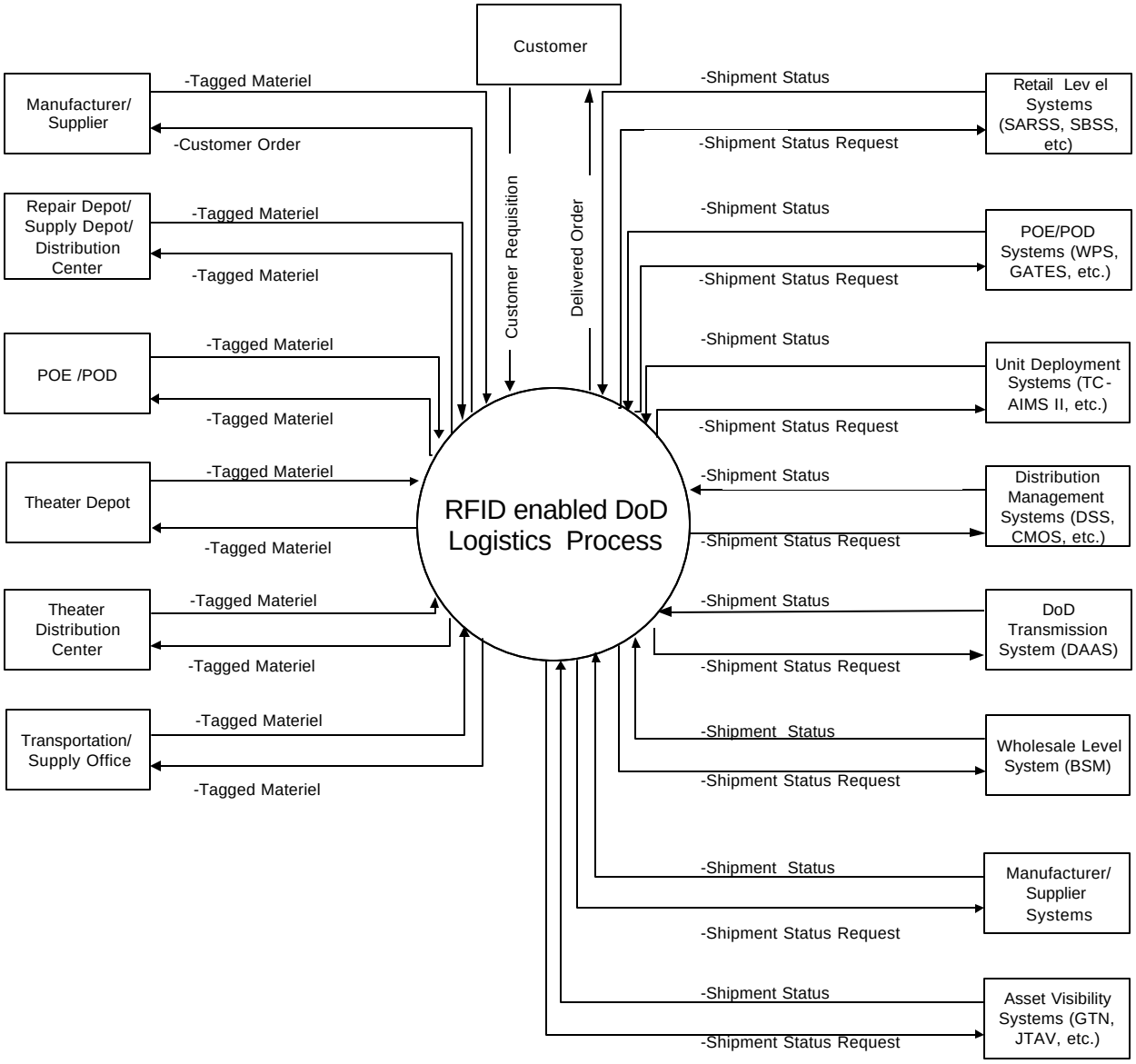


Figure 24 Context Diagram for RFID Enabled DoD Logistics Process

Manufacturers/Suppliers – Commercial providers who produce/supply materiel to the DoD.

Transportation/Supply Offices – Military activities that place/fill orders, receive materiel, maintain/monitor inventory, arrange transportation, and distribute materiel to the end customer.

Repair Depots/Supply Depots/Distribution Centers – Military/Commercial activities for the receipt, classification, storage, accounting, issue, maintenance, procurement, manufacture, assembly, research, salvage, or disposal of materiel.

POE – Military/Commercial activities that consolidate materiel, lift/transport materiel, and deliver materiel according to the terms of service. The activities are a geographic point in a routing scheme from which cargo or personnel depart. This may be a seaport or aerial port from which personnel and equipment flow to a port of debarkation.

POD – Military/Commercial activities that consolidate materiel, lift/transport materiel, and deliver materiel according to the terms of service. The activities are a geographic point at which cargo or personnel are discharged. This may be a seaport or aerial port of debarkation.

Theater Distribution Centers (TDC) – Military activities that receive materiel in consolidated form and reconfigure shipments in smaller and/or direct packaging for delivery to the end customer.

Theater Depots – Military/Commercial activities that place/fill orders, receive materiel, maintain/monitor inventory, arrange transportation, and distribute materiel to the end customer.

Customers – Military personnel/activities that place orders, receive materiel for either replenishment inventory or immediate consumption/use, return items, and deploy/redeploy.

Manufacturer/Supplier System – Commercial systems that prepare materiel for shipment, generates the necessary documentation for the DoD, and provides an ASN to the entry node/system within the DoD Supply Chain.

Wholesale Level Systems – Systems at the wholesale level that facilitate receipt, storage, consolidation, packing, shipping, inventory, inspection, and workload management involving materiel.

Retail Level Systems – Systems at the retail level that facilitate the requisitioning, tracking, receipt, storage, and issue of materiel to end customers (units).

Unit Deployment Systems – Systems used in support of unit movement that provide an integrated information transportation system capability for routine deployment, and redeployment/retrograde operations of materiel.

POE/POD Systems – Systems that process materiel, support/generate documentation, and assist in the planning/execution operations at aerial and surface ports.

Distribution Management Systems – Systems that facilitate the receipt, reconfiguration/ packaging, and distribution of materiel.

Asset Visibility Systems – Systems that provide command and control of materiel to include storage/repair/in-transit and serve as a central data repository.

DoD Transmission Systems – Systems that facilitate and route the flow of information within the DoD.

4.7 Summary

The end state for the DoD supply chain is to be a fully integrated adaptive entity that leverages state-of-the-art enabling technologies and advanced management information systems to automate routine functions and achieve accurate, timely in-transit, in-storage, and in-repair asset visibility with the least human intervention. In addition, this end state should provide continuous effective information for logistics decision making in support of logistics requirements to military operations in austere environments. In short, a single, seamless, responsive enterprise system linked to the source of supply and capable of responding to exigent requirements at best speed and using the most efficient means.

Passive RFID offers the most practical, efficient, and effective means to deliver real logistics transformation opportunities to DoD. Building on the successes of barcoding and active RFID, DoD is prepared to drive forward with this emerging technology and further enhance the capabilities of our warfighting customers.

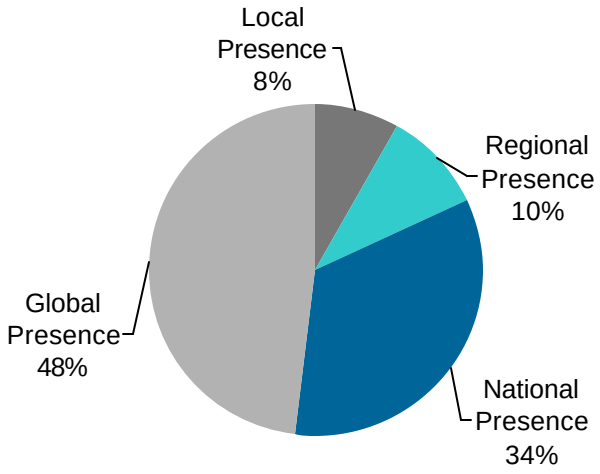
4.8 Analysis Introduction

The Department of Defense undertook a detailed analysis of its supply chain when determining how it intended to roll-out the use of passive RFID within its logistics operations. The three alternatives considered were: Baseline - The Market Adopts Passive RFID without DoD Involvement, The Market Adopts Passive RFID with DoD Involvement According to a Phased Implementation Plan, and The Market Adopts Passive RFID with DoD Involvement According to an Immediate Implementation Plan (No Phasing).

5 BASELINE – THE MARKET ADOPTS PASSIVE RFID WITHOUT DOD INVOLVEMENT

5.1 Market Adoption/Growth Estimates

Over the past year, several leading companies (Wal-Mart, Michelin, Proctor & Gamble, Target, International Paper, Best Buy, etc.) have announced plans to adopt and implement passive RFID to improve their supply chain operations. The universal growth of RFID continues to move forward at a fast pace and based on the composition of the early RFID adopter base, the indications are this global trend will continue to gain momentum. Figure 26 indicates the extent to which RFID will become a factor in each "geographic" representation.)



Allied Business Intelligence, Inc, 2003

Figure 25 What Best Describes Your Organization?

In 2004, the Meta Group estimated that approximately 30% of manufactured capital goods would be RFID enabled by 2008 and grow to 80% by 2013. According to the AMR report released in 2005 (RFID Technology Assessment 2005-2007: Where is the ROI?), "RFID budgets will average just over $500K in 2005, with 16% growth in the next year and 20% growth in 2007; market acceleration for mainstream adoption will not happen until at least 2008."

In 2003, IDC (International Data Group) estimated that Wal-Mart's impact alone would cause retail supply chain RFID spending to grow from $91.5 million to almost $1.3 billion in 2008 with a 2003-2008 compound annual growth rate (CAGR) of 70%. It was estimated in 2003 by Bear Sterns that global market for RFID would grow to $9.4 billion in 2007.

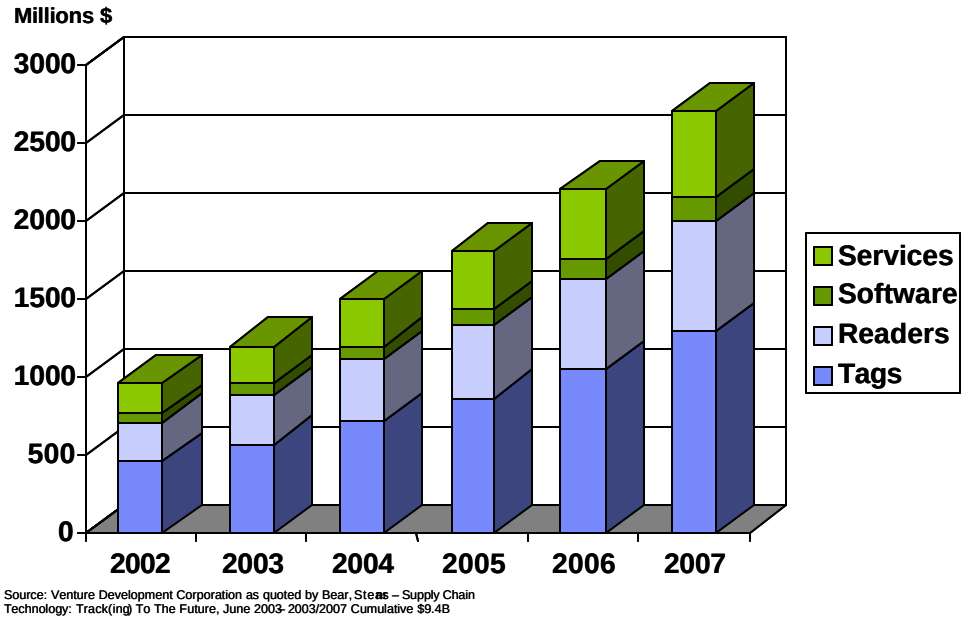


Figure 26 Estimated Global RFID Market for 2003 to 2007

Numerous market analyst reports continue to assess the overall impact of the recent mandates on spending and the adoption of RFID but several key findings can be made from all of these reports:

- **The global RFID market is growing**
- **Costs are coming down and the technology is maturing**
- **Adoption rates are increasing**
- **Standards are developing at a rapid pace for a technology recently described as nascent**
- **Early market adopters will shape the development of this technology**

In summary, the adoption of RFID is moving at a rapid pace and companies that embrace RFID as early adopters will be in a key position to shape the design, standards development and employment of this technology.

5.2 Benefits of Market Adoption Without DoD

The exact nature of DoD's impact to the overall RFID effort is difficult to quantify as no existing studies have focused on the DoD specifically. If the RFID market continued to move forward without DoD participation, the following factors would continue to be realized:

1) **Market Development** – The RFID market will continue to develop as a result of the needs of Wal-Mart's program, other commercial adopters, and other government agency adopters.
2) **Adoption Rate** – DoD's overall impact on adoption is significant but the exclusion of DoD will not stifle the adoption rate – the marketplace will continue moving forward.

It may be argued that DoD's departure would slow the adoption rate but it will not stop the eventual global adoption of RFID.

3) **DoD Suppliers** – Some DoD suppliers sell to more customers than just DoD. The removal of DoD from the RFID adoption group may delay the initial cash outlay of DoD suppliers but they will eventually have to comply with another mandate from a commercial business or other government agency.

5.3 Costs of Market Adoption Without DoD

The main driver for DoD besides the potential benefits of RFID was the ability to shape the design, standards development and employment of this technology. If DoD were to stop moving forward with RFID, we would expect to see an increase in cost for the following reasons:

1) **Adoption Rate** – The adoption rate would decrease resulting in an increase to the costs of implementing RFID in the short-term.
2) **Standards Development** – DoD would not be involved in the development of standards for RFID. The short-term effect would be that all new RFID tags and products would most likely be designed without the interests of the DoD and other government users in mind. As the adoption of RFID continued to grow, DoD would eventually enter back into the market to find themselves a late adopter. DoD would then potentially have to use standards that might not work for the Department and would possibly have to embark on developing a different standard. This scenario could potentially result in higher costs to both the DoD and DoD suppliers even after the total prices have dropped due to large scale adoption by the commercial sector.
3) **DoD Suppliers** – As cited above, DoD suppliers could face higher costs in implementing RFID for other commercial suppliers due to the lack of DoD involvement in RFID during the development of standards. The most recent example of this is the creation of the DoD tag data format that allows DoD suppliers to use a CAGE/DODAAC rather than an EPC company prefix. The lack of DoD involvement could result in an added burden to complexity and cost involved for a company doing business with DoD. The lack of DoD involvement could also serve as a barrier to entry into business with the DoD for potential suppliers, resulting in a reduced pool of DoD suppliers.
4) **Research and Development –** Over the years, DoD has been a key driver of R&D in new technologies. DoD has been a lead adopter for active RFID for over 10 years and now the commercial sector is beginning to realize the benefits of active RFID (WhereNet, RFCode, Savi, etc.). The same situation is true with passive RFID and if DoD were removed from the RFID effort then many potential opportunities may be missed where both the DoD and the commercial sector can realize joint benefits via collaboration.
5) **Impact to the Warfighter** – Over the past few years, the DoD has focused on adopting the best practices of the commercial supply chains where applicable. The DoD operates one of the most complex and diverse supply chains in the world as our network does not operate in a closed environment nor are a large percentage of our locations fixed. The employment of these commercial best practices allows DoD to support the warfighter on the ground and meet their requirements at a lower cost to

the taxpayer. If DoD were not able to deploy RFID, it would cause a negative impact on the effectiveness and efficiency of the DoD supply chain.

5.4 Benefit and Cost Analysis

In summary, the removal of DoD from the overall RFID landscape would not cause much of an impact to the overall adoption of RFID on a global scale, but would result in higher costs and potential barriers for DoD when reentering the market at a later time. It could also place suppliers in a potential situation where the developed standards don't work as DoD may have unique needs for the employment of RFID. The most critical potential impact would be to the warfighter on the ground by reducing the effectiveness and efficiency of the DoD Supply Chain.

5.5 Impact to Small Business

5.5.1 Benefits to Small Businesses

If the DoD does not implement RFID, many small businesses will not have to implement RFID in the next two years because of a DoD requirement, but may have to implement RFID due to a commercial sector customer's RFID requirements. It is expected that most businesses will eventually have to comply with some organization or customer's RFID requirements. Being required to have at least a minimal RFID compliance level is a benefit in itself. This provokes the business to review its entire supply chain and business processes to determine if RFID would provide relief from any current pain points. Additionally, this analysis can give small businesses a basis from which to move forward and update as RFID technology develops and becomes more prevalent.

5.5.2 Costs to Small Businesses

The costs to small businesses if the DoD does not implement RFID policy will vary widely from small business to small business. Those small businesses which supply both commercial companies requiring the use of RFID technology and the DoD, will be split between two processes or systems; the commercial RFID enabled process and the DoD process. Those small businesses only supplying the Department will maintain current operations- spending no money on an RFID requirement, but also gaining nothing from potential business process changes and the implementation of a new technology to exponentially increase the improvements from business process changes. Those small businesses that have to comply with commercial customer's RFID requirements may have to segregate its outgoing RFID tagged commercial materiel from its outgoing non-RFID tagged DoD materiel. This could lead to a higher unit cost per item to the DoD because of the cost associated with maintaining two separate inventories and two separate business processes. The pool of suppliers from which DoD and commercial entities pull are becoming increasingly common and will continue to merge in the future, making the number of suppliers who must run two types of processes (RFID and other) larger and larger.

Should DoD decide to adopt RFID in a few years, EPCglobal standards would already be set and RFID products would be based on and be manufactured on those standards. Without DoD's continued involvement and participation in the development of these standards and the evolution

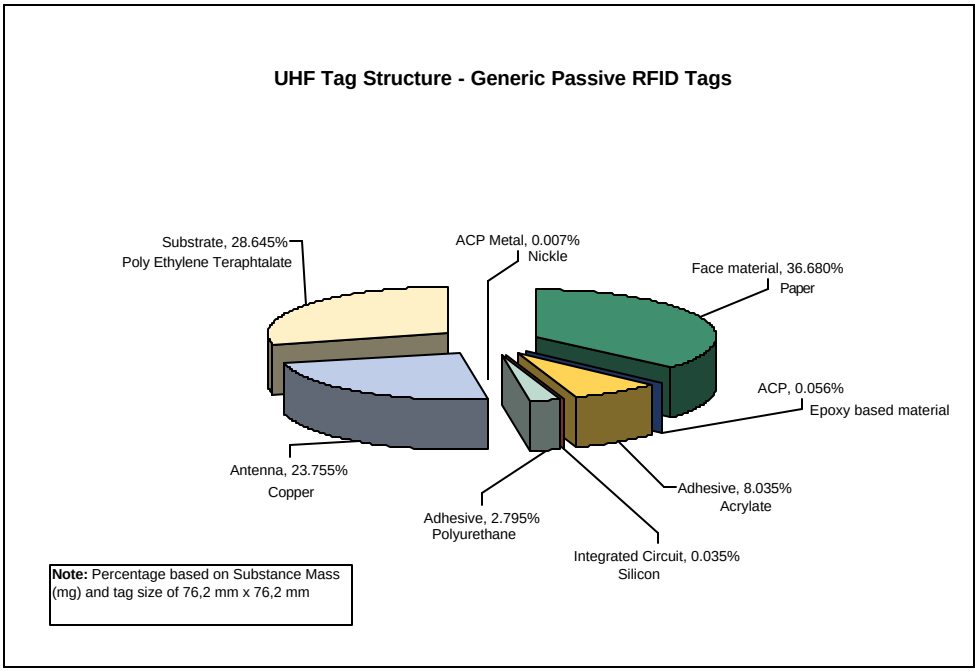
of RFID technology, there is no guarantee that the standards developed without DoD input would allow DoD to ever participate in RFID without developing its own standards. For example, if DoD had not worked with EPCglobal to insert a DoD tag construct, suppliers who are not members of EPCglobal would have to join in order to participate in the Department's RFID efforts- however, with the DoD construct, this is not the case. Additionally, if DoD had to develop another set of standards for RFID, that would unnecessarily strain small businesses trying to comply with both commercial and DoD RFID requirements.

5.6 Impact to Recycling Industry

As the technology matures and RFID implementation progresses, there could be potentially billions of passive RFID tags on materiel entering, processing within, and being disposed of by supply chain activities. The potential for a large number of tags to enter into the waste-stream and their effects on the recycling industry and processes has become a concern. The application of RFID tags to corrugated boxes and other items that can no longer be reconditioned for reuse, raises the question of how this technology will affect the recycling industry. Some components of RFID tags might be considered contaminants that inadvertently mix into the recycled materials and some additional processes at the recycler may be necessary. However, there is evidence that current mitigation actions are adequate, and in fact, there has been no documentation to support any adverse effects to current recycling equipment or recycling processes, in spite of the large number of tags already entering the waste stream. A few examples of completed studies include a major paper manufacturer, with the use of RFID in its paper cores, who examined the effects the RFID tags would have on their recycling process. At its southwestern facility, they regularly consume approximately 50,000 chips per month in the paper rolls. The manufacturer investigated the recycling of the cores through its recycler and has found no measurable indication that the debris from the tags is impacting the process. The junk traps on the re-pulpers appear to effectively remove any RFID remnants. Another example is from an industry association who commissioned a study to assess the potential impact of copper foil and printed silver ink RFID antennae on the recycling stream. In the recycling process the antennae are potential sources of metals that could be mobilized during the re-pulping, fiber treatment and manufacturing processes at the recycling mill. The tests on the foil antenna resulted in finding that the tag maintains its integrity in the re-pulping process due to the fact that this type of tag is typically enclosed in a plastic laminate. The hydrapulper cleaning system is able to separate these tags out at a 99%+ level, eliminating mobilization of the copper metal and providing a safe and easy way to dispose of the tags. The test results on the printed silver ink antenna indicate that the silver had a high tendency to remain in the fiber substrate of the paperboard, additionally the silver concentration in solid waste and product streams are well below regulatory thresholds. Another industry association noted that those antennae printed on clear plastic tags with metallic inks will be able to be recovered in the normal recovery process used by the recycling industry. An RFID experts group provided additional evidence that foil antennae of aluminum or copper will not taint the corrugated or carton board recycle stream due to the fact that the tags remain intact or are removed with staples in the first filtration after re-pulping with no carry over. Furthermore the addition of RFID tags to the first re-pulping does not significantly alter the percentage of constituent makeup (Metal Antenna, Silicon IC, Substrate, Adhesives) of the first re-pulping filtrate (10%). Waste disposal of the filtrate after

the addition of RFID tags is not considered to be a future problem. This group is currently pilot testing printed silver based antennae. Another study commissioned by another industry association found that those crystalline connected antennae applied in a label format with a metal antenna are likely to come off the substrate as a complete entity and be screened out. This study also examined the additional amount of adhesive load that would be generated by the addition of RFID tags to packaging containers; the finding is that mills are currently set up to handle the 'stickie' load generated today and the addition of RFID tag adhesive, usually acrylates and in a quantity of up to 30mg per tag, will not pose an additional problem for the mills.

Analyses have been completed on the chemical composition of RFID tags and these analyses have found that tags are comprised of various materials. Passive tags consist of a computer chip made of silicon and is attached to a small antenna. The antenna usually is copper, but there are other types of antenna metals such as aluminum. In the case of ink antennae, the ink usually contains silver. In stick-on label version of RFID tags, the substrate is Poly Ethylene Teraphtalate (PET), and the connection is an epoxy or conductive glue. Passive RFID tags do not contain a battery component.



Source OSD/Analysis

Figure 27 Composition of a Generic Passive RFID Tag

The following chart gives the chemical makeup of a typical passive RFID tag.

Tag size		76,2 mm x 76,2 mm	15 mm x 97 mm	15 mm x 148 mm	
Breakdown of component		Substance Mass (mg)	Substance Mass (mg)	Substance Mass (mg)	Specific Gravity
Face material	PP	270	65	100	
	Paper	525	130	200	
Adhesive	Acrylate	115	30	45	
IC	Si	0.5	0.5	0.5	
ACP	Epoxy based material	0.8	0.8	0.8	
ACP Metal	Nickel	0.1	0.1	0.1	
Adhesive	Polyurethane	40	10	15	
Antenna	Copper	340	105	140	8.9
	Aluminium	50	15	20	2.7
(printed)	Silver		10.9		10.5
(printed)	Bonding Agent		4.6		
Substrate	PET	410	100	155	
Adhesive	Acrylate	155	40	60	

Notes:
Flip chip IC's have Gold bumps <.05mg per IC
Nickel balls in ACP are sometimes Silver plated
Most Printed Antenna are printed on paper rather than a plastic substrate
Specific gravity of steel (staples) is 7.7

Source AIM Global

Figure 28 Chemical Makeup of Passive UHF Tags (Typical)

Without DoD involvement in the implementation of RFID there is the potential to reduce the initial amount of RFID tags in the waste-stream and recycling process, although the commercial requirements/mandates will still result in large quantities of tags in the marketplace. This reduction of tags has the potential to decrease costs to the recycling industry. However, there is also the possibility that the recycling process will be unaffected by the RFID tags, and the process will proceed as normal with no additional costs. The fact remains that tags from commercial adopters are already entering the waste-stream and the impact on recyclers must be evaluated regardless of whether DoD enters the RFID marketplace. Currently, several trade associations are conducting studies on the impact of RFID tags on cases and pallets to the recycling industry and DoD will closely follow this work.

5.6.1 Benefits to Recycling Industry

The only identifiable benefit to the recycling industry if DoD did not move forward with implementing passive RFID would be potential short-term reductions in the number of tags entering the waste-stream/recycling system. However, the recycling industry can experience benefits from the use of RFID, whether or not DoD moves forward with implementation. As noted by Association for Automatic Identification & Mobility (AIM Global), these benefits can be captured under the strategy of environmental responsibility; Recycle, Reuse, Reduce. Given the evidence provided above and action plans to create additional evidence, the existing waste stream recycling at a minimum will not be affected. Moreover, there is even the opportunity to improve efficiency because solid waste separation will become automated. The recycling process will also allow the retrieval of valuable RFID tag components. With reuse there is the potential for an increase in the reuse of totes and pallets due to their location and rental partner being real-time and also an increase in the utilization of re-shipper corrugate cases. Additionally, this will also help to establish an infrastructure to handle the reuse of hardened RFID tags. Finally, in reduction, natural economic forces are anticipated to significantly reduce constituent content of RFID tags, which will also help lead to a decrease in tag costs.

5.6.2 Costs to Recycling Industry

If the DoD did not move forward with implementing passive RFID, the long-term costs associated would be much greater than the short-term benefits to the recycling industry. Although it is believed that the impact of RFID tags on the recycling process will be minimal, it is best to focus on taking action to reduce the impact of RFID on the overall environment. The Environmental Protection Agency (EPA) has an established waste management hierarchy that focuses on attempting to reduce the amount of waste that is created, reusing whenever possible, and recycling what is left. A key to the EPA's program is called "source reduction" – meaning that material never enters the waste-stream as it is managed at the source of generation.

To date, little discussion has been generated around the impact of RFID tags on the environment. However, DoD has already taken the initiative to request that AIM Global analyze components of passive tags, the analysis which was presented earlier. Additionally, DoD has also raised the issue of the impact of RFID tags on the environment to the EPCglobal Board of Governors. DoD has a vested interest in increasing support to the warfighter, reducing overall costs, and minimizing the impact to the environment. If DoD were not to move forward with implementing passive RFID, then much of the impetus to minimize the impact to the environment would be removed. It is believed that this would cause a negative impact to the recycling industry resulting in a further increase in potentially harmful components moving through the recycling process and waste-stream.

5.7 Summary

Allowing the market to move forward without DoD's involvement will not stop the growth of passive RFID but it will increase the end costs to the DoD/DoD suppliers, reduce the effectiveness of the warfighter, and may decrease the focus on assessing the impact to the recycling industry/environment. As with any new technology it is far better to be part of the process and leading the change rather than reacting to the change. By allowing DoD to move

forward with passive RFID, the DoD will be able to ensure that this technology meets its needs while providing benefits to other areas outside of DoD.

6 ALTERNATIVE 1 - THE MARKET ADOPTS PASSIVE RFID WITH DOD INVOLVEMENT ACCORDING TO A PHASED IMPLEMENTATION PLAN

6.1 Background

Although DoD currently has limited impact on the RFID market in terms of overall numbers of suppliers currently involved, its initial actions with respect to passive RFID have served as a major impetus for adoption, hardware and software development, standards making, and investment activities. DoD's continued involvement will allow it and its suppliers to benefit from DoD's influence as it works to ensure that its requirements are identified and communicated to the providers of passive RFID involvement. DoD's phased implementation approach considers key elements (classes of supply, levels of packaging and location) to stagger the implementation in a manner that minimizes the initial impact to its supplier base while maximizing the benefit received as each phase of the implementation is completed.

6.2 Benefits of Proposed Phased RFID Implementation Plan

The DoD undertook a detailed examination of the components of its supply chain in order to determine an appropriate implementation schedule for the introduction of passive RFID into the supply chain. The DoD has approximately 60,000 suppliers that ship materiel to it in a given year. As such, the DoD wants to carefully manage the way it places the RFID requirement on its suppliers to ensure that it can closely monitor progress and proactively deal with any supplier issues/concerns that arise during the implementation. In order to develop the implementation plan, the DoD looked at three key elements: classes of supply (i.e., types of materiel delivered to the DoD), DoD receiving locations, and levels of packaging (e.g., case vs. pallet, etc). By examining each of these factors, the DoD has been able to develop a plan that targets critical items at key distribution locations.

The DoD manages ten classes of supply:

Class I	Subsistence and gratuitous health and comfort items
Class II	Clothing, individual equipment, tentage, organizational tool sets and kits, hand tools, and administrative and housekeeping supplies and equipment.
Class III	Petroleum fuels, lubricants, hydraulic and insulating oils, preservatives, liquid and gas, bulk chemical products, coolants, de-icer and antifreeze compounds, components and additives of petroleum and chemical products, and coal.
Class IV	Construction materiel including installed equipment and all fortification and barrier materiel.
Class V	Ammunition of all types (including chemical, radiological, and special

	weapons), bombs, explosives, mines, fuses, detonators, pyrotechnics, missiles, rockets, propellants, and other associated items.
Class VI	Personal demand items such as snack foods, beverages, cigarettes, soap, toothpaste, writing materiel, cameras, batteries, and other nonmilitary sale items.
Class VII	Major end items such as launchers, tanks, mobile machine shops, and vehicles.
Class VIII	Medical materiel, including repair parts peculiar to medical equipment.
Class IX	Repair parts and components to include kits, assemblies and subassemblies (reparable or nonreparable) which are required for maintenance support of all equipment.
Class X	Materiel to support non-military programs such as agriculture and economic development

Figure 29 Ten Classes of Supply

The DoD examined the characteristics of the supply chains for each of the classes in order to lessen the impact on the supplier community by determining the classes' introduction earlier or later in the phasing plan.

After a careful analysis, the DoD has determined that the initial classes of supply that will be tagged are: subclass of I, II, VI, and IX:

> The subclass of I is the Packaged Operational Rations. These are most commonly identified as the Meals-Ready-To-Eat (MRE) that our soldiers stationed and deployed throughout the world consume for basic operational sustenance. These are not high-value items but they are critical to ensuring the welfare and readiness of our troops. They are packaged by the pallet and the use of RFID on these rations will allow the DoD to have better visibility of where this food is within the supply chain. In the future, the DoD may use more advanced tags to monitor temperature changes within the food to ensure the quality and safety of the food being consumed by our warfighters.
>
> Class II is another critical class of supply for the warfighter as it contains the clothing that is worn by our warfighters. The DoD completed a pilot that tracked the Joint Service Lightweight Integrated Suit Technology (JSLIST) suits (Chemical/Biological Protective Equipment) during 2004 and was pleased with the added visibility of these items that was gained through the use of RFID tagging on cases and pallets of JSLIST suits. As with packaged operational rations, ensuring that our warfighters have the proper equipment is key to ensuring the safety, health and preparedness of our fighting forces. RFID tagging of this materiel will enhance the visibility of these items and eventually be used to have a better grasp of the inventory management of these items.

The DoD shares common suppliers with Wal-Mart – another major entity that is placing an RFID requirement on its suppliers. Class VI is comprised of personal demand items – these are items that are supplied by suppliers/manufacturers who supply the same items to DoD and Wal-Mart. The DoD has consistently been looking at ways to ensure that it is not forcing its suppliers to have to do unique things for DoD as opposed to those requirements mandated by other entities like Wal-Mart. As a result, the DoD is requiring tags on Class VI shipments. This is a benefit to the suppliers who deliver to both DoD and Wal-Mart because it allows them to not have to maintain separate shipping processes for the two entities. Class VI items also tend to be high-moving items and this will help the warfighters have better visibility of where their materiel is in the pipeline which will in turn improve our order accuracy and instill confidence in the supply system with those individuals.

Class IX is probably the most highly visible class of supply because of the criticality of these parts to the weapons systems maintained and operated by the DoD. These parts range from low to high dollar value but all are critical components of equipment and weapons systems that the DoD needs to have visibility of to ensure warfighter readiness. For example, if a plane cannot fly due to a part that is broken with no locally available replacement, then the Department needs to be able to identify where that replacement part is in the system and get it to the proper location. Until it is able to accomplish this task, the DoD is operating at a lower level of readiness.

This phased implementation approach benefits both the DoD and the DoD supplier community. By limiting the number of suppliers immediately impacted by this program, the DoD is allowing itself time to effectively manage the introduction of this new technology into its supply chain. DoD will have more time to work with the smaller number of impacted vendors in order to ensure their understanding and to help fix any problems that arise. It also allows DoD to make any necessary modifications to the program through the analysis of the initial implementation. DoD is targeting the commodities whose supply chains are most ready to immediately inject the use of RFID. These commodities also represent types of supply that are key to ensuring the readiness of our militaries' warfighters.

The supplier community has an additional benefit from this phased approach. The DoD will incorporate this requirement into new contracts, thus allowing the supplier and DoD entity to negotiate appropriate prices that reflect the cost of the RFID requirements. This process will allow the suppliers to get detailed guidance on the RFID requirements through the negotiation process. By limiting the number of suppliers who will be impacted in the first phase of implementation, DoD is also increasing its ability to work more closely with the vendor community since it does not have to deal with all 60,000 + suppliers implementing immediately. This will allow suppliers to receive feedback from the DoD on their performance and assist them with their compliance efforts.

6.3 Costs of Proposed Phased RFID Implementation Plan

There are two main costs to the phased implementation plan: internal (DoD) infrastructure costs and external costs to the supplier community in order to comply with the mandate. This section will focus on the cost to the supplier community.

The DoD will be levying this requirement in new or renewed contracts. DoD will allow the suppliers impacted by this requirement the opportunity to negotiate the cost of complying with this requirement into the value of the new contract. In order to comply with the RFID requirement the supplier must meet two main requirements: (1) applying passive tags at the case and pallet level and (2) sending an advance shipment notice (ASN) to DoD through the Wide Area Workflow (WAWF) system.

There are various ways to meet the first requirement for passive tagging. A supplier will need to examine the amount of business that they do with DoD (i.e. shipment volumes) in order to determine which method of compliance best suits their business environment. In a high-level description of the steps a supplier must take to comply, a supplier will need to have passive tags that are encoded with the appropriate data construct, apply them to the appropriate level of packaging, ensure that the tags are readable at the point of debarkation from their facility, and finally transmit the advance shipment notice with RFID tag information to the DoD through the WAWF system. As mentioned previously, there are various ways to comply with this requirement. The DoD has identified one scenario in which suppliers upgrade their existing printers (these printers print required Military Shipping Labels (MSL) today per contract requirements) to printers that can embed RFID tags within the MSL tags and verify their readability as they exit the printer. The supplier can then simply affix the RFID tag similar to how the MSL is applied today. Finally, a supplier can then manually enter the RFID tag number(s) into the WAWF system through a web-interface. An analysis of the cost of this method of compliance is included in the following paragraph.

Suppliers should consider taking advantage of integrating the benefits of RFID into their business processes to realize lower costs in their own supply chains. However, it is realized that DoD suppliers may pass on reasonable costs to the Department. DoD expects affected suppliers to negotiate fair and reasonable pricing into future contracts to help defray the initial costs of implementing this technology in order to comply with terms and conditions of future contracts. The estimated minimum per shipment cost increases in the first year of implementation are based on suppliers purchasing RFID tags and an RFID printer, which cost approximately $0.50 per tag and $4,000 per printer. The following figures outline these cost estimates for various shipment quantities in both year one, which includes the purchase of tags and a printer and year two in which only tags are purchased.

YEAR 1

Shipments	Printer Cost (1)	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Increase	Per Shipment Cost Increase	Per Case Cost Increase
500	$4,000	10,500	$0.50	$5,250	$9,250	$19	$0.93
5,000	$4,000	105,000	$0.50	$52,500	$56,500	$11	$0.57
15,000	$4,000	315,000	$0.50	$157,500	$161,500	$11	$0.54
25,000	$4,000	525,000	$0.50	$262,500	$266,500	$11	$0.53

YEAR 2

Shipments	Printer Cost (0)	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Increase	Per Shipment Cost Increase	Per Case Cost Increase
500	$0	10,500	$0.50	$5,250	$5,250	$11	$0.53
5,000	$0	105,000	$0.50	$52,500	$52,500	$11	$0.53
15,000	$0	315,000	$0.50	$157,500	$157,500	$11	$0.53
25,000	$0	525,000	$0.50	$262,500	$262,500	$11	$0.53

*** In this example, tag costs were held constant for illustrative purposes. Tag costs should decrease as volume increases**.

Figure 30 Estimates for Potential Cost Increases Per Shipping Volume

6.4 Benefits and Costs Analysis (Qualitative and Quantitative) of Phased RFID Implementation Plan

The DoD has completed an initial business case identifying the anticipated costs and benefits and outlining the expected return on investment (ROI) for implementation of passive RFID internal to the DoD. It is important to note that this business case analysis (BCA) only looked at the costs and benefits associated with utilizing RFID within the shipping and receiving functions internal to the DoD supply chain itself. The potential benefits increase exponentially when we begin to look at the benefits of utilizing RFID for inventory management and within the maintenance depot. However, the following description of the analysis focused on the costs and benefits of utilizing this technology in the shipping and receiving functions.

The BCA identified two views of cost and benefit: optimistic and pessimistic. As a summary, the BCA clearly stated that there is a reasonable to good expectation that implementation of passive RFID across DoD will provide a positive economic return on investment in the near term and an excellent expectation of positive economic returns in the long term.

The BCA looked at five key areas of benefit: reduced shipping losses, reduced inventory losses, reduced duplicate ordering issuing costs, reduced order duplicate transportation costs, and reduced labor expenses (including time savings). These are summarized in the following figure:

Benefit	Estimated Benefit
Reduced Shipping Losses	0.25% - 1% of sales
Reduced Inventory Losses	Reduce losses 5 %– 10%
Reduced Duplicate Order Issuing Costs	1% - 2% of Issuing Net Landed Costs
Reduced Duplicate Order Transportation Costs	1% - 2% of Transportation Costs
Reduced Labor Expenses	$40K per FTE

Figure 31 Key Areas of RFID Benefit

Definitions:

Reduced Shipping Losses: Includes pilferage, misrouted, astray and lost materiel.

Reduced Inventory Losses: Includes improper manifesting, overages, shortages and misdirected freight.

Reduced Duplicate Order Issuing Costs: Using RFID to instill confidence in the logistics systems and provide visibility to reduce the number of instances of duplicate requisitions being submitted.

Reduced Duplicate Order Transportation Costs: Using RFID to reduce the number of duplicate orders which in turn will reduce the duplicate transportation costs associated with those orders.

Reduced Labor Costs: Utilizing RFID to make a process more efficient, thus enabling a reduction in the cost of labor associated with completing that process.

The following figure identifies the Optimistic View of Savings:

($ Millions)	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11
Reduced Shipping Losses	-	112.8	218.4	326.4	443.6	453.2	463.1
Reduced Inventory Losses	-	5.4	10.8	16.2	21.6	27	27
Reduced Duplicate Order Issuing Costs	-	8.5	8.5	8.5	8.5	8.5	8.5
Reduced Duplicate Order Transportation Costs	-	36	36	36	36	36	36
Reduced Labor Costs	-	1.12	3.76	6.08	7.8	10.2	15.1
	Gross Savings: $2,437 M				Net Savings: $1,781 Million		

Figure 32 DoD Savings Total Optimistic View

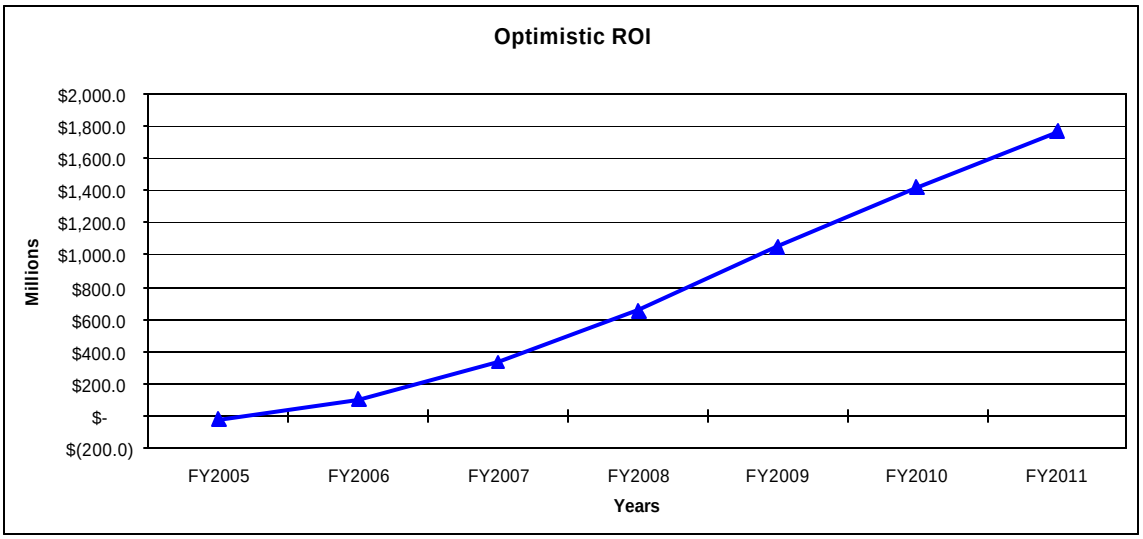


Figure 33 ROI Optimistic View

The following figure identifies the Pessimistic View of Savings:

($ Millions)	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10	FY 11
Reduced Shipping Losses	-	-	-	108.82	110.90	135.96	138.92
Reduced Inventory Losses	-	2.70	5.40	8.11	10.80	13.50	13.50
Reduced Duplicate Order Issuing Costs	-	4.25	4.25	4.25	4.25	4.25	4.25
Reduced Duplicate Order Transportation Costs	-	18.00	18.00	18.00	18.00	18.00	18.00
Reduced Labor Costs	-	1.12	3.76	6.08	7.80	10.20	15.10
	Gross Savings: $726.3 M				**Net Savings: $69.9 Million**		

Figure 34 DoD Savings Total Pessimistic View

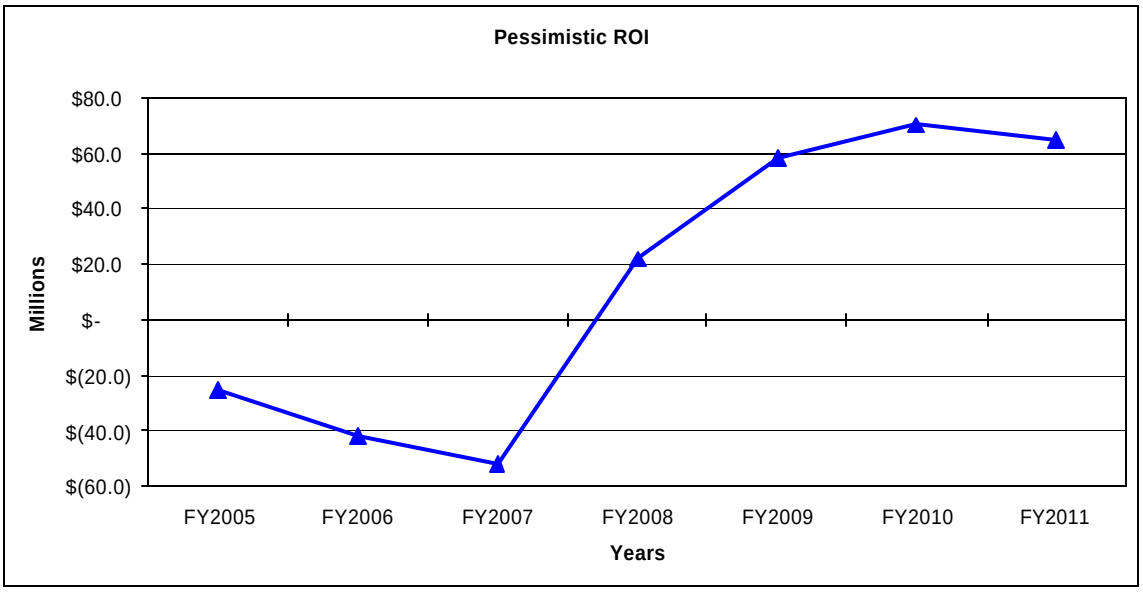


Figure 35 ROI Pessimistic View

The main conclusion from these two charts is that regardless of looking at the low-end vs. high-end savings estimates, DoD will see a significant return on its investment. The phased implementation approach will allow DoD to work closely with its suppliers in a collaborative manner in order to achieve maximum benefit for both the DoD and its supplier community.

6.4.1 Benefits to Small Businesses

The phased implementation approach provides a major benefit to small businesses because it limits the type of commodities that a vendor would have to tag and it also limits the number of ship-to locations. These two facts significantly limit the number of small entities that will be impacted in the first year. This allows the majority of small businesses to have time to work with the technology to understand how they will need to incorporate it into their business processes so that they are as efficient as possible when passive RFID becomes a contract requirement. It also has the benefit of small businesses potentially experiencing reduced costs of the technology. This is reflected by the generic reduction in technology costs over time. DoD is phasing the implementation in such a manner that costs will be reduced and lessons learned will become greater as more businesses are phased into the implementation.

Another benefit for small businesses with the phased implementation approach is that those impacted in their first year will have the benefit of getting solid feedback from the DoD with respect to their performance compliance. Since DoD is not requiring immediate tagging on all shipments, this allows the Department to have the time and resources to analyze incoming shipments to check for compliance and provide feedback to the impacted suppliers. As mentioned previously, by limiting the number of suppliers who will be impacted in the first phase of implementation, DoD is also increasing its ability to work more closely with the vendor community since it does not have to deal with all 60,000 + suppliers implementing immediately.

This will allow suppliers to receive feedback from the DoD on their performance and assist them with their compliance efforts.

6.4.2 Costs to Small Businesses

The implementation and use of Radio Frequency Identification (RFID) within the Department of Defense (DoD) supply chain will require DoD suppliers to be able to ship items to the Department tagged with the appropriate radio frequency tags. This requirement is being phased in by suppliers according to which class(es) of supply a company provides to the Department and to which locations those products are shipped. This regulatory action is not expected to affect the large majority of suppliers in the economy at large, but rather, only those companies which hold DoD contracts. Suppliers should consider taking advantage of integrating the benefits of RFID into their business processes to realize lower costs in their own supply chains. However, it is realized that DoD suppliers may pass on reasonable costs to the Department. DoD expects affected suppliers to negotiate fair and reasonable price increases into future contracts to help defray the initial costs of implementing this technology in order to comply with the terms and conditions of future contracts.

Small businesses, which make up the majority of the suppliers to the Department of Defense, in addition to larger businesses supplying the DoD, will have to make a financial investment in order to tag items for the DoD. For a small business, or a business of any size, there are a wide variety of ways to comply with the RFID policy. The following paragraphs and charts gives several different examples of potential compliance options; these examples are by no means the only ways a small business can become complaint with the RFID policy and are offered solely as examples and not intended to reflect the true costs of an enterprise implementation of RFID. DoD urges small businesses to carefully examine their businesses to determine the most effective way for to meet the policy requirements.

Based on notional estimates, it is estimated that approximately 14,000 small businesses will be affected by this regulatory action in 2005. If those small businesses ship between 10 and 50 shipments with 21 RFID tags on each shipment (20 case tags, one pallet tag) to the DoD each year, and purchase an RFID printer and RFID tags, the approximate cost to comply in 2005 would be between $4,105 and $4,525 for each small business. With the expectation that RFID printer costs and RFID tag costs will drop over the next year and approximately 7,000 additional small businesses will become compliant in 2006, the costs to those small businesses implementing in 2006 are estimated to range from $3,574 to $3,868. In 2007, it is estimated that another 14,000 suppliers will become RFID compliant, costing those small businesses between an estimated $3,542 and $3,710 each. The figure below **(**Figure 36**)** outlines the notional cost estimates to implement RFID, with an RFID printer and RFID tags, for small businesses in each 2005, 2006 and 2007.

2005 Approximately 14,000 small businesses are affected

Shipments Range	Printer Costs	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Per Small Business	Total Cost for All Small Businesses Implementing in 2005
10	$4,000	210	$0.50	$105	$4,105	$56,123,560
50	$4,000	1,050	$0.50	$525	$4,525	$61,865,800

2006 Approximately 7,000 *additional* small businesses are affected

Shipments Range	Printer Costs	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Per Small Business	Total Cost for All Small Businesses Implementing in 2006
10	$3,500	210	$0.35	$74	$3,574	$24,428,446
50	$3,500	1,050	$0.35	$368	$3,868	$26,438,230

2007 Approximately 14,000 *additional* small businesses are affected

Shipments Range	Printer Costs	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Per Small Business	Total Cost for All Small Businesses Implementing in 2007
10	$3,500	210	$0.20	$42	$3,542	$48,426,224
50	$3,500	1,050	$0.20	$210	$3,710	$50,723,120

Figure 36 Estimates of Costs of RFID on Small Businesses Implementing with RFID Printers and Tags

It should be noted that suppliers who utilize printers for shipping labels today will need only to replace their current printers with RFID capable machines therefore adding incremental costs over what they currently pay for printers.

Another option for small businesses to use to comply with the RFID tagging requirements is to purchase a RFID reader (that can write to the tags) and RFID tags. The following Figure 37 outlines the cost of this option to small businesses.

2005 Approximately 14,000 small businesses are affected

Shipments Range	RFID Reader Cost	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Per Small Business	Total Cost for All Small Businesses Implementing in 2005
10	$2,500	210	$0.50	$105	$2,605	$35,615,560
50	$2,500	1,050	$0.50	$525	$3,025	$41,357,800

2006 Approximately 7,000 *additional* small businesses are affected

Shipments Range	RFID Reader Cost	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Per Small Business	Total Cost for All Small Businesses Implementing in 2006
10	$2,000	210	$0.35	$74	$2,074	$14,174,446
50	$2,000	1,050	$0.35	$368	$2,368	$16,184,230

2007 Approximately 14,000 *additional* small businesses are affected

Shipments Range	RFID Reader Cost	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Per Small Business	Total Cost for All Small Businesses Implementing in 2007
10	$2,000	210	$0.20	$42	$2,042	$27,918,224
50	$2,000	1,050	$0.20	$210	$2,210	$30,215,120

Figure 37 Estimates of Costs of RFID on Small Businesses Implementing with RFID Readers and Tags

If small businesses want to comply with the policy with the absolute minimum impact, they can purchase pre-printed tags at a cost of approximately $0.50 each. If all small businesses were to comply with the RFID requirements in this manner, the costs to each of the approximately 14,000 small businesses implementing in the first year (2005) would be between $105 and $525 per small business. In the second year, 2006, approximately 7,000 additional small businesses would be affected by the RFID requirements, the costs to these small businesses to purchase tags for compliance would range from $74 and $368. In 2007 approximately 14,000 additional small businesses will be affected and the individual costs to these small businesses could range from approximately $42 and $210. This option assumes that the tag manufacturer guarantees the tag readability. Figure 38 outlines the costs to small business if small businesses were to only purchase pre-printed RFID tags to meet the RFID requirements.

2005 Approximately 14,000 small businesses are affected

Shipments Range	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Per Small Business	Total Cost for All Small Businesses Implementing in 2005
10	210	$0.50	$105	$105	$1,435,560
50	1,050	$0.50	$525	$525	$7,177,800

2006 Approximately 7,000 *additional* small businesses are affected

Shipments Range	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Per Small Business	Total Cost for All Small Businesses Implementing in 2006
10	210	$0.35	$74	$74	$502,446
50	1,050	$0.35	$368	$368	$2,512,230

2007 Approximately 14,000 *additional* small businesses are affected

Shipments Range	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Per Small Business	Total Cost for All Small Businesses Implementing in 2007
10	210	$0.20	$42	$42	$574,224
50	1,050	$0.20	$210	$210	$2,871,120

Figure 38 Estimates of Costs of RFID on Small Businesses Implementing with RFID Tags Only

No matter how a small business chooses to implement RFID in its first year of compliance, there will be the ongoing cost of replenishing RFID tags. Based upon the notional estimates of 14,000; 7,000; and 14,000 small businesses being affected by the regulation in 2005, 2006, and 2007 respectively, Figure 39 outlines *only* the ongoing tag replenishment costs through 2006 and 2007, as there would be no ongoing cost of replenishing tags in 2005 since small businesses are just beginning to implement RFID and buying their first RFID equipment.

2006 Approximately 14,000 Small businesses buying tags for replenishment

Shipments Range	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Replenishment Costs Per Small Business	Total Cost for All Small Businesses Buying Replenishment Tags in 2006
10	210	$0.35	$74	$1,004,892
50	1,050	$0.35	$368	$5,024,460

2007 Approximately 21,000 Small businesses buying tags for replenishment

Shipments Range	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Replenishment Costs Per Small Business	Total Cost for All Small Businesses Buying Replenishment Tags in 2007
10	210	$0.20	$42	$861,336
50	1,050	$0.20	$210	$4,306,680

Figure 39 Ongoing Tag Replenishment Costs for Small Businesses Already RFID Enabled

Moreover, the emergence of third party logistics (3PL) services within the private sector offers small businesses a more economical way to comply with the DoD mandate and the requirements from large retailers such as Wal-Mart, Target, Best Buy, and Albertson's. These 3PL providers will allow many small companies to leverage the expertise of these 3PLs and share the costs of services without having to invest in tags, printers or other RFID specific infrastructure. A recent survey by Capgemini of 650 logistics and supply chain executives found that more than 75% of those used 3PLs. Companies use 3PL services to manage everything from customs clearance, shipping management, to warehouse logistics. Additionally, 3PL providers are now adding RFID services to that list. Not only are 3PLs working to provide their customers with the ability to make them RFID compliant, but software providers are developing RFID packages developed specifically for the outsourced warehouse and logistic industry.

As mentioned in the above estimates, RFID tag costs are expected to decrease. As noted by AIM Global, it is expected that this is partly due to the Research and Development (R&D) efforts of RFID Tag suppliers to reduce the constituents (Metal Antenna, Silicon IC, Substrate, Adhesives) in RFID tags since today's tag costs are almost entirely based on constituent costs. Another item of interest to small businesses, as noted by the Reusable Industrial Packaging Association (RIPA), is the development of businesses that are planning to buy used RFID tags to reprogram (to ensure uniqueness of the tag number) and to resell these tags, potentially at a discounted cost.

It is important to note, as described above, that DoD is utilizing the contract as a phasing tool. This means that this clause will only be inserted in new or renewed contracts. This allows the supplier to recoup the cost of RFID compliance in the unit price of the item being sold to the DoD. DoD feels that suppliers who choose to incorporate RFID technology into their business processes will reap similar benefits that DoD expects which will help limit the cost that suppliers need to pass onto the DoD. Regardless, the DoD is prepared to negotiate these costs into the contract.

6.5 Impact to Recycling Industry

6.5.1 Benefits to Recycling Industry & Costs to Recycling Industry

At the onset of DoD implementation of RFID technology, use of the tags will be limited to selected business process functions in specific locations and will not involve large-scale operations or involve large numbers of tags. With this implementation plan it will allow the necessary time to change business processes and become efficient in RFID waste management. In addition, with DoD involvement and with a phased implementation plan, it will allow the DoD to participate with EPA and other government agencies to address the concern of RFID tags entering into the waste-stream—source reduction, designing RFID tags to reduce the quantity in environment and/or the toxicity of material.

As the technology matures and the DoD implementation progresses, there could be potentially billions of passive RFID tags on materiel entering, processing within, and being disposed of by DoD supply chain activities. Some components of RFID tags might be considered contaminants that inadvertently mix into the recycled materials, some additional processes at the recycler may be necessary. However, as mentioned previously, there is evidence that current mitigation actions are adequate, and in fact, there has been no documentation to support any adverse effects to current recycling equipment or recycling processes. A case in point, a major paper manufacturer, with the use of RFID in its paper cores, examined the effects the RFID tags would have on their recycling process. The manufacturer investigated the recycling of the cores through its recycler and has found no measurable indication that the debris from the tags is impacting the process. The junk traps on the re-pulpers appear to effectively remove any RFID remnants.

7 ALTERNATIVE 2 –THE MARKET ADOPTS PASSIVE RFID WITH DOD INVOLVEMENT ACCORDING TO AN IMMEDIATE IMPLEMENTATION PLAN (NO PHASING)

7.1 Background

As stated previously, although DoD currently has limited impact on the RFID market in terms of overall numbers of suppliers currently involved, its initial actions with respect to passive RFID have served as a major impetus for adoption, hardware and software development, standards making, and investment activities. DoD's continued involvement will allow it and its suppliers to benefit from DoD's influence as it works to ensure that its requirements are identified and communicated to the providers of passive RFID. Immediate DoD implementation of passive RFID with no phasing of the implementation would require that all materiel, shipped to any DoD location be tagged at the case and pallet level that were shipped to any DoD location worldwide.

7.2 Benefits of Immediate Implementation

DoD has identified a variety of benefits that it will achieve through the use of RFID. One might therefore think the way to maximize these benefits would be to tag as many shipments as possible to as many locations as possible. While DoD would certainly realize benefit from this approach, it would only achieve a marginal level of benefit based on the introduction of more classes of materiel being tagged. Inherent in DoD receiving these benefits is the fact that locations receiving these tagged shipments have infrastructure in place that allows them to read RFID tags and associate those reads to data resident in DoD logistics systems in order to derive a business benefit. As a result, the DoD would only receive these increased benefits in locations that are outfitted with passive RFID capabilities. In 2005, this is limited to the Defense Distribution Center Susquehanna, PA (DDSP) and the Defense Distribution Center San Joaquin, CA (DDJC). Therefore materiel being tagged and shipped to all other locations would arrive without being read by any RFID equipment thus depriving the DoD of gaining the value of that tag. The costs would therefore outweigh the benefits as the DoD would be paying for the suppliers' RFID costs (in the contract cost) and not receiving the expected benefits.

The main benefit to suppliers from an immediate implementation would apply those suppliers who supply a variety of commodities to the government. If all materiel were required to be tagged, a supplier would not have to segregate materiel (a potential scenario under the phased implementation approach). DoD does not believe that there are many suppliers who supply materiel across classes of supply.

7.3 Costs of Immediate Implementation

The following is a notional estimate of what it would cost to do an immediate RFID implementation with 60,000 DoD suppliers. The analysis divided the 60,000 suppliers into categories based on annual shipping volumes. DoD estimated the percentage of the 60,000

suppliers that resided in each category to derive this estimated cost. The cost per supplier is based on the estimates identified in other areas of this analysis.

60,000 Suppliers				
Number of Shipments Per Year	% of Suppliers in Each Shipping level Category	# of Suppliers in Each Shipping Level Category	Cost Per Supplier	Cost for All Suppliers Shipping at Same Level
10	10%	6,000	$4,105	$24,630,000
50	10%	6,000	$4,525	$27,150,000
500	45%	27,000	$9,250	$249,750,000
5,000	20%	12,000	$56,500	$678,000,000
15,000	10%	6,000	$161,500	$969,000,000
25,000	5%	3,000	$266,500	$799,500,000
			Total	$2,748,030,000

Figure 40 Notional Estimate of Immediate RFID Implementation

In terms of sheer volume, the immediate implementation of passive RFID would be nearly impossible. From the supplier perspective, there would simply not be enough RFID equipment (tags, readers, printers) available in the marketplace to support all 60,000+ suppliers. The RFID market is not prepared to support such a volume in such an immediate timeframe. From the DoD perspective, this would also simply be too great of a change to handle. As mentioned previously, DoD will not have infrastructure in place at every DoD location immediately. DoD is faced with the same marketplace limitations as the supplier community – they would not be able to fulfill their demand for all of the RFID equipment necessary to have an immediate implementation.

Moreover, with any introduction of a new technology, it is wise to introduce that technology in a measured way so that normal operations are minimally impacted. It also allows the end user (both DoD and DoD suppliers) to get adjusted to the technology and utilize lessons learned in order to improve the way that one expands the use of that technology in order to exploit the maximize benefits of that technology. A comparison can be drawn with the implementation of other Automated Identification Technology (AIT) (e.g. barcode) within DoD. Each time the DoD has introduced a new technology, it has done so in a measured way in order that both the Department and the suppliers have time to understand the requirements and to analyze and potentially alter business processes in order to derive the maximum amount of benefit.

7.4 Benefit and Cost Analysis (Qualitative and Quantitative)

It logically follows that, as we scale to tag all shipments immediately, the implementation costs increase exponentially. However, it will not follow that the benefits accrued will increase exponentially.

The benefits identified in Section 6.2 will still be the same benefits. We will see an incremental increase in the benefit in the area where we are tagging all materiel going to DDSP and DDJC. However, we will not see the large increased benefit because DoD will not have the infrastructure in place to capture this benefit.

7.5 Impact to Small Business

7.5.1 Benefits to Small Businesses

The major benefit to small businesses from immediate implementation (vs. phased implementation) would apply only to those suppliers who supply a variety of commodities to the government. Under the phased scenario, this supplier might have to segregate their production/shipping lines to have a line that dealt with product that needed to be tagged and product that did not need to be tagged for DoD. This would obviously be a less than efficient operation for the supplier. However, DoD does not believe this is a huge problem because there are few small businesses that supply more than one type of commodity to DoD. As such, under the phased implementation plan, small businesses' products would either be within the scope of the program or out of scope of the program.

It is difficult to identify an increased benefit to small businesses (and even to DoD) with an immediate implementation based on the fact that DoD will only have the two main CONUS DLA strategic depots outfitted with RFID infrastructure during the beginning of this implementation.

7.5.2 Costs to Small Businesses

The following is a notional estimate of the cost to small business if they were required to immediately tag all materiel with RFID tags. The DoD estimated that there would be around 35,000 small businesses impacted immediately and broke this number into three sizes: suppliers shipping 10 shipments to the DoD per year, suppliers shipping 50 shipments to the DoD per year and suppliers shipping 500 shipments to the DoD per year. This analysis assumed that a shipment would contain 21 tags (20 case tags and 1 pallet tag) and that each supplier would use an RFID-enabled printer in order to apply the tag. The total cost of this immediate implementation would equate to approximately $172,429,555 for all small businesses doing business with the DoD. See the accompanying Figure 41 for detail.

Approximately 35,000 small businesses

% in Shipment Range	Shipments Range	Printer Costs	Tags (1 per case and 1 per pallet)	Per Tag Cost	Total Tag Cost	Total Cost Per Small Business	Total Cost to All Small Businesses
45%	10	$4,000	210	$0.50	$105	$4,105	$63,139,005
40%	50	$4,000	1,050	$0.50	$525	$4,525	$61,865,800
15%	500	$4,000	10500	$0.50	$5,250	$9,250	$47,424,750
						Total	$172,429,555

Figure 41 Total Cost to Small Businesses with no DoD Phased Implementation of RFID

Requiring approximately 35,000 suppliers to become RFID compliant, essentially overnight, eliminates the possibility of allowing small businesses to learn from early adopters or those small businesses that have been phased into RFID compliance ahead of them. This scenario would

require changes to existing contracting requirements. However, contractors would be entitled to an equitable contract adjustment based as a result of any such change to existing contract requirements. DoD expects affected suppliers to negotiate fair and reasonable pricing into future contracts to help defray the initial costs of implementing this technology in order to comply with terms and conditions of future contracts.

7.6 Impact to Recycling Industry

7.6.1 Benefits to Recycling Industry & Costs to Recycling Industry

Immediate DoD implementation of passive RFID and no phasing of the implementation could have the potential to overload the waste-stream and interrupt the recycling process. This abundance of tags entering into the system at one time will not allow for the development of a new business process or the efficiency of RFID waste management. With this push of RFID tags, it has the possibility to increase costs to the recycling industry due to the purchasing of new machinery, if necessary, to accommodate the volume of RFID tags entering into the waste-stream and the rapid change in business process. As mentioned in the baseline, the Environmental Protection Agency has an established waste management hierarchy that focuses on attempting to reduce the amount of waste that is created, reusing whenever possible, and recycling what is left. With the no phasing implementation, it will not allow sufficient time for the DoD to work with this government agency and others to address the concern of RFID tags entering into the waste-stream—source reduction, designing RFID tags to reduce the quantity in the environment and/or the toxicity of material.

8 SUMMARY OF ANALYSIS OF ALTERNATIVES

8.1 Overall DoD Implementation Plan

As outlined in this document, the Department of Defense undertook a detailed analysis of its supply chain when determining how it intended to roll-out the use of passive RFID within its logistics operations. The three alternatives considered were: The Market Adopts Passive RFID without DoD Involvement, The Market Adopts Passive RFID with DoD Involvement According to a Phased Implementation Plan, and The Market Adopts Passive RFID with DoD Involvement According to an Immediate Implementation Plan (No Phasing).

The option to allow the market to proceed without DoD involvement was considered unacceptable for several reasons. First, by not participating during the initial development and growth of this technology, the DoD is leaving itself open to the possibility that standards may be developed that do not take into consideration the needs of the DoD. This could potentially severely restrict the DoD's ability to adopt the use of the technology in the future. In this scenario, the DoD might actually have to be forced to have its suppliers follow an alternative standard. In addition, DoD has over 60,000 suppliers and some of those suppliers are being impacted by commercial companies' RFID mandates. The exclusion of DoD from this initial passive RFID implementation phase may adversely affect the suppliers who are impacted by other passive RFID mandates. These suppliers might have to maintain separate inventories and distribution processes which could impact their cost to the government.

The option to allow the market to develop with DoD's involvement according to an immediate implementation plan was also deemed to be inadequate. The primary reason is the volume associated with the number of shipments that would have to be tagged. If implemented immediately, the DoD would not have the infrastructure in place to support the reading of a tag on every shipment sent to the Department. The market would also not be able to support such a scenario because there would not be enough equipment and tags available to meet this requirement. Finally, the DoD needs time to adjust its business process to take full advantage of the benefits that passive RFID will provide. An immediate implementation would tend to sub-optimize the gains and benefits that the DoD expects to achieve through the introduction of this technology.

The option that is the most pragmatic is for the market to adopt passive RFID with DoD's involvement according to a phased implementation approach. DoD's participation in the initial phase of this technology development will ensure that its requirements are recognized and reflected in the standards that are currently being developed. DoD will also be able to shape the requirement for future generations of passive RFID tags, readers, and software. The phased implementation allows the DoD to establish passive RFID infrastructure at key locations thus ensuring that tagged materiel from suppliers can be read at the important receiving locations. The phased approach also allows DoD to work more closely with the impacted suppliers to ensure compliance and to develop solutions to any problems that arise during the initial stages of the implementation. This would be impossible if DoD had to deal with all 60,000 suppliers trying to comply at the same time. Finally, and perhaps most importantly, it will allow the DoD to continually identify areas for business process improvement throughout the implementation.

Business process reengineering is where DoD will reap the true benefits of passive RFID enabling the DoD to transform its logistics operations in an economical fashion that continues to equip the DoD and its warfighters with everything necessary to accomplish their mission(s).

9 ACRONYMS

Acronym	Definition
2D	Two-Dimensional (barcode)
3PL	Third Party Logistics
463L	U.S. Air Force Cargo Pallet System – used on USAF aircraft
ACP	Acid Catalyzed Phenolic
AIM	Association for Automatic Identification & Mobility
AIS	Automated Information System
AIT	Automatic Identification Technology
AMC	Air Mobility Command
APOD	Aerial Port of Debarkation
APOE	Aerial Port of Embarkation
ASN	Advance Shipment Notice
BCA	Business Case Analysis
BSM	Business System Modernization
CAGE	Commercial Activity and Government Entity (code)
CAGR	Compound Annual Growth Rate
CCP	Container Consolidation Point
CD	Compact Disk
CD-ROM	Compact Disk- Read Only Memory
CMB	Contact Memory Button
COCOM	Combatant Commander
CONUS	Continental United States
DAAS	Defense Automatic Addressing System
DDJC	Defense Distribution Center, San Joaquin, California
DDSP	Defense Distribution Center, Susquehanna, Pennsylvania
DFARS	Defense Federal Acquisition Regulation Supplement
DLA	Defense Logistics Agency
DoD	Department of Defense
DODAAC	Department of Defense Activity Address Code
DSS	Distribution Standard System
DTS	Defense Transportation System
DVD	Direct Vendor Delivery
EAN	European Article Numbering
EPA	US Environmental Protection Agency
EPC	Electronic Product Code
FTE	Full Time Equivalent
GAO	Government Accounting Office
GTN	Global Transportation Network
IDC	International Data Corporation
ITV	In-Transit Visibility
IP	International Paper
JSLIST	Joint Service Lightweight Integrated Suit Technology
JTAV	Joint Total Asset Visibility

MRE	Meals Ready-To-Eat
MSC	Military Sealift Command
MSL	Military Shipping Label
MSW	Municipal Solid Waste
M/T	Measurement Tons
MTW	Major Theater War
OCONUS	Outside the Continental United States
OMC	Optical Memory Card
OSD	Office of the Secretary of Defense (U.S. DOD)
PDF	Portable Data File
PET	Poly Ethylene Teraphtalate
POD	Port of Debarkation
POE	Port of Embarkation
RF	Radio Frequency
RFDC	Radio Frequency Data Capture
RFID	Radio Frequency Identification
RF-ITV	Radio Frequency – In-transit Visibility
ROI	Return on Investment
ROM	Read-Only Memory
RTLS	Real Time Locating System
SARSS	Standard Army Retail Supply System (U.S. Army)
SDDC	Military Surface Deployment and Distribution Command
SPOD	Surface Port of Debarkation
SPOE	Surface Port of Embarkation
TC-AIMS II	Transportation Coordinator's Automated Information for Movement System II
TDC	Theater Distribution Center
TRANSCOM	Transportation Command
UCC	Uniform Code Council
UID	Unique Identification or Unique Identification Number
WAWF	Wide Area Workflow