



# RFID

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## ▶ **BENEFITS AND PITFALLS ON THE WAY TO NIRVANA**

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The information contained in this document provides Exactus' view on the current state of RFID with its underlying issues and challenges, foreseeable adoption trends, evolution of technology and suggested deployment approach and road maps based on the prevailing market situation and availability of tools and technologies as of the date of publication. As market conditions continue to evolve and change, the accuracy and integrity of information may no longer be valid subsequent to the date of publication of this document and readers should accordingly rely on more current and relevant information. Exactus is making this document available for informational purposes only and no guarantees, expressed or implied are made.

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## Executive Overview

Radio Frequency Identification (RFID) is gaining considerable attention not only because of the business imperative for suppliers to be compliant with RFID/EPC mandates from retail chains like Wal-Mart, Albertsons, Metro and Target as well as the Department of Defense and FDA, but also due to the promise the technology holds in streamlining logistics operations and delivering real benefits in data accuracy, labor savings, higher visibility and improved customer service.

Exactus firmly believes that RFID will have a significant impact on the supply chain operations over the coming years, and early adopters of the technology will be able to gain a distinct competitive advantage. Whilst there are still few success stories where RFID has delivered dramatic top and bottom line business results, the potential to revolutionize the accuracy of information, efficiency of operations and security within the supply chain is tremendous.

Although RFID technology has been around for some time and has been deployed with a fair degree of success in such areas as toll collection, vehicle identification and filling stations, its widespread adoption in the retail and distribution sector for product identification is still at an early stage. Nonetheless, RFID is expected to become pervasive enough over the next decade to be considered a mainstream technology that companies will be required to implement to stay competitive. Many industry pundits are of the view that Supply Chain Management (SCM) is indeed the “killer application” that will significantly help increase RFID deployments.

Some consider RFID to be just a lot of hype and believe it is still in an embryonic stage. Others view it as a must have technology that can take you to Nirvana. We believe it is neither, and the benefits that could accrue would really depend on what one is trying to achieve with the technology and their expectations of it. Invariably, there are tremendous benefits to be realized from RFID provided one has a clear understanding of the possibilities and pitfalls and takes a measured approach to implementing the technology as part of an overall strategy. Although many advances have been made in certain specific areas, the industry as a whole is still somewhat fragmented with regards to embracing a more structured standards framework.

Enabling the delivery of the right goods to the right destination and at the right time is the key to supply chain visibility and RFID holds

**The RFID industry is expected to grow to \$8.3 billion by 2013.**

*Source: AIM Research*

**Approximately 10% of medicines on the market in many S.E. Asian countries are counterfeit, with that number going up to 50% in some countries.**

*Source: European Federation of Pharmaceutical Industries and Associations*

much promise in delivering measurable improvements in effectively tracking inventory from its point of departure and accurately accounting for it at any given moment to minimize lost, stolen or misplaced goods.

Currently, most RFID applications are focusing on pallet level tagging, and as tag costs decrease we will see the value migrating to case and item level tagging, which will provide significant benefits in tracking products across the value chain, in particular, for consumer goods manufacturers and retailers.

There are several market drivers necessitating companies to adopt an RFID strategy. Indeed, for many companies the adoption of RFID will not be driven by internal initiatives but by compliance mandates from some very large retailers and consumers, many requiring that cases and pallets delivered by suppliers must use tags, with deadlines approaching in 2006 and 2007. Even for those companies that are not affected by mandates, RFID offers some compelling reasons businesses should consider early adoption of this technology to transform their operations and realize substantial benefits.

Consider some of the following:

- Global shrinkage in the consumer packaged goods supply chain has been estimated to cost companies between \$60-\$80 Billion yearly.
- Counterfeiting costs companies over \$100 Billion yearly, with some estimates suggesting that up to 12% of products are counterfeit.
- Out of the more than 60,000 containers entering US ports daily and hundreds of thousands of trucks entering the US across the Mexican and Canadian borders, less than 3% are inspected thoroughly.
- According to US Food and Drug Administration, up to 20% of foods are discarded due to spoilage in the supply chain.

RFID tags store large amounts of unique information (typically 64 to 96 bits) and can be used to identify not just a class of products, but individual occurrence of pallets, cases and items. With RFID technology, theft or tampering can be immediately identified, without requiring product inspection. Moreover, product diversion and smuggling can also be contained using RFID. Terrorism can be

checked with RFID tagged containers and trucks to safeguard the borders against any potential infiltration.

By enabling organizations to accurately gather mission-critical information in real time at the point of business activity, as well as the location and status of physical objects across the value chain, RFID technology can provide significant improvements in efficiency, data integrity and inventory visibility, which in turn can help lower overall costs and deliver goods faster and more accurately to the end user.

This white paper will review the elements of RFID technology, costs and ROI considerations, its impact on processes, short-term as well as long-term benefits, and the inherent risks and current limitations of RFID technology. It will also provide some guidelines and recommendations on deployment approaches and methodologies that companies can adopt as well as pitfalls to avoid when implementing RFID solutions.



## RFID 101 – A Quick Primer

RFID stands for Radio Frequency Identification. In its simplest form it is a system of small electronic tags capable of transmitting a radio signal, readers capable of reading the radio signal, an intelligence layer to decipher and manage the collected data and requisite hardware and software infrastructure. The tag consists of a small integrated circuit on a tiny silicon chip with its own data storage and is attached to a small antenna. Tags store a unique serial number and are attached or embedded to retail objects, pallets or containers. A fixed or handheld tag reader sends a signal to the electronic tag which absorbs some of the RF energy from the reader signal and reflects it as a return radio signal containing information from its memory. Readers can simultaneously capture data from multiple tags and pass on the information to data management systems. The transmitters can be placed on containers, pallets, cases, individual products, materials handling equipment and really anywhere that tracking the movement of goods can add commercial value to a business process.

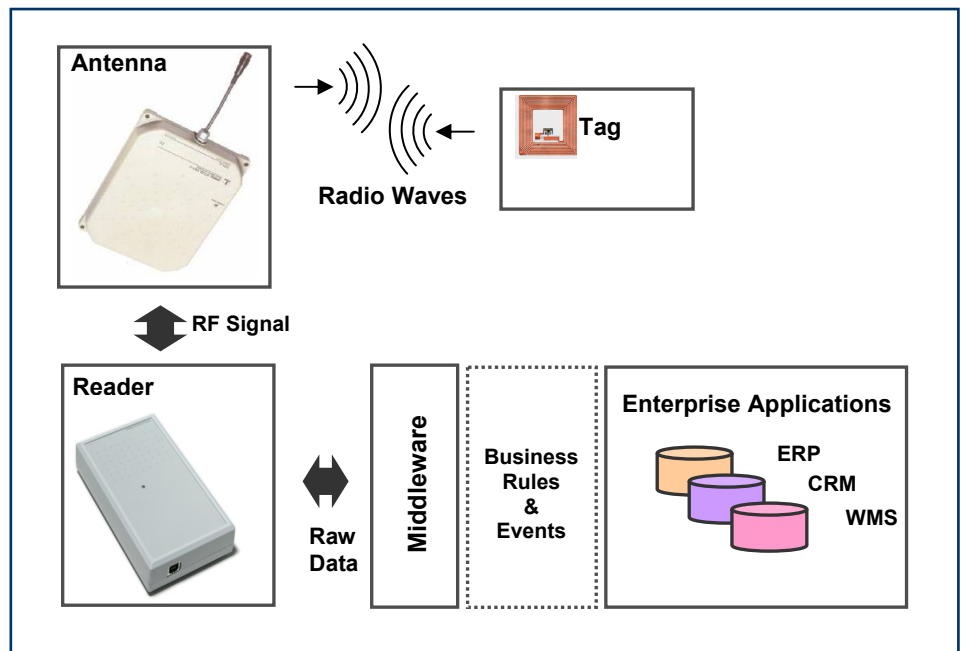
### *RFID Tags*

Three types of RFID tags are currently in use - active, passive and semi-passive. Active tags broadcast a signal via a battery powered antenna which is picked up by a reader. Active tags have a long range and are typically used for tracking high value goods. Passive tags do not contain a battery but draw power from electromagnetic radio waves transmitted by the reader, which in turn induce a current in the tag's antenna and the energy required for data transmission. Passive tags cost less than active tags and are typically used for tracking items, cases and pallets. Semi-passive tags use a battery for powering the chip's circuitry, but draw power from the reader's radio waves for communicating. Passive tags have shorter read distances while active and semi-passive tags can read up to over 200 feet. Passive tags cost the least, and it is for this reason that the majority of tags in the retail supply chain are expected to be passive.

The chips embedded in RFID tags can either provide read only functionality or read-write, the latter allowing encoding as well as updating the EPC on the tags by the reader. Read only tags are less expensive and the EPC information is either programmed on the tags by the manufacturer or it can be set in the field for those tags which employ electronically erasable/programmable memory. We can expect widespread use of multiple read/write re-usable tags by suppliers in a few years time for pallet-level tracking.

**RFID Antenna**

Antennas comes in all sorts of shapes and sizes and the choice of an RFID antenna will depend on the particular application as well as the frequency of operation and the range requirements. Reading range of an antenna can be effected by many variables such as antenna size, tag size, tag orientation with respect to transmitting antenna, ambient electrical noise and magnetic interference within the band of operation, antenna location with respect to other materials and structures in the vicinity, proximity to metals and liquids, etc. Some readers come with embedded antennas while in some applications antennas can be mounted in dock doors, rollers, conveyor belts and other fixed objects. Typical RFID antenna types include stick antenna, gate loop antenna and multiple element array antenna.



**Typical RFID Architecture**

In the above RFID architecture example, a read command is issued by the RFID reader in transmit mode upon receiving instructions driven by pre-defined business rules from the RFID middleware. The antenna transmits a radio signal which energizes the RFID tag, and the tag upon becoming energized transmits the pre-programmed ID information back to the antenna. The RFID reader now receives the information in receive mode and decodes it into raw data which is then passed on to the middleware. The RFID middleware, after performing the necessary error handling and filtering, processes business events and routes them to backend systems for further processing.

A typical RFID system uses tags that store a unique serial number, which are attached to or embedded in designated objects such as retail items or containers. Fixed or handheld readers transmit a UHF signal that supplies power to the tags and communicates with them from a distance, even when the tags are not visible. Readers capture the data on multiple tags virtually simultaneously and pass the data to the management systems.

RFID offers several advantages over previous ID systems such as barcodes. For example, contrasting barcodes, RFID tags do not require “line of sight” to the tag reader, whereas barcode scanners must “see” to read the barcode. Moreover, unlike barcodes which can only identify the manufacturer and product, RFID additionally allows identification of items with a unique identifier and can identify many unique items at once.

#### *RFID Reader*

An RFID Reader is basically a device used to communicate with RFID tags. It is interfaced to one or more antennas which transmit radio waves to the tag and receive the signals back from it. The radio frequency signals are decoded by the Reader into raw unfiltered data which is then processed by the middleware. Depending on the particular application, HF or UHF frequencies will be used by the reader to accurately detect the RFID tags. UHF frequency RFID readers are typically used to detect fast moving items while HF frequency RFID readers are good for penetration when items are in the vicinity of liquids. Radio frequencies are susceptible to interference and can easily get deflected, absorbed or distorted. The extent of degradation will depend on such factors as the transmission frequency, the transmitting power and the proximity of RFID readers and tags to metallic objects and liquids. Interference from motors, conveyor belts, and other rotating machinery must be taken into consideration as part of the overall RFID network and system design. Moreover, business rules must also be put in place to cater to false reads as a result of environmental conditions, no matter how good the overall design.

#### *Standards*

In the same way as UPC (Universal Product Code) was the basis of identification in bar code systems, EPC (Electronic Product Code) is the next generation of product identification used in RFID systems. There are several challenges in establishing a set of standards to govern the EPC data structure embedded in RFID tags. Some of these include rationalization of proprietary systems from different vendors, individual country regulations pertaining to frequencies and power

and multiple standards bodies attempting to establish standards. The tag attached to a pallet by a supplier must be read and understood by the customer, and that can only happen if universal standards are established and adhered to by all concerned parties. The two organizations leading the definition of RFID standards are EPCglobal (a joint venture between Uniform Code Council and EAN International) and ISO (International Standards Organization). EPCglobal is developing the EPC standards for RFID, including radio frequencies at which tags will operate to ensure interoperability and leveraging of the existing telecommunications infrastructure. ISO will produce guidelines, procedures and policies on a wide range of issues and applications to establish internationally compatible and consistent standards that can be adopted globally.

### *EPCglobal Network Elements*

The RFID tag communicates its EPC number to a reader. EPC forms a unique number on the tag that can identify a product, its manufacturer, serial number, version and the like. EPC has a header that defines the overall length of EPC, type, version and length of subsequent partitions. Then comes the EPC Manager which identifies the entity responsible for managing the subsequent codes. The next piece of information in an EPC code is the Object class which identifies the item, for example SKU. The last item is the Serial Number which is a unique serial number for all items in a given class.

The EPC tag information is passed on by the Reader to an application called ONS (Object Name Service) that points to the information located on the network related to the objects being tracked. It can be thought of as a directory, similar to the DNS (Domain Name Service) on the world wide web. In other words, the ONS directory converts the EPC into a URL on internet which is then translated into an IP where detailed information about the item, case or pallet is stored.

The common language used to define data related to physical objects is called PML (Physical Markup Language). Based on XML, it links information with physical products and describes the systems and processes associated with the physical objects. Object Name Service provides the bridge between the product description handled by PML and the product identification handled by EPC.

Finally the brain that manages and moves information within the EPCglobal network is called Savant software. Savant is based on a distributed architecture.



## Middleware & Enterprise Integration

In simple terms, RFID middleware is essentially about monitoring and management of data and devices – a sort of a traffic cop for RFID related data. It extracts data from RFID readers and, after filtering and aggregating the information, routes the RFID data to the point of transaction, typically enterprise systems such as ERP or WMS. It is a critical component of an event driven architecture to support real time processing.

Most middleware products available today are based on the Savant specifications from EPC global (formerly MIT Auto-ID Center), though it cannot yet be said that Savant is the de facto standard. Some of the good middleware applications can support business rules, processes and logic, in addition to device management, to help leverage RFID data in decision making. Ideally, an RFID middleware solution should be able to transform data from not only RFID devices but also bar code devices, GPS systems, satellite systems and other sensors and appropriately route it to any network or application. Other important features in middleware solutions include directory services, remote data access, session management, concurrent control over multiple processes, initiation and termination of local and remote processes on multiple computers, rules/exception based event recognition and data management and task management, whilst maintaining high security and integrity of data.

In surveys conducted by market research firm VDC, the two main areas of RFID middleware functionality ranked highly by end users are data monitoring and management (e.g. data aggregation, integration, filtering and routing) followed by device monitoring and management (e.g. device driver/control, system diagnostics, alerts & notifications and device health monitoring).

Within a large enterprise that has multiple systems such as supply chain planning and execution systems, enterprise resource planning systems, performance management systems, transportation management systems and other data capture and storage applications, it becomes increasingly important to include RFID middleware as part of the overall solution architecture to enable input devices such as RFID sensors, readers and transponders to interact with a “traffic cop” middle layer for passing raw data and device configuration information as well as business rules and alerts

to and from the enterprise applications, typically through a business process management layer in between.

Broadly speaking, robust RFID middleware solutions must provide reader and device management through a common interface, filter and route data intelligently to the appropriate destinations, provide messaging and connectivity features to integrate data into existing enterprise applications (as well as appropriate adapters and open APIs for integration with other third party applications), provide process management and B2B integration for collaborative processes (e.g. inventory replenishment and vendor managed inventory) and offer reliable processing incorporating such features as dynamic load balancing and fail-over.

We can expect to see RFID middleware solutions evolving from providing functionality related to reader connectivity, filtering, aggregation, routing and tracing to more elaborate functions including context based and edge-tiered filtering and routing, process management as well as incorporating B2B integration.

Although some of the RFID pure play vendors like Oat Systems and GlobeRanger developed middleware solutions that were employed in early pilot installations, there are now over a dozen integration specialists, application providers and platform vendors offering middleware solutions, including IBM, Oracle and Sun Microsystems, that are designed to collect and filter data from RFID devices, execute business processes and integrate the RFID information with third-party software. Even traditional EAI solution providers like webMethods and TIBCO have entered the RFID market.



## Challenges to Consider

A report published by Aberdeen Group called “RFID in the Consumer Industries: Being a Winner Not a Follower” highlights the results of a survey indicating that the main concerns related to RFID adoption are: Cost Issues (47%), Technology concerns (32%), budget issues (13%) and mandate requirements (8%).

Costs of implementing any new technology are generally always a consideration in most application areas, and RFID should be no different. Indeed, prices are currently still high for both RFID tags and readers. Whilst the high price of tags is not such an issue in reusable packaging, it is likely that prices will remain high until 2007 to 2008, limiting wider take-up in other areas. A drop in the price of RFID readers is also expected, although it is hard to predict when this will occur.

We are still a long way from the barcode’s penny-level costs and widespread adoption of EPCs will require RFID technology to become orders of magnitude cheaper and economically viable for a broad range of consumer goods. Or, if the RFID technology costs do not come down drastically, at least unique and significant new value must be generated by RFID that is exclusive and distinct from that offered by barcodes. We see a bit of both happening in the medium to long term and expect both barcode and RFID technologies to co-exist in the consumer packaged goods value chain for the foreseeable future.

In addition to the upfront costs of deploying readers, tag costs, costs associated with purchasing software to capture reader information, and other related infrastructure and software costs, there are also the issues related to integrating new hardware and software with existing applications and systems not only within a customer’s organization but also with those operated by various companies across the value chain. Software to integrate RFID technology with other business applications, such as supply chain management and ERP systems, is currently immature, although software vendors are investing heavily in this area.

When we examine the next main concern after costs, the technology issues, we note that there are just too many variables that need to be taken into consideration and it becomes increasingly important to rely on the expertise of a partner who has had real-world experience in implementing RFID systems. RF interference, the inability to read

**The main concerns related to adoption of RFID are cost (47%), technology (32%) and budget (13%).**

*Source: Aberdeen Group*

100% of the cases on a pallet 100% of the time, the need to determine the best tag antenna type for each product, and the optimal tag placement on or within a case are all contributing inhibitors to widespread adoption of RFID today.

The first order of business for any company considering RFID would be to conduct a thorough readiness appraisal of their existing infrastructure, including network security, availability of power, adequacy of wireless LAN, etc. Next, the environment needs to be studied so that possible sources of RF interference can be identified. Even common RF items like cordless telephones and microwaves can introduce unwanted interference. If there are too many liquids or products containing a lot of water, then a particular type of frequency suited for such conditions must be considered. Whilst UHF technology is most applicable to RFID, it is not best suited in environments where large amounts of liquid are present.

There are challenges related to RFID tags that need to be considered as well. Radio frequency performs differently around different materials and so specific types of tags would have to be considered for objects made from wood, glass, cardboard, metal or liquids. Metal and water based materials are not the friendliest materials for tag applications. Tag sensitivity, size and shape will yield different performance levels. Moreover, the position of a tag on the case will also effect the ease with which the tag will be read, with the optimal position depending on the contents of the case. Also, when tags are stacked closely together, they may interfere with one another. Preventive handling techniques (e.g. grounded wrist straps) may be required where electrostatic discharge can damage RFID tags. Radio Frequency holes can exist in the center area of pallets and this needs to be taken into consideration when positioning tags on cases and pallets.

False and no reads are a fact of life and will occur for various reasons, but these issues can be handled if proper business rules are put in place for exception management.

Antenna selection criteria is also an important aspect that needs due consideration. The antenna size, a function of operational frequency, and power levels will affect read range. Polarization (circular, vertical, horizontal) will dictate antenna to tag orientation. RFID applications can generate large volumes of data and as data requirements grow, the ability for technologies to scale up becomes all the more critical.

Standardization issues for tags and readers have not yet been resolved, although it is clear that early retail adopters all support the emerging EPC standard. Many of these issues are expected to be resolved by the end of 2005 or early 2006. Standards enforce interoperability required for collaboration in value-chain applications pertaining to data acquisition and management. In the absence of a common, standard and consistent interface across RFID devices (readers, scanners, etc), managing the reader infrastructure can be a real challenge, especially when high speed collection, aggregation filtering and routing of data has to be done accurately across multiple applications and within multiple locations. Tags manufactured by different suppliers send data differently and therefore multi-protocol readers will be required until a universal standard is embraced by all manufacturers.

Legislation can also limit the use of a certain technology, for example in some European countries, there are limits on the use of UHF frequencies and in some countries certain radio frequencies are not available for use.

One other challenge that is slowing up widespread adoption of RFID technology is that knowledge and experience of its use is limited at present. There are several pilot programs under way, but it is only after long-term use of the technology that all the major issues will come to the fore. At present, with a limited experience in RFID and with limited resources and domain knowledge available, many companies are finding that RFID implementations can require a great deal of time and effort. For this reason, it becomes even more imperative to work with a technology partner that can bring to bear practical field experience and expertise in RFID technology to make a project successful.



## Building the Business Case

Practical implementation issues notwithstanding, coming up with a business case and cost justification in terms of why RFID and EPC should be embraced and what goals are to be achieved from introducing these technologies is quite a challenge. Adoption of these technologies as a result of mandates from retailers does not require much justification or a business case. However, even without pressures from customers, there are some compelling reasons why companies would want to invest in RFID technologies. For example, RFID can significantly help reduce errors in labor-intensive and error prone processes such as complex picking by accurately pointing out whether or not items from a storage location have to be picked, often improving the picking throughput by orders of magnitude. Faster handling of merchandise can be accomplished by scanning pallets at much higher speeds using RFID, compared to barcodes. By being able to track products more closely, losses in the supply chain due to theft, counterfeiting or spoilage can be reduced considerably. And the list goes on.

Before embarking on the RFID journey, companies must evaluate RFID project feasibility and economic value that can accrue to their business. Some obvious areas where the benefits of RFID are predictable and quantifiable are relatively easy to justify while in other cases it may not be quite as straightforward. Rather than try to figure out the price point at which RFID becomes effective based on the prevailing prices, companies should identify whether a specific business case exists for the technology and the opportunity cost of not implementing RFID or deferring to a later timeframe.

Every company operates differently and has its own unique set of challenges and opportunities to improve its performance and competitive position. One approach in developing a successful business case could involve developing a roadmap that defines the strategic and tactical reasons for implementing RFID, taking into consideration the business objectives and benefits that a company wants to pursue such as better asset management, improved revenues or margins and reduced operating expenses. The functional, operational and technical changes warranted would then be identified. The ROI must be established with regards to incorporating new technologies as well as modifying existing procedures and business processes, taking into account the effectiveness and efficiency of existing business processes and the improvement goals.

**Employee Theft (48%) and Shoplifting (32%) are the two major sources of Inventory Shrinkage.**

*Source: 2004 National Retail Security Survey, Dr. Richard Hollinger, University of Florida*

Next, a business process or problematic area of limited scope and complexity needs to be identified for a pilot project that can most benefit from RFID technology. For example, it could be shrinkage reduction or monitoring counterfeit products in a retail environment. Sometimes external drivers could force this decision - perhaps customers are asking for RFID tagging. Or, one of our major competitors may have already implemented a successful pilot and could be embarking on an enterprise wide RFID project.

Once the real problem has been identified, the potential benefits have been noted and implementation costs are known, the business case can be substantiated on its own merits. At this point, it is important to ensure that all key stakeholders are aligned behind the same goal and realistic improvement objectives have been agreed to by all concerned.

After taking into consideration all implementation issues related to tags, readers, interference, environment, etc., a “proof-of-concept” RFID pilot project journey can be started. Practical lessons learnt from the experience can help further justify expenditure and organizational change.

There is little doubt that companies can expect improved operations and inventory management from implementing RFID, however those benefits need to be weighed against the costs of the RFID infrastructure as well as the costs of applying tags to every pallet and case.

Some of the accrued business benefits from pallet level tagging include put-away efficiencies, faster goods receipt, better inventory control and storage and improved production planning. With case level tagging, benefits include efficient and accurate picking, packing and shipping, improved product tracking and tracing, reduced case theft, accurate physical count and reconciliation and improved cycle counts. Finally, with item level tagging, some of the benefits that can be realized include reduction in item theft/shrinkage, better handling of product recall and warranty processing and improved assembly and routing operations.

A closed loop approach to measure the overall benefits of RFID is the best way forward. By way of example, let's assume that an organization wants to focus on inventory visibility using RFID technology to understand how the inventory flows within and between the facilities of the organization. RFID collects a lot of information automatically and once the data is synthesized into

meaningful numbers, the flow of inventory can be analyzed to uncover inefficiencies within the current processes. Once the inefficiencies have been ascertained, the established policies, procedures and processes can be modified and transformed as appropriate. And with the RFID data and information readily available, the organization will be able to assess the outcome of the modifications on the inventory throughput, flow and turnover.



## RFID Benefits And Where To Look For Them

In theory, RFID can provide real-time visibility of all products at any time within the supply chain, which in turn could lead to some real benefits. For example, threshold based automatic replenishment can reduce out-of-stock situations, reduction of manual inventory management tasks can reduce human errors, more timely and accurate data related to product supply and demand can reduce inventories, shrinkage can be easily identified and reduced, counterfeit and gray market products can be identified and tracked down from the EPC codes stored on the RFID tags, a real benefit for the pharmaceuticals industry, and generally an improvement in asset management and overall efficiencies within warehouses and DCs can be realized with RFID.

Some enterprises are turning to logistics asset management solutions to reduce their capital costs, improve the availability of assets in the right place, and comply with customer mandates. Although the near-term value of RFID seems to be in reduced material handling cost, improved inventory visibility is likely to be one of the main benefits in the long term.

Companies that treat RFID deployment as only an IT issue to comply with a customer's or supplier's mandate will simply view RFID as a cost of doing business. Indeed, for many of these organizations there is little choice left, because failure to comply with the mandates could lose their ability to do business with these customers that wield enormous size and clout to the point that some vendors could even be out of business for non-compliance.

However, even without consideration for mandate compliance, for most organizations, RFID-enabled processes can provide a significant opportunity to improve operations to stay ahead of the competition. Often, just identifying and sizing the business problem can be half the battle. However, once the problem areas have been identified, the next step is to identify the potential benefits that can be realized and establish if those benefits will justify the investment and changes required to move to another level.

Deploying RFID tags and technology systems that use RFID information will give companies precise visibility into logistics assets, knowledge of the status and condition of the logistics assets, and the

**Shrinkage continues to be a multi-billion dollar source of revenue loss. U.S. retailers lost \$33.6 billion of inventory to theft in 2003, which amounts to 1.65% of their total annual sales.**

*Source: 2004 National Retail Security Survey*

**Wal-Mart's savings from RFID deployment could reach \$8.35 billion annually – more than the total revenue of half the Fortune 500 companies.**

*Source: Phillip J. Windley, Associate Professor, Brigham Young University.*

ability to plan for and coordinate the movement of those assets to ensure availability in the right location at the right time. Without these capabilities, a company will not be able to provide differentiated customer service that leads to greater customer retention, increased revenue from additional opportunities with existing customers and improved profitability.

As tag costs diminish, we can expect to see a shift in value from tagging shipping pallets to tagging cases and eventually individual items. The initial benefits realized by consumer goods manufacturers from case-level tagging to track products will be considerable and eventually be even more in the case of retailers when they leverage item-level tagging to improve valuable in-store operations.

Just to put into perspective the potential financial benefits that RFID can deliver, consider the estimates for Wal-Mart alone put forward by Phillip J. Windley, Associate Professor of Computer Science at Brigham Young University. By his approximation, Wal-Mart's savings from new levels of automation through RFID deployment could reach \$8.35 billion annually – more than the total revenue of half the Fortune 500 companies. The bulk of the savings, almost \$6.7 billion, are expected from reduction in manpower currently needed for scanning barcodes and improved productivity. Other areas that make up the overall savings figure include \$600 million from stock-out avoidance, \$575 million from theft and error avoidance as well as vendor fraud, \$300 million through accurate tracking of cases and pallets and \$180 million through reduction in inventory. With those kinds of anticipated savings, the \$3 billion Wal-Mart plans to invest in RFID over the coming years would appear to be a bargain.

One area that many companies do not pay close attention to when considering RFID deployment is the management and control of reusable logistics assets or RTIs (Reusable Transport Items). These circular flow assets such as totes, bins, racks, dollies, roll cages and refillable liquid or gas containers have an intrinsic value and constitute as a significant capital expense for an organization. The management and maintenance of these assets in the distribution network can be quite resource intensive. RFID can help track these assets very effectively to ensure they are not lost, stolen or simply misplaced.

RFID applications are relevant to any organization that is involved in the production, movement or sale of physical goods. That means manufacturers, distributors logistics service providers and retailers (as well as their entire supplier base). RFID has the potential to

improve efficiency and product visibility, increase sales by reducing out-of-stocks, improve asset utilization, cut costs, improve the quality of goods, improve safety of foodstuff and pharmaceuticals and reduce shrinkage and counterfeiting.

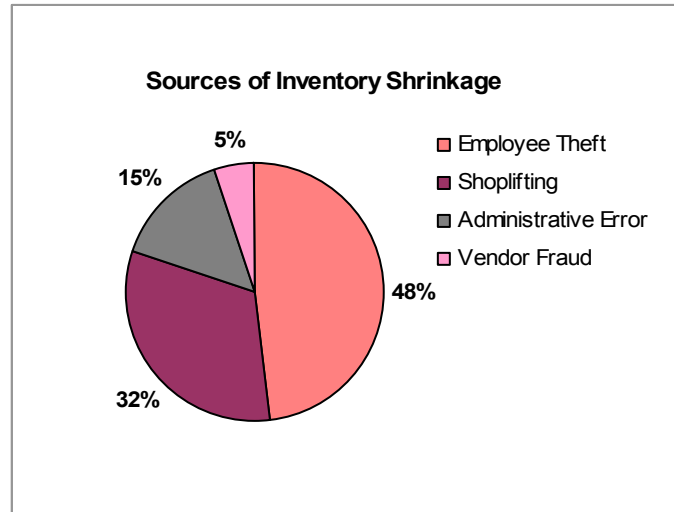
In order to identify areas of business improvements in the supply chain, customers should ask some of the following questions.

- Are we picking wrong items and shipping incorrect orders.
- Are goods being consistently delivered late.
- Are we missing fulfillment commitments.
- Are we having difficulty in locating goods.
- Are we losing goods – are they being misplaced or stolen from the warehouse.
- Is our forecast of goods usually inaccurate.
- Is there an excessive amount of effort required to accurately reconcile physical goods to customer orders/returns.
- Are we facing out-of-date stock wastage.
- Are we engaged in unnecessary stock takes to balance inventory, orders and cash.
- Are we spending too much time and effort to handle returned goods.
- How often do customers request goods that are not on the shelf.
- Do we always know and can we prove that goods have been delivered and accepted.

The above is just a starting point and by no means an exhaustive list of questions to ask about your business to help identify potential areas of improvement from RFID deployment. Once a SWOT analysis is carried out, a number of business processes will get highlighted as areas of improvement that need closer inspection. It is the business process layer that will drive competitive advantage for most organizations and this is the layer that should also drive the RFID deployment decision within a company. A thorough examination must then be initiated about the affected processes in terms of how they will be optimized using RFID technology and also their impact on enterprise applications and system infrastructure.

Another area that all companies dealing with inventory must investigate is inventory shrinkage. Billions of dollars worth of excess inventory in retail supply chains is unaccounted for at any given moment. With the current systems and technology in place, it is extremely difficult to track the inventory from its last point of departure in the supply chain. It may have got lost or stolen or it may

simply have been stored in the wrong place without knowledge of it. According to the 2004 National Retail Security Survey conducted by Dr. Richard Hollinger at University of Florida, employee theft, shoplifting, administrative errors and vendor fraud are the main sources of inventory shrinkage. In fact, U.S. retailers lost \$33.6 billion of inventory to theft in 2003 which amounts to 1.65% of their total annual sales, a staggering figure, indeed.



Source: 2004 National Retail Security Survey, Dr. Richard Hollinger, University of Florida

The three key factors that influence companies' decisions to invest in RFID initiatives are improved customer service (38%), ROI on capital investment or improvements in asset management (27%), and improved operational efficiencies (25%).

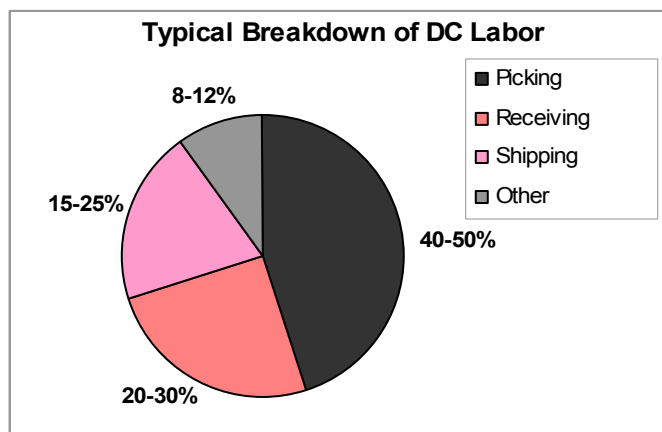
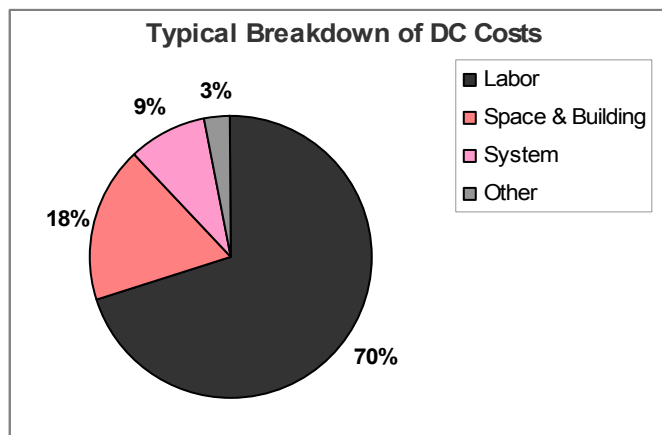
Source: Aberdeen Group, 2004.

According to a study done by Aberdeen Group, aside from mandates, the three key factors that influence companies' decisions to invest in RFID initiatives are improved customer service (38%), ROI on capital investment or improvements in asset management (27%), and improved operational efficiencies (25%).

A reduction in labor costs, along with a reduction in inventory shrinkage, can play an integral role in operational improvements. Labor costs are impacted from inefficient systems and processes, disorganized facility layout and human error.

Although just the use of RFID technology can have a dramatic effect on labor productivity, it is important to pay close attention to optimization of tag placement in production processes and making effective use of tags in the overall operations of a distribution center. Labor contributes the most to the overall distribution center costs and can range from 50-80% of the DC costs for manufacturers and retailers. RFID can provide substantial cost benefits related to labor processes in three key areas: receiving, picking and shipping. Accuracy and throughput in these operations can also be

dramatically improved using RFID. In receiving, SKUs and quantities can be checked automatically, without the need to apply a barcode or pallet label before the put-away process, thereby considerably reducing check-in and verification times. In the picking operation, RFID can eliminate time consuming tasks such as scanning, handling of an RF unit and applying case labels. And in the shipping operation, verification of outbound orders and the labor costs associated in maintaining high customer service levels can be considerably improved.



**Source:** Focus on the Supply Chain: Applying Auto-ID within the DC by PWC Consulting

The application of RFID based technologies to help solve business problems can encompass such activities as tracking stock as it moves in real time, increasing visibility into location and quantity of goods in warehouse, tracking assets like pallets and containers, identifying fake and tampered goods and improving reverse logistics business processes, to mention just a few. Companies need to look at pain areas in a particular business operation and then build a case to

address the problem, clearly identifying what the objectives are and what benefits can be realized. Here are a few scenarios that can serve as food for thought:

In the consumer packaged goods area, there can be a solid case for inventory cost reduction and the expenses related to its management. Applying RFID technology could bring about an improvement in asset utilization and a reduction in wastage, inventory handling costs, manual checks, inventory stock levels, claims and logistics costs.

Retailers and manufacturers can build a case for preventing shrinkage, theft and diversion as well as revenue increase from RFID deployment and realize such benefits as reduced shrinkage and out-of-stocks, improved inventory turns and order fill rates and better in-store customer service.

Manufacturing companies can build a case to prevent sale and distribution of counterfeit products and the benefits they can expect include, better sales volumes and profits, retention of a quality corporate image and a safeguard against safety and security hazard for consumers.

For most companies, an RFID business case will invariably also bring about some form of a competitive advantage, whether it is a cost advantage in logistics, improved DC productivity, a more flexible and adaptive supply chain or an improved yield per site or customer.



## Summary

RFID is poised to revolutionize supply chains and usher in new levels of cost savings, efficiency and productivity. The new Auto-ID tools encompassing EPC and RFID technologies hold tremendous promise to transform the manufacturing, retail and logistics industry value chains in a dramatic fashion similar to what barcode technology did over 30 years ago, but with far more capabilities and flexibility.

With RFID, the movement and availability of stock is always known, and fewer out-of-stock situations can mean increased revenue and better customer satisfaction. By tracking movement of individual cases of high-value RFID tagged products through the supply chain, theft and tampering can be minimized, along with a decrease in costs associated with loss prevention. Time sensitive goods with limited shelf lives can be managed more effectively with RFID. RFID can also improve inventory accuracy by minimizing the number of times staff must scan a case or pallet to determine its content, as is the case with barcodes. RFID data can provide real-time analysis to help eliminate distribution bottlenecks, identify sales velocity and improve business processes for faster product velocity. By providing real-time and accurate information about the contents of a shipment, RFID can speed the order-to-delivery cycle time and improve shipment receipt reconciliation. RFID data can be used to analyze product life cycle information in the supply chain to discover where a defect in a product could most likely have been introduced for improved defect tracking and recall management. These are just some of the benefits that can accrue from RFID deployment.

As companies consider RFID deployment, they should start with value targeting and develop a business case for leveraging RFID benefits. A pilot deployment can help minimize the risks and highlight the most effective and beneficial ways of using RFID. A technology assessment plan should take into account reader platform compatibility, EPC compliance, software upgradeability, management of large data volumes and scalability of applications. Last, but not least, working with a partner with in-depth knowledge and expertise in RFID, who can provide implementation and on-going support, should not be overlooked.



## Glossary

### Active Tags

RFID Tags with a transmitter that use batteries as a partial or complete source of power to boost the effective operating range of the tag when sending a signal to the reader. Active tags can be read from distances over 300 Feet and are typically used for tracking expensive items over long ranges.

### Antenna

A device made of conductive elements which radiate and/or receive electromagnetic energy. In RFID, an antenna radiates energy in the radio frequency spectrum to and from the RFID tag.

### Automatic ID

The generic term which covers methods of automatic data collection, broadly encompassing bar coding, RFID, biometrics and other electronic technologies that identify and track goods.

### Auto-ID Center

A non-profit organization that emerged from collaboration between private companies and academia which led the development of an internet-like global network for tracking goods globally through the use of RFID.

### Back Scatter

Method of communication between passive tags and readers where the reader's radio waves are reflected back to the reader and modulated to transmit data, usually at the same carrier frequency.

### Bar Code

A standard method of identifying the manufacturer and product category of an item (UPC) using lines of varying widths and spacing that are read by a scanner. Adopted in the early 1970s, barcodes can only be read individually, they must be visible to be read, with scanners requiring clear line of sight to read them and their information cannot be changed (new label is required).

### Battery-assisted Tag

These RFID tags use batteries to run the circuitry on the microchip but communicate using a back scatter technique like passive tags. Also called semi-passive tags, their read range is longer than passive tags because they don't use up the energy from the reader and reflect it back entirely.

### EAN (European Article Numbering)

The bar code standard used throughout Europe, Asia, and South America, administered by EAN International.

### **EAN.UCC**

The global bodies regulating data standards for product description in retail.

### **EPC (Electronic Product Code)**

An identification standard created by Auto-ID Center typically comprising a 64 or 96 bit number whose format is governed by EPCglobal. Each RFID tag contains a unique EPC which can identify manufacturers, product categories and individual items.

### **EPCglobal**

A non-profit subsidiary of the EAN.UCC international standards body with chapters in different countries and regions that controls the format of EPCs. The technology originally developed by Auto-ID Center is being commercialized by EPCglobal.

### **GTIN (Global Trade Item Number)**

A unique identifier for each product.

### **High Frequency Tags**

RFID systems that operate at 13.56 MHz with a typical maximum read range of up to 3 feet. High Frequency tags transfer data faster than low-frequency tags, but consume more power.

### **Low Frequency Tags**

RFID systems that operate at about 125 kHz with a typical maximum read range of up to 20 inches. They are less subject to interference than UHF tags, but their data transfer rate is slow.

### **ONS (Object Name Service)**

Object Name Service is a directory similar to the Domain Name Service which points computers to sites on internet. It is an Auto-ID Center designed system in PML format for looking up unique EPCs and pointing computers to information about them.

### **Passive Tags**

An RFID tag without a battery. These are the most common RFID tags in which radio waves from a reader are converted into energy by the chip's antenna which "wakes up" the tag and provides the power for the tag to operate. The tag is then able to send back its information stored on a chip. Passive tags can range in price from 20 cents to a dollar and these prices are expected to come down further.

### **PML (Physical Markup Language)**

PML was designed by Auto-ID Center as a method of describing products in a manner that computers can understand. It is a subset of XML that allows the attributes of physical items to be described in a standard way that can be interpreted by any PML-compliant application.

### **Reader**

It is a device used to communicate with RFID tags and retrieves information from tags using radio waves. Readers generally have one or more antennas which generate radio waves and receive information back from the tags and transmit the data to host computers or peripheral devices.

### **RFID (Radio Frequency Identification)**

RFID is a technology that allows data held on a microchip to be broadcast with a wireless transmitter using radio waves. RFID allows faster reading than barcodes as many tags can be read simultaneously and data from the chip can be read even without line of sight. An RFID system consists of a tag with an antenna that contains information identifying an item and a reader that communicates with the tag to read the information stored in the tag's memory. RFID tags can be active, passive or semi-passive.

### **Savant**

A software architecture developed by EPCglobal that acts as middleware to filter and manage the high volumes of data from EPC readers and pass on to enterprise systems. Many of the functions of Savant are now being incorporated in commercial middleware products.

### **Ultra-High Frequency (UHF) Tags**

RFID systems that operate at multiple frequencies between 866 MHz to 960 MHz. They can send information faster and farther than high or low frequency tags, typically 3 to 10 feet, and in the case of the 915 MHz band, over 20 feet. They are more expensive and use more power than low frequency tags.

### **UPC (Universal Product Code)**

The barcode standard used in North America and administered by the Uniform Code Council.