



The True Cost of Radio Frequency Identification (RFID)



How RFID Is Changing the Business Environment Today

Radio frequency identification (RFID) technology has been in use for several decades to track and identify goods, assets and even living things. Recently, however, RFID has generated widespread corporate interest as a means to improve supply chain performance. Market activity has been exploding since Wal-Mart's June 2003 announcement that its top 100 suppliers must be RFID-compliant by January 2005. Mandates from Wal-Mart and the Department of Defense (DoD) are making many companies scramble to evaluate, select and implement solutions that will make them compliant with their customers' RFID requirements, and additional retailers and other large supply chain channel masters are likely to follow suit.

What's driving this huge surge of interest? It's the promise of highly automated tracking of goods and assets from "cradle to grave" as they move throughout supply chain processes, proactively communicating information about their identities, locations and even histories to supply chain systems—without the human intervention generally required with bar code-based systems. The ability to ensure a high level of security for goods, facilities and people is also at the forefront of RFID benefit discussions. The results of this improved flow of information include:

- **Substantially reduced pipeline inventories**
- **Reduced operating costs**
- **Improved customer service**

Reaching this nirvana, however, will take time—likely many years. RFID costs, technology maturity and other factors ensure that RFID and traditional bar code processing will need to co-exist in most supply chains for a long while. Because of this, it is important to devise a technology strategy that incorporates both types of technology and allows you to select the appropriate solution depending on the situation. Equally important is the ability of your system to accommodate the changing business requirements and processes you must incorporate as you navigate the unpredictable waters of RFID adoption.

Nonetheless, the need to meet RFID compliance requirements immediately and over the long term is driving a flurry of RFID activity by both users and RFID vendors. Whether you are preparing to meet these compliance requirements or are evaluating opportunities to drive internal improvements through RFID process enablement, the information is unclear and confusing. In fact, there is a seemingly unending stream of conflicting information surrounding the benefits of RFID versus bar codes; the true costs of tags, readers and new software; where the technology really stands in terms of performance; and how to use the technology internally to drive ROI.

What You Will Learn in This Report

As a supply chain professional, you need clear information that will help you sort RFID reality from the hype, make investments that support your business for years to come, and pick technology partners that will empower you to effectively meet your project goals. Whether you will be required by a customer or partner to implement RFID in the near future or will look to adopt RFID-based solutions for your own needs, it is critical that you become educated now. This report provides an excellent foundation for understanding RFID and how you can take advantage of this technology to meet internal requirements or external customer mandates.

This report will cover the following topics:

- I. RFID Technology Overview:** An introduction to RFID technology and how it works.
- II. Is Now the Time for RFID:** A review of the benefits that RFID brings to the table above other technologies.
- III. Bar Code and RFID Co-Existence:** It isn't an either/or decision. It's critical to your success that you understand how these two technologies can and should co-exist during the early stages of general adoption.
- IV. Is RFID Right for You:** Key questions that will guide you in your initial decision process regarding RFID's applicability to your company. Later in this report you'll find an RFID Application/Adoption Framework which will help you evaluate the scope of your project over time.
- V. Steps to Take to Implement RFID:** How to approach implementation to achieve maximum flexibility, efficiency and cost savings.

I. RFID Technology Overview

If you are already familiar with the basics of RFID, feel free to skip ahead to a different section of this report.

Generally speaking, RFID is the automatic identification and tracking of items through use of an identification chip or "tag" that sends data to readers through wireless data communication. It is useful to think of an RFID system as one in which these tags enable items to "speak" about their identity, location, activity or history through readers and, ultimately, to application software that can process and utilize this information.

RFID technology is already being used in many applications, such as for toll booth automation and self-service retail processes (e.g., Mobil's SpeedPass). From a supply chain standpoint, RFID facilitates tracking of inventory and other assets at multiple points in the supply chain, potentially including the item's history as it passes through multiple owners or processes (such as an asset's repair history). Currently, most of the focus is on basic identification of an item as it passes through the supply chain. This is similar to the way bar codes are used, but with important advantages unique to RFID technology. Powering this vision is the prospect of having proactive visibility to the location and unique identity of each item in the supply chain. As Internet guru Esther Dyson has written, the revolutionary capability is being able to track in real time the identity of every item "both as a *kind* of a thing and as a *particular instance* of a thing."¹ Additionally, RFID eliminates the errors associated with the manual scanning of bar codes.

The Five Components of an RFID System

There are five key components of an RFID system, though there are many variations of each component and combinations of components. These are described below:

1. Tags (Transponders)

An RFID tag is comprised of a microchip containing identifying information and an antenna that transmits this data wirelessly to a reader. At its most basic, the chip will contain a serialized identifier, or license plate number, that uniquely identifies that item, similar to the way many bar codes are used today. A key difference, however is that RFID tags have a higher data capacity than their bar code counterparts. This increases the options for the type of information that can be encoded on the tag, including the manufacturer, batch or lot number, weight, ownership, destination and history (such as the temperature range to which an item has been exposed). In fact, an unlimited list of other types of information can be stored on RFID tags, depending on application needs. An RFID tag can be placed on individual items, cases or pallets for identification purposes, as well as on fixed assets such as trailers, containers, totes, etc.

Tags come in a variety of types, with a variety of capabilities. Key variables include:

"Read-only" versus "read-write"

There are three options in terms of how data can be encoded on tags: (1) Read-only tags contain data such as a serialized tracking number, which is pre-written onto them by the tag manufacturer or distributor. These are generally the least expensive tags because they cannot have any additional information included as they move throughout the supply chain. Any updates to that information would have to be maintained in the application software that tracks SKU movement and activity. (2) "Write-once" tags enable a user to write data to the tag one time in production or distribution processes. Again, this may include a serial number, but perhaps other data such as a lot or batch number. (3) Full "read-write" tags allow new data to be written to the tag as needed—and even written over the original data. Examples for the latter capability might include the time and date of ownership transfer or updating the repair history of a fixed asset. While these are the most costly of the three tag types and are not practical for tracking inexpensive items, future standards for electronic product codes (EPC) appear to be headed in this direction.

Data capacity

The amount of data storage on a tag can vary, ranging from 16 bits on the low end to as much as several thousand bits on the high end. Of course, the greater the storage capacity, the higher the price per tag.

Form factor

The tag and antenna structure can come in a variety of physical form factors and can either be self-contained or embedded as part of a traditional label structure (i.e., the tag is inside what looks like a regular bar code label—this is termed a 'Smart Label'). Companies must choose the appropriate form factors for the tag very carefully and should expect to use multiple form factors to suit the tagging needs of different physical products and units of measure. For example, a pallet may have an RFID tag fitted only to an area of protected placement on the pallet itself. On the other hand, cartons on the pallet have RFID tags inside bar code labels that also provide operators human-readable information and a back-up should the tag fail or pass through non RFID-capable supply chain links.

Passive versus active

"Passive" tags have no battery and "broadcast" their data only when energized by a reader. That means they must be actively polled to send information. "Active" tags are capable of broadcasting their data using their own battery power. In general, this means that the read ranges are much greater for active tags than they are for passive tags—perhaps a read range of 100 feet or more, versus 15 feet or less for most passive tags. The extra capability and read ranges of active tags, however, come with a cost; they are several times more expensive than passive tags. Today, active tags are much more likely to be used for high-value items or fixed assets such as trailers, where the cost is minimal compared to item value, and very long read ranges are required. Most traditional supply chain applications, such as the RFID-based tracking and compliance programs emerging in the consumer goods retail chain, will use the less expensive passive tags.

Frequencies

Like all wireless communications, there are a variety of frequencies or spectra through which RFID tags can communicate with readers. Again, there are trade-offs among cost, performance and application requirements. For instance, low-frequency tags are cheaper than ultra high-frequency (UHF) tags, use less power and are better able to penetrate non metallic substances. They are ideal for scanning objects with high water content, such as fruit, at close range. UHF frequencies typically offer better range and can transfer data faster. But they use more power and are less likely to pass through some materials. UHF tags are typically best suited for use with or near wood, paper, cardboard or clothing products. Compared to low-frequency tags, UHF tags might be better for scanning boxes of goods as they pass through a bay door into a warehouse.

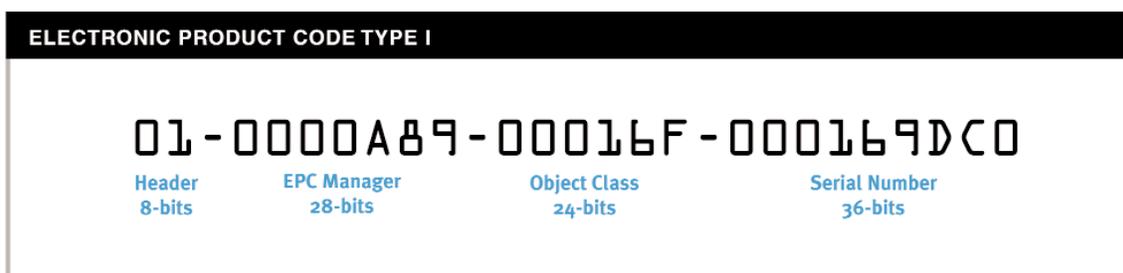
While the tag requirements for compliance mandates may be narrowly defined, it is likely that a variety of tag types will be required to solve specific operational issues. You will want to work with a company that is very knowledgeable in tag and reader technology to appropriately identify the right mix of RFID technology for your environment and applications.

EPC Tags

EPC refers to "electronic product code," an emerging specification for RFID tags, readers and business applications first developed at the Auto-ID Center at the Massachusetts Institute of Technology. This organization has provided significant intellectual leadership toward the use and application of RFID technology.

EPC represents a specific approach to item identification, including an emerging standard for the tags themselves, including both the data content of the tag and open wireless communication protocols. In a sense, the EPC movement is combining the data standards embodied in certain bar code specifications, such as the UPC or UCC-128 bar code standards, with the wireless data communication standards that have been developed by ANSI and other groups (e.g., 802.11b).

The current structure for an EPC compliant tag would resemble the following:



The EPC (version 1.0) is a number made up of a header and three sets of data, as shown in the figure on the previous page. The header identifies the EPC's version number. This allows for different lengths or types of EPC in the future. The second part of the number identifies the EPC Manager—most likely the manufacturer of the product to which the EPC is attached (i.e., 'The Coca-Cola Company'). The third, called object class, refers to the exact type of product, most often the SKU (i.e., 'Diet Coke 330 ml can, U.S. version'). The fourth is the serial number, unique to the item. This tells us exactly which 330 ml can of Diet Coke is being identified. This makes it possible, for example, to quickly find products that might be nearing their expiration date or to manage product recalls (e.g., for contamination issues).

There are potentially other elements of the EPC standard, including emerging wireless protocol specifications and standards for looking up referential data about the product over the Internet based on an EPC read, but these standards are far less developed than the structure of the tag data itself. The Auto-ID Center has recently turned over work on these standards and applications to a new organization called EPCglobal, a subsidiary of the Uniform Code Council. Most consumer goods and retail channels (such as Wal-Mart), as well as many others, can be expected to adopt some or all of the emerging EPC specifications.

2. Readers

The reader/writer sends an RF signal to tags to request the information contained on the chip. Upon receipt of this information, it is translated into a digital form and sent to the application software.

Again, there are a variety of different reading systems and technologies. These include: (1) Hand-held readers that act much like a hand-held bar code scanner, meaning they are tethered to portable data collection devices or to fixed terminals/PCs running application software; (2) RFID readers embedded into mobile data collection devices. This would typically mean an RFID reader that is internal to a portable wireless data collection device such as those used in warehouses, shop floors and by transportation personnel; (3) Fixed readers, which are mounted to automatically read tags as product passes by or near them. Examples include readers mounted on conveyor equipment, readers mounted on entry points to the back room of a retail store, "portal readers" placed at dock locations to automatically read tags as product is shipped or received, and readers mounted on material handling equipment.

Reader requirements will vary depending on the type of tag (e.g., passive versus active) and application usage. Again, you can expect that almost all applications will require multiple forms of readers to make a successful system, such as hand-held or embedded readers in mobile data collection devices and fixed readers at dock door locations. In the future, as reader costs decline and the use of RFID increases, we can expect many more fixed station readers throughout a facility to automatically track a product's movement without requiring an operator to scan the item.

3. Encoders

Unless a company uses a read-only tag serialized from the tag manufacturer, the capability to write data to the tag will also be necessary—whether this capability is once or many times, depending on the type of tag (as previously described). Readers themselves can and often will serve as the 'write' or encoding mechanism, but not always. Many companies will also use a new generation of traditional bar code printers that can print both human-readable data content and bar codes, while simultaneously writing data (serial number, etc.) to a tag inside the label construction. This can ensure, for example, that the serial number on the label bar code is the same as the serial number on the RFID tag.

4. Middleware

This refers to specialty software that sits between the reader network and the true application software to help process the significant amount of data coming from the tags and readers. For example, sending only one "transaction" read after a reader submits multiple reads of the same tag. More specifically, RFID middleware provides the following functions:

- **Reader interfaces:** Middleware provides drivers to retrieve data from the readers of various hardware manufacturers.
- **Data filtering:** Not every tag will be read just once, and sometimes a tag is read incorrectly. Middleware uses embedded logic to aggregate, purge and filter tag data, thereby 'cleaning' the data feeds to the application software.
- **Reader coordination:** By monitoring multiple readers, middleware can detect the movement of RFID tags as they pass from the read range of one reader to another. This directional movement detection can be captured and passed on to the application software as an inventory movement notification.
- **System monitoring:** Middleware will monitor tag/reader network performance to generate a real-time view of tags being read. It may also capture history and analysis of tag-read events for application tuning and optimization.

5. Application software

To drive value from RFID, or even to manage the process flow for RFID compliance requirements, you must deploy RFID-enabled software that processes RFID data, controls workflows and business transactions, and passes RFID data on to other systems (such as EDI translators or ERP software) as required. Thus far, much of the publicly available information on RFID has been on the hardware aspects of the technology (tags and readers) or the description of business applications at a high level. Yet, the requirements and role of application software to utilize the technology and deliver business value is absolutely critical, whether in a compliance scenario or in driving internal supply chain improvements. Regardless of the type of RFID application(s) you choose to implement, your selections must empower you to deploy RFID quickly and cost-effectively—and without disruption to your existing operations and customer relationships. Even if your RFID requirements today are minimal, you will likely need to adapt your operations over time to incorporate new compliance mandates. This is a consideration you should keep at the forefront of discussions with potential vendors. You will find additional information on vendor selection toward the end of this report.

Many types of application software can and will be used to support RFID-based operations. Some of the most common include:

- **Compliance enablement:** Software to help companies meet the specific RFID requirements of their customers. This software automates processes around tagging for customers that require it, collecting RFID tag data in shipping, printing RFID tags or Smart Labels, creating advance ship notice (ASN) data based on RFID reads, etc.
- **Logistics/WMS:** RFID will enable new levels of tracking and fulfillment processes in logistics and warehouse management (WMS) software. New workflows to take full advantage of RFID capabilities (e.g., automated RFID receiving) will need to be created in existing WMS systems to offer advantages beyond those available with traditional bar coding today.
- **Supply chain visibility:** As an extension of warehouse management, RFID will be used to achieve real-time visibility to goods across the supply chain, including international movements, tracking of inventory across company facilities and during the transportation process, and as goods move among trading partners.

- **Shop floor control:** Manufacturing and shop floor software will enable products (raw materials, work-in-progress and finished goods going to distribution) to be tracked in real time. Production-related data (such as lot and batch number) might also be written to the tags for downstream use. Asset tracking software supports tracking of a variety of fixed assets (trailers, reusable containers, etc.) in real time (where are they now?) and over the entire product lifecycle (how many times has this asset been used?).

RFID application software is perhaps the most difficult component of the system to evaluate—yet also the most critical for powering your potential RFID project. What should you look for? Below are some important attributes:

- **Compliant:** As appropriate for your situation, your software vendor should be knowledgeable about and fully compliant with the requirements of customers mandating RFID tagging.
- **Flexible:** Given the early state of much RFID technology, you should look for a vendor that:
 - Provides a platform flexible enough to meet both current and emerging requirements
 - Can easily handle both bar code and RFID processing
 - Can quickly react to changing technology and standards developments

Flexibility will be critical in the rapidly changing world of RFID. Specifically ask potential vendors how they will address these adaptability issues.

- **Process-oriented:** Moving to RFID is all about process change and adopting new logistics and manufacturing workflows. A software provider that is process-oriented and can easily facilitate new and changing workflows will offer great benefits down the road.
- **End-to-end:** Many software vendors only address part of the potential RFID footprint (WMS, compliance, visibility, etc.). As the greatest benefits from RFID will come from using RFID information across supply chain functions, you should give preference to vendors that can address multiple supply chain processes from supplier to customer—even if you don't plan to tackle those areas immediately. These application areas might include yard, transportation and event management; trading partner enablement and collaboration; and data collection.
- **Integration expertise:** Making RFID data collection work with software applications will take expertise, especially given the relative immaturity of the technology. As AMR Research Analyst John Fontanella has said, "With compliance as the first goal, take a hard look at companies that have deep data collection expertise, including many of the major Warehouse Management System (WMS) vendors as well as proven data collection specialists."² A software provider should have strong data collection experience and demonstrate its ability to integrate RFID networks and troubleshoot the inevitable problems.

Each of the technology components discussed in this section work together to create your RFID system. Understanding how each piece functions both on its own and as a part of the whole will help you evaluate potential vendors and find the solutions that best fit your unique requirements should you decide to pursue an RFID project.

II. Is Now the Time for RFID?

For many, the answer to this question is simple. The time for RFID is now because major customers such as Wal-Mart or the Department of Defense have already required vendor tagging or are likely to do so soon. They will be looking for compliance solutions that enable them to meet deadlines efficiently and cost-effectively, with an established path for future RFID utilization as other customer requirements and applications dictate.

Alternately, other companies seek benefits for internal purposes and are not yet required by a trading partner to implement the technology. For companies that have only modestly taken advantage of bar code technology, RFID can be the catalyst that starts a project to improve manufacturing and distribution operations through enhanced tracking, visibility and processing. Other companies have already implemented bar code tracking systems and more advanced technologies such as a WMS using bar code tracking. For them, making the decision to deploy RFID will be a matter of extracting further benefit from the use of RFID tags instead of or in conjunction with bar codes.

The Advantages of RFID Over Bar Coding

- 1. No "line of sight" requirements:** Bar code reads can sometimes be limited or problematic due to the need to have a direct "line of sight" between a scanner and a bar code. RFID tags can be read through materials without line of sight.
- 2. More automated reading:** RFID tags can be read automatically when a tagged product comes past or near a reader, reducing the labor required to scan product and allowing more proactive, real-time tracking.
- 3. Improved read rates:** RFID tags ultimately offer the promise of higher read rates than bar codes, especially in high-speed operations such as carton sortation.
- 4. Greater data capacity:** RFID tags can be easily encoded with item details such as lot and batch, weight, etc.
- 5. "Write" capabilities:** Because RFID tags can be rewritten with new data as supply chain activities are completed, tagged products carry updated information as they move throughout the supply chain. While "two-dimensional" bar codes like pdf-417 offer this capability to some extent, a new label must be printed and applied at each "event," making multiple "writes" impractical. Furthermore, bar codes cannot be attached to things like sensors to record environmental history.

RFID Benefit Summary

With the advantages derived from RFID, companies adopting RFID-based solutions have several ways to drive ROI and gain additional business benefits. The extent of this benefit will vary depending on your existing level of bar code automation, the planned application environment (e.g., compliance versus closed-loop—in which items begin and end at the same point and are tracked throughout), and other factors.

Strong returns from RFID usage are possible in the following areas:

- **Reduced inventory with real-time visibility:** RFID can enable real-time visibility to assets and goods across the supply chain. This empowers companies without strong bar code system support to gain these capabilities for the first time, while companies already using bar coding in manufacturing and distribution can achieve better tracking than is usually possible when relying only on operator-directed scanning.
- **Improved control and financial settlement:** RFID can be used to improve processes now plagued by inaccuracy, such as deliveries to customers where there are discrepancies about what was actually delivered and received.

- **Reduced labor costs:** Because RFID does not require a line of sight and enables more automated reading, it can reduce labor in manufacturing and distribution while ensuring highly accurate processes. Some estimates say it takes up to seven seconds for a single bar code scan. The time is often increased if an operator has to physically move first, such as getting off a fork truck to scan a pallet.
- **Increase efficiency and product flow:** RFID eliminates many manual and paper-based operations, such as paper "travelers" that follow an item through the manufacturing process. RFID reduces the number of manual activities associated with information flow and product hand-offs between steps, as well as processes and functions (i.e., automating receiving activities). Eliminating millions of scans per year can drive measurable productivity gains. RFID offers the potential of eventually moving toward a totally "hands-free" warehouse or shop floor by replacing human bar code scanning, which will unleash yet another wave of productivity gains.
- **Improved decision-making:** RFID provides real-time visibility to supply chain assets and gives operators (such as repair technicians) detailed product information right from the tag. This provides a strong foundation for improved decision-making and often speeds processing.
- **Goods authentication:** With highly accurate product tracking, RFID can reduce losses from shrinkage and counterfeit goods, which is critical to many industries. Immediate identification of legitimate product and source tracking for "gray market" goods are also possible.
- **Improved supply chain integration:** RFID tag data can be the "information glue" that enables multiple parties in the supply chain to connect regarding the flow of goods. Although this is the goal of the EPCglobal network currently being developed under the auspices of the Uniform Code Council, it can be accomplished even without the network infrastructure being built by EPC.

Current Limitations of RFID

Obviously, these potential benefits need to be weighed against the potential costs in tags, reader infrastructure and application software support. The good news is that tag and infrastructure costs continue to decrease. Today, users can expect to pay about 20 cents for a standard EPC-compliant tag. Readers are priced at approximately \$1,000 each. Most experts, however, predict the "five cent" tag will be here by 2006, and reader prices are expected to decline to a few hundred dollars each.

In addition to considerations about RFID tag and reader costs (at times, it's simply not cost-effective), there are other practical limitations to keep in mind. The lack of globally accepted standards for radio wave frequency causes problems for supply chains branching into the international space. The lack of accepted standards also means that tags from one provider may prove unreadable by another provider's readers. Other limitations stem from the process of readers sending out signals to tags and receiving the required information. Signals from different readers can interfere with one another if coverage areas overlap (reader collision), and tag collision can occur when two tags send information simultaneously.

Despite current tag prices and some of the aforementioned limitations, there are many applications for RFID today that can provide solid ROI and serve as a platform for additional future application (i.e., container tracking and choke point applications). Many companies will also be facing customer compliance mandates that must be acted upon. These companies will explore all of their options for meeting these requirements effectively while determining whether they can also drive internal benefits from their investment in RFID.

But this will all take time. The reality is that most companies will need to adopt a co-existence strategy for bar codes and RFID that recognizes both technologies will have a place in their supply chain operations for many years.

III. Bar Code and RFID Co-Existence

Companies need to recognize that the choice is not between bar codes and RFID, but rather a determination of where to intelligently use each technology to achieve the highest level of benefits. Even those companies building toward an advanced vision of proactive, RFID-based automated identification and tracking of all goods throughout the supply chain must recognize both technologies will need to co-exist in their supply chains for many years.

For example:

For many years, some advanced customers may require RFID tagging, while others will continue to rely on bar code identification.

- Per-tag costs and other considerations may mean that one unit of measure (e.g., pallets) will receive RFID tags, while another (e.g., cartons) will be identified using bar codes.
- The rollout of the required infrastructure (readers, software) will be phased, meaning some facilities and processes will be "RFID-ready" before others.
- Given the early challenges with reading and processing this still-maturing technology, bar code back-up will usually be required.

These are just a few of the many examples of why bar code and RFID co-existence should be the center point of your RFID thinking for the next three to five years—and perhaps indefinitely. The need for co-existence will impact adoption strategies overall for both RFID and supply chain technology. It will also significantly influence the selection of the right supporting application software (WMS, shop floor tracking, compliance enablement), and physical scanning and tag reading infrastructure that will support the co-existence requirement.

Given the need for co-existence, the ideal software solution would be one that easily enables you to configure the application to use RFID, bar codes or both. The configuration tool should empower selection of the appropriate technology by customer, supplier, process, ship-to location or even individual SKU. Not having this flexibility will make it difficult or impossible for you to accommodate a variety of different and ever-changing requirements.

For example, Wal-Mart's initial requirements mandate RFID tagging only for shipments to a few of its distribution facilities in Texas. Companies need to be able to easily create RFID labels, adjust shipping processes and collect RFID tag data only for those Wal-Mart orders going to the RFID-enabled distribution centers. Other Wal-Mart orders and other customer shipments are processed as usual. Over time, additional Wal-Mart shipments will also require RFID processing, as may those for other customers, perhaps with tagging requirements different than Wal-Mart's.

Receiving processes also provide an example of the potential need for RFID/bar code configuration. Perhaps receipts from company-owned facilities initially come in with RFID tags, while those from outside suppliers use bar codes. The software should be able to distinguish those receipt types and automatically trigger the appropriate handling, tagging and labeling steps.

This kind of application software configurability will be necessary to smoothly manage the bar code/RFID co-existence reality, easily meet multiple processing requirements, and migrate from one auto ID technology to another over time.

IV. Is RFID Right for You?

Following is a list of questions that can help you begin to assess whether you should take a closer look at RFID:

- *Are you a supplier to Wal-Mart, the Department of Defense, or other major retailers?* If yes, you may be faced with compliance requirements today or in the near future.
- *Do you have real-time inventory visibility in your warehouses or across your supply chain?* If no, RFID may be the right technology to help you achieve better inventory control.
- *Are your current receiving and shipping processes cumbersome?* If you are using manual receiving and shipping, or if bar code scanning still involves a significant amount of labor, RFID may alleviate these logistics choke points.
- *Do you have fixed assets that are not well-tracked throughout the supply chain?* If yes, RFID may be the ideal technology to gain improved visibility and control.
- *Do inaccuracies/discrepancies in accounting for goods in trading partner commerce lead to inventory or invoice adjustments, manual reconciliation or other problems?* Automated RFID reconciliation of deliveries versus receipts can eliminate discrepancies and shrinkage.
- *Do you have products that require lifecycle tracking or are subject to counterfeiting and gray market channel activities?* RFID can uniquely and instantly identify legitimate goods and help trace gray market channels.

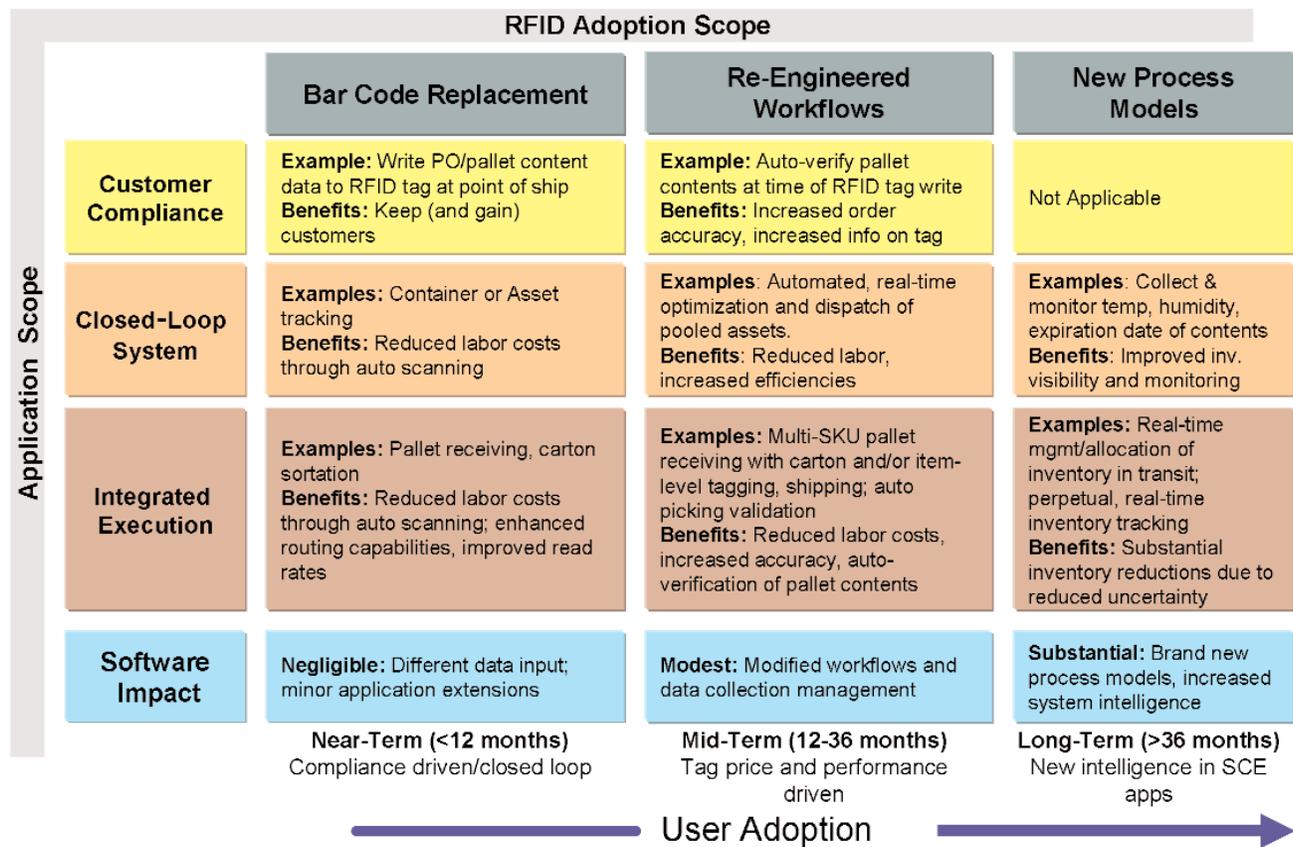
The framework on the next page was developed to help you understand the types of opportunity and effort involved in RFID initiatives. This framework identifies RFID opportunities along two variables:

- 1. Application scope:** Is the potential application compliance-oriented, an internal closed-loop application, or an application that will go across intra- and inter-company processes and facilities?
- 2. Deployment scope:** Will the use of RFID be most closely characterized as a bar code replacement, use some of the inherent advantages of RFID through re-engineered workflows of existing processes, or enable completely new process models that take maximum advantage of RFID capabilities and data?

This analytical framework can help you appropriately consider the overall scope of your application thinking—both now and over time. It provides specific examples of the types of applications falling into each category of deployment.

As one would expect, the impact on application software (i.e., how many new capabilities must be added) increases as you move from left to right across the deployment scope. This is true whether a company is trying to build application software support internally or understand the capabilities of third-party software vendors.

RFID Framework



This framework will help you clarify the types of RFID applications to consider, determine initial project goals, and create a vision for where you will ultimately move using the technology.

Vendor Evaluation

Regardless of which of the above-mentioned application scopes best describe your business, it's critical that you find a software vendor (compliance, WMS or otherwise) that offers the types of solutions that will fit your requirements. With the need for co-existence between bar codes and RFID, the software you select must allow you to adapt your processes and move seamlessly to other application/adoption scopes. A flexible system architecture is key to ease and cost-effectiveness of migration over time. The architecture of legacy systems tends to be too rigid to support rapid changes, which would hinder your ability to adopt additional RFID capabilities when business and customer requirements shift—often at a moment's notice. In-depth knowledge of what a system offers in terms of functionality and flexibility arms you with the decision-making criteria you require to complete a true evaluation of each solution you are considering. Ultimately, this knowledge will allow you to determine a system's ability to quickly and cost-effectively meet changing customer and business requirements (key to maintaining competitive advantage), generate strong ROI, and provide low total cost of ownership (TCO).

V. Steps to Take to Implement RFID

There are a number of key steps to take in evaluating the opportunities RFID could hold for your business and understanding the potential ROI these opportunities can derive. The following guidelines will improve this process:

- 1. Understand your compliance landscape in detail:** If you are facing compliance mandates today or suspect that you will in the future because you supply retail customers or the Department of Defense, begin assembling detailed compliance requirements. Ask your customers about their RFID plans. Make sure you understand current requirements in significant detail. Many companies have received fines or had trouble with customers because they did not completely understand bar code labeling requirements. Disseminate compliance information to multiple functions within your company so that everyone is ready to contribute to achieving compliance.
- 2. Designate an internal project champion:** At least one person should be designated as the lead for understanding and driving RFID adoption. A broader team from IT, operations, sales, etc. will be appropriate as you move further down the path.
- 3. Evaluate current manufacturing and distribution workflows for improvement opportunities:** By looking at both physical and information flows, you can see where the lack of accurate, real-time information is adding cost or hampering efficiency. Performing a cost/benefit analysis on a process-by-process basis will enable you to determine where RFID makes sense in a particular environment. You'll probably find that in some cases, traditional bar coding may be the best choice, while in others the additional capabilities offered by RFID may solve the problem. Recognize the best answer will often involve a combination of technology approaches.
- 4. Understand your scope of deployment, both initially and over time:** Use the framework shown earlier in this report to understand your project goals. Does the project represent a compliance, closed-loop or integrated supply chain process scope? Is the goal to incrementally improve on bar codes, significantly re-engineer existing processes through use of RFID, or develop substantially new process models and capabilities?
- 5. Build a business case with real teeth:** Of course, with the exception of urgent compliance requirements, you will need to develop a strong business case to receive project authorization and funding. The key is to develop one that is based on detailed analysis, and that will serve not just to receive project funding but to measure the success of the project itself.
- 6. Incorporate flexibility into your strategy:** Recognize that technical and application developments are likely to evolve rapidly, and that bar code and RFID co-existence will be the rule for many years. In some cases, companies may actually go back and forth between the two technologies. For example, a customer may decide after asking you to participate in an RFID pilot that they will stay with traditional bar code processing for some time. Both technologies will have a place, often in parallel, and given the dynamic nature of today's supply chains, it is a mistake to develop a plan that does not consider the need for co-existence and flexible response to changing requirements. The key enabler of flexibility will be the capability of your application software in logistics, manufacturing or compliance to easily support either bar code or RFID processing, and to be able to do so through simple configuration by process, customer, supplier, etc.
- 7. Lay out a multi-phased implementation:** Few companies will approach RFID with a "big bang." Your strategy should include a phased approach that details the rollout of applications, facilities and processes over time, as well as the metrics which define the success necessary to move on to each subsequent phase.
- 8. Use intelligent pilots:** In a new area such as RFID, piloting the technology in a limited application first is key. However, too many companies are doing pilots without a clear end result in mind. RFID pilots should have very specific objectives and be tied closely to the business case originally developed, with clearly defined metrics and reporting.

With these steps, you maximize the success of your project while ensuring your company's long-term competitive advantage and continued ability to meet customer demands.

Choosing the Right Path

The adoption of RFID technology is a fundamental shift in supply chain processes for which all businesses should be prepared. While Wal-Mart and the DoD will require RFID tracking to be implemented as early as 2005, others will take a slower, more cautious approach. With the information provided in this report, you now have a stronger understanding of how RFID works, how it can impact your supply chain operations, and how to approach implementation when the time is right. Above all, it is critical to remember that a strategy of co-existence with RFID and bar codes is the best way to ensure your ability to meet a variety of customer requirements while protecting your company's bottom line.

¹ Esther Dyson: "RFID: Logistics Meets Identity" Report, June 2003

² John Fontanella, *AMR Research Alert*, "RFID in a Box: Pandora's or Panacea?" Dec. 4, 2003

About HighJump Software, a 3M Company

HighJump Software, a 3M company, is the global leader in providing highly adaptable, best-of-breed supply chain execution solutions that streamline manufacturing and distribution from the point of source through consumption. HighJump's tightly integrated solutions empower operational excellence in the warehouse and optimize the flow of inventory throughout the supply chain by facilitating collaboration with customers, suppliers and trading partners. These comprehensive solutions combine robust, standard functionality, a best practices-based implementation methodology, and a uniquely adaptable architecture that facilitates fast, cost-effective system modifications. The result: the industry's lowest total cost of ownership for more than 700 satisfied customers worldwide. As part of the 3M family, HighJump leads the industry in financial strength and delivers on an unmatched commitment to innovation and quality. HighJump leverages these advantages to continually expand its solution footprint and empower operational excellence for domestic and multinational customers.

About Microsoft

Founded in 1975, Microsoft (Nasdaq "MSFT") is the worldwide leader in software, services and Internet technologies for personal and business computing. The company offers a wide range of products and services designed to empower people through great software—any time, any place and on any device.

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