Demystifying RFID in the Supply Chain

An Overview of the Promise and Pitfalls

UPS Supply Chain Solutions℠

Our Insight.
A UPS Supply Chain Solutions
White Paper

Introduction

Imagine that on your way to work, a traffic light at a major intersection flashed red, yellow and green, all at the same time. Should you stop, proceed slowly or accelerate? Many companies are facing a similar predicament when considering Radio Frequency Identification (RFID) technology as a new tool for supply chain efficiency. Should they embrace it, if so when, what are the potential benefits, and what are the potential pitfalls?

RFID is essentially a carrier technology that best fits under the umbrella of automatic identification.

Recently, Wal-Mart and the Department of Defense (DOD) told their top suppliers to begin tagging cases and pallets with RFID tags by January of 2005. The balance of Wal-Mart suppliers are expected to comply with RFID tagging by 2006. Tesco and Target Stores have recently told their suppliers to prepare shipments with RFID tags. The impact of this goes far beyond those under compliance pressures today. Indeed, Gartner anticipates that by 2012 most "enterprises will be forced to redesign their value chain processes as a result of RFID changing the storage, collection, and use of data concerning goods in the supply chain."[1]

Not surprisingly solution providers are lining up to help these firms become compliant and RFID ready. To equipment providers, software companies, and systems integrators, there is a virtual gold rush to capture the new market. Add this to the processes and products, once considered off limits for RFID applications are now on the radar screen for improvement. If predictions are true, then the RFID market will approach $3 billion by 2009.[2] The stakes are high for competitive positioning and the time is right to develop an RFID strategy.

Simplifying the Technology – An Overview of RFID

RFID is essentially a carrier technology that best fits under the umbrella of automatic identification. The Electronic Product Code (EPC) is the more specific term for an entire system that is planned for companies to more effectively track and manage assets. This new identification system has the characteristics of interoperability and open standards backed by EPC Global, a partnership of the Uniform Code Council and European Article Numbering International (EAN). The components of an EPC system enabled by RFID are:

Electronic Product Code – a metacode data structure developed by the Auto-ID Center to uniquely identify virtually any kind of physical asset, such as a pallet or a consumer product. The EPC structure can adopt other industry standard coding schemes into its structure. The number is contained in a radio frequency tag as a license plate, indexed to a store of related information. The EPC is expected to replace the 12 character Universal Product Code (UPC) over time.

RF Tags – hardware components that carry the data about the item, including the EPC. There are many classes of tags that scale in functionality and cost. Passive tags are less costly, derive their power from the reader's magnetic field and generally have short read ranges. Active tags have their own power source, longer read ranges and are generally much more expensive than passive tags.

[1] Prediction – By 2008, RFID and e-tagging technologies will drive broad application innovation, Gartner, Inc., SPA-21-6374, December 03, 2003.
[2] "RFID: Smart Tags, High Costs," ComputerWorld, December 15th, 2003

Tag Classifications

CLASS	COMMENTS
Class 0	Read-only: passive identity tags
Class I	Write-once passive identity tags. It is possible to unlock a Class I tag for rewrite.
Class II	Read-write passive tags with added functionality, e.g., memory or encryption
Class III	Semi-passive RFID tags
Class IV	Active tags- communicate with readers and other tags on the same frequency band
Class V	Essentially readers – can power Class I, II and III tags as well as communicate with Class IV and with each other

Radio Frequency Bands

FREQUENCY	BENEFITS	DRAWBACKS	COMMON APPLICATIONS
LOW 9-135 KHz	• Accepted worldwide • Works near metal • Inside use today	• <1.5m Read Range • Impractical for warehouse operations • Not in EPC Standards	• Animal ID • Beer Kegs • Auto Key & Lock • Library Books
HIGH 13.56 MHz	• Accepted worldwide • Works near metal • Inside use today	• <1.5m Read Range • Does not work near metal	• Item level tracking • Airline baggage • Building access
ULTRA HIGH 300-1200	• Longer read range potential, > 1.5m	• Not readily useable in Japan • Does not work in moist environments • Detuning when tags in close proximity	• Case, pallet and container tracking • Truck and trailer tracking
MICROWAVE 2.45 OR 5.8 GHz	• Longer read range potential, > 1.5m • Growing commercial use	• No commercial use license in parts of EU • Complex systems development	• Access control (vehicles)

Antenna – wire, coil or printed conductive inks that transmit or reflect radio waves. Antennas are always part of a reader system - some readers have separately attached antennas, while other readers have integrated antennas.

Reader – also know as an "interrogator," this is a data capture device that communicates with tags, savants and computer networks.

Savants – local data repositories for EPCs and linked information; also support middleware that brokers information through PML (Physical Markup Language).

Object Name Service (ONS) – the resource that points electronic inquiries to the location of EPC data. It is very similar to the common Domain Name Service (DNS) used to access internet addresses.

Throughout the distribution lifecycle, RFID readers capture and publish time and locations data to provide visibility to supply chain trading partners.

EPC Information Services – a suite of services, data structure and query language for data collection and sharing among trading partners.

A Simplified RFID Example: Manufacturer-To-Retailer Supply Chain

While there are many possible variations, a basic vision proposed for the RFID in a manufacturer-to-retailer supply chain is depicted as follows:

1. The manufacturer places RFID tags with EPCs on products or in packaging to enable item tracking, history file creation, and future trading partner use (e.g., retail point-of-sale).

2. The manufacturer references the EPCs for linking cartons or pallets for shipment building, package sortation, and Advanced Shipment Notification.

3. Throughout the distribution lifecycle, RFID readers capture and publish time and location data (at a minimum) to provide visibility to supply chain trading partners. Subject to implementation guidelines, the information would reside on servers accessed via PML queries using the Object Name Service described above.

4. The retailer or wholesaler receives the advance shipment notification containing the EPC information, and automatically posts the receipt upon goods arrival without human intervention.

5. At the retail store, checkout, inventory management and replenishment are automated because of RFID enabled capabilities.

It is important to note that these types of automated processes are possible only if the trading partners involved have collaborated and designed their business processes accordingly. Further, near-term efforts with RFID will focus upon pallet and carton level tagging, not item level tagging.

The Promise and the Pitfalls of RFID

Inventory obsolescence, pilferage, and stock-out are promising areas for RFID.

Within the realm of supply chain management there have been significant market inefficiencies that traditionally were considered out of reach because of the high costs required to address them or the lack of effective solutions. Some examples of these inefficiencies include “just-in-case” inventory costs, inventory obsolescence, pilferage and stock-outs. These are the areas where RFID is generating interest and the most promise – achieving greater supply chain efficiency.

The Promise of RFID

Recent advancements in RFID technology coupled with decreasing costs have allowed RFID to gain greater prominence and therefore a higher level of adoption. The following are examples of the unique capabilities offered by RFID:

Orientation independence – RF tags do not require line of sight as in the case of barcodes. This eliminates some of the additional steps required to orient the object toward the scanner

Information capabilities – Different tag types have a broad range of options for data content and read-write capabilities. The communication of this data could be harnessed for near real-time event management and decision making.

Asset security and monitoring – RFID can be coupled with sensors to record and store changes in temperature, movement or other environmental conditions.

Tag Durability – Barcodes can be easily marred or otherwise damaged in diverse operating environments and RF tags are typically much more durable.

Real-time data capture – For many companies, the "killer app" of this solution will be harnessing real-time data to drive business value. Being able to answer questions such as "where are the assets right now?" or "how many assets are there right now?" will allow firms to automate business processes and decision making.

Because of the perceived benefits of these features, more companies are implementing RFID and experiencing tangible results. The most prominent applications are:

APPLICATIONS	EXAMPLES
Process Automation	RFID events can trigger parallel and downstream processes
Asset Security	Anti-counterfeit, anti-theft, intrusion detection and environmental monitoring
Labor Reduction	Passive readers reduce scanning and handling labor
Compliance	Documents, product expiration, etc. can be indexed or stored on the chip
Inventory Management	"Smart" tags report physical inventory counts or movement
Asset Tracking	Accounting for unit load devices, vehicles, or other assets can be automated
Automated sortation	Packages, etc. sorted to correct dock door via tag information
Auto-replenishment	"Smart shelves" generate orders based on tag and inventory data
Payment processing	Automated authorization (e.g. pre-payment for gasoline purchase)
Returns processing	Verification of returnable status and product identity are on the tag or can be referenced through databases.

With RFID, Wal-Mart hopes to decrease stock-outs, which may cost as much as four percent of revenue, through better visibility.[3] Marks and Spencer, an English retailer, has already seen improvements in tracking high-ticket merchandise and lowering the volume of theft. The Department of Defense intends to realize real-time tracking of assets such as tanks, jeeps, and supply vehicles. Additional examples of companies implementing RFID include:

COMPANY	ITEM TAGGED	TAG PASSIVE	TAG ACTIVE	CHIP TYPE (MHZ)	READ	WRITE	YEAR	STAGE	OUTCOME
Harley Davidson	Bins carrying parts of custom motorcycles during assembly	•		13.56	•	•	1998	Rollout	Automatically displayed manufacturing instructions for employees at each stage of the assembly process
Toyota: Phase1	Carriers containing car frames as they move through paint stations during production	•		13.56	•	•	2001	Rollout	Streamlined manufacturing and vehicle tracking; saves on interest charges
TrenStar	Beer kegs as they move through the supply chain	•		125-128	•	•	2001	Rollout	Improved demand forecasts and increased efficiency; identification of black-market sales and elimination of misdirected shipments
International Paper	Cores of large paper rolls moving through the warehouse	•		915	•		2003	Running	Reduction of lost and misdirected paper rolls
Gap	Denim apparel through the supply chain and onto store shelves	•		13.56	•	•	2001	Pilot	Improved customer service through better inventory management on shop floor; increased supply chain efficiency and data accuracy
Raxel	Reusable plastic containers for carrying biohazardous waste	•		125-128	•	•	2002	Implemented	Avoid contamination by ensuring proper cleaning, asset visibility
Michelin Tires		•		905-928	•	•	2003	Running	Compliance with the TREAD Act and recall
Las Vegas Airport	Airline baggage tags	•		905-928	•	•	2003	Deployment	Automated rerouting of baggage and increased accuracy 99.5% up from 70%-85% accuracy with barcodes to ensure that they send each bag back to the right airline
Department of Defense	Shipping containers		•	433	•	•	1994	Rollout	90% reduction in the number of containers required

[3]"The RFID Imperative," CIO Magazine, December 1, 2003.

Who Benefits from RFID and How

Who benefits from RFID enablement will depend upon the applications and the trading partner relationships. As an example, the outlook for manufacturers is quite different from that of retailers. Proponents of RFID state that manufacturers can benefit primarily from:

- Reduced retail stock-outs, providing more volume and revenue to manufacturers
- Improved asset visibility, leading to improved asset utilization and working capital efficiency
- Real-time decision making capabilities – routing, sorting, recalls, etc.
- Improved product returns management
- Counterfeit prevention
- Obsolescence prevention

Manufacturers under a compliance mandate will experience little benefit from the effort unless they can effectively redesign business processes to internally take advantage of the event-based data. Time is of the essence for many of these firms to both meet compliance objectives and change internal processes for mutual benefit.

Retailers can see more immediate benefits when a critical mass of RFID tags are in place. Such benefits include:[4]

- Decreased inventory of as much as 5% of total inventory
- Reduced labor costs in stores and warehouses, as much as 7.5% has been estimated
- Reduced stock-outs, as high as 7% of revenues
- Reduced shrinkage by theft -- this is a multi-billion dollar issue
- Increased inventory accuracy
- Automated replenishment
- Counterfeit prevention
- Obsolescence prevention

BENEFITS OF RFID

Consumers can also benefit from RFID with improved service, availability of items, product and service quality, and more.

Consumers can also benefit from RFID, but it depends upon how retail unit tagging is carried out. The most common benefits possible are:

Improved service – potentially faster checkout avoiding traditional lines. Users would wave an RFID enabled card near a reader, instantly completing the purchasing transaction.

Improved availability of items – better visibility of products, allows for timely ordering, manufacturing, distribution, and restocking of goods.

Improved product and service quality – manufacturers could quickly locate and recall faulty products, even before they reach consumers.

The Pitfalls of RFID

Despite these enticing benefits, there are some issues with implementing RFID applications in the global supply chain. These issues are well known to the

[4] "AT Kearney Study Shows RFID Benefits For Retailers," www.itwebco.za, November 12, 2003.

More importantly, firms must determine how they will use the new data to change business processes.

industry and solutions are in development. We will examine some of the more prominent issues facing RFID implementation today that are important strategy considerations.

Cost

One of the major inhibitors of RFID growth has been the cost of tags. When firms multiplied tag costs by their annual volume, the extended costs did not make sense due to significant profit margin impacts. Now that tag prices have dropped and are projected to drop much further, the economics are more compelling. Order volumes for tags are beginning to portend future scale – a recent ten million unit tag order by International Paper is a prominent example.[5] Obviously, whether tags will be reused or disposed of will be a cost driver that should be considered. This will often be impacted by the level of partnering that can be achieved by downstream trading partners who would actually carry out any plans to return, reuse or discard the tags.

Tag costs are obviously the major variable cost component for RFID, but what about other related cost components? Software, systems integration, process redesign and organizational impacts will be significant and must be part of the business case as well. With the anticipated scale and scope of RFID deployment, tag costs are expected to continue their decline.

Tag Readability

Early adopters of RFID are developing processes to improve read rates and solution providers are fine tuning ... to improve readability.

This issue has been mentioned in the business press as a significant stumbling block, citing read rates in the 80%-90% range.[6] However, recent conversations with major companies in the testing phase cite read rates of nearly 100%. Whether readability is an issue may well depend on:

- tag frequencies and ranges
- reader capabilities and locations
- operating environment (interference from other devices, temperature, humidity, static, vibration, and shock)
- the type of assets being tagged (metal objects and liquid containing items tend to create problems for read integrity of passive tags)

RFID are developing processes to improve read rates and solution providers are fine tuning their products to further improve readability Real questions exist for just how to accurately read some items, especially if they are nested within a pallet. The scenario of using RFID for inventory certification and automated replenishment is obviously not achievable unless read percentages are high.

The good news is that early adopters of RFID are developing processes to improve read rates and solution providers are fine tuning their products to further improve readability. Given the increasing demand for RFID and its history of incremental improvement, readability issues will become manageable for most applications.

Data Management

What will be done with the new influx of RFID data? This question is a timely one, since most ERP systems and WMS systems are not designed for RFID data

[5] Matrics -IP Press Release- "10 Million Tag Order", December 16, 2003.
[6] "Zebra Technologies Makes RFID Tags Beep," AMR Research, December 3, 2003.

capture – both the data volume and its unique characteristics, such as the Electronic Product Code. The Electronic Product Code will occupy a larger data field than the Universal Product Code now in place. Software vendors have taken notice of these issues and are beginning to offer solutions. New structures for data management should be considered prior to any RFID investment. More importantly, firms must determine how they will use the new data to change business processes.

More importantly, firms must determine how they will use the new data to change business processes.

Data Ownership and Sharing
A self-contained RFID implementation for tracking high value assets would not be subject to the same issues as other implementations. The EPC vision where multiple trading partners post and retrieve item specific data as it progresses throughout the supply chain will be much more difficult to accomplish, due to the issue of data ownership. The benefits of sharing data among multiple parties can be significant – the willingness of the participants to do so has historically been a challenge.

Standards
Someone once said that the nice thing about standards is that there are so many to choose from, and RFID is no exception. As with other technologies, there are both proprietary and open standards for how data is structured, communicated and managed among trading partners and within applications. There are significant efforts underway by standards bodies to converge on common requirements, but there will be differences based upon applications and other factors. Tag operating frequencies will differ between the United States and other regions for quite some time. Support for open standards and multiple frequency readers make sense for global supply chains. These considerations should not be major stumbling blocks to determine the business value of RFID.

Business Process Changes
Process automation through RFID will require new work methods and performance measurements for the supply chain. The degree of difficulty will be comparable to that of other systems implementations, where significant impacts to process, organization and technology are commonplace. The design of any RFID strategy must consider new processes and procedures to automate tasks and decision making where possible, as well as consider organizational changes.

Privacy Concerns
While we may be several years away from individual retail item being tagged with electronic product codes, the media has focused on the concerns of individual privacy. The main concern is that consumers do not want themselves or the items they purchase to be tracked once they own the item. The industry has developed a "kill tag" feature that would disable the RFID functions once ownership is transferred at retail. Additionally, the inability to read tags from long distances should alleviate some fears of compromised privacy. Because privacy is so important, firms can expect this to be an issue for some time, with ultimate resolution through voluntary adherence to industry standards or through involuntary government regulation.

There are significant efforts underway by standards bodies to converge on common requirements.

Key Strategy Considerations

So what should firms be doing about RFID in light of the mixed messages? To gain strategic perspective on RFID, we recommend the following:

Conduct Education and Research

- Begin an RFID education effort with a dedicated team that is chartered to recommend and follow a course of action
- Research the standards development underway to ensure that the technologies under consideration will meet both domestic and global standards.

Build a Robust Business Case

- Ensure that decisions are fact-based, beginning with the high-level business case. A technology neutral partner who is experienced in RFID may be best able to assist you.
- The business case should include a comparison of RFID capabilities with traditional bar-code capabilities. There are unique differences between the technologies which may spell out clear applications for RFID. There are also some overlapping applications where optical barcodes will continue to be most appropriate.

Establish Requirements

- Analyze databases and business processes for the impact of Electronic Product Code requirements. Mandates are sure to come in this area.
- Determine the business needs for static data (beyond identification) to reside on the asset. The ability to reference dynamic data is often preferable to static data because of the need to change some characteristic or event linked to the asset.
- Do not underestimate the need to change business processes to achieve the automation and asset visibility that RFID can provide.

Pilot Before Implementing

- Invest in pilot tests to determine the capabilities and limitations of the software and hardware, as well as the true costs and benefits of RFID. Update the business case based upon the findings.

Plan

- For RFID mandates, determine how to balance compliance with the long-term interests of the business. Ensure that short-term investments in compliance can be scalable to address other customer and internal business needs.
- Plan for co-existence of barcodes and RFID for an extended period – to be measured in years.

Invest in pilot tests to determine the capabilities and limitations for the software and hardware...true costs and benefits....

Our Point of View

Despite the hype, the promise of RFID technology is real, and can provide increased asset visibility, enhanced information content and velocity. Equally as real are the pitfalls of RFID including cost, competing standards, technology limitations and privacy concerns.

Anticipate the ROI will be low, but future gains are possible by redesigning business processes.

Recent compliance requirements from Wal-Mart, Target, the Department of Defense and others will have a ripple effect across industries, ultimately driving significant adoption of RFID technology. The transition to RFID may not occur overnight, but this technology has been given a jump start by these industry leaders. Anticipate that return on investment for RFID will be low or non-existent initially, but that future gains are possible by redesigning business processes. Further, significant technical implementation and cost hurdles to RFID implementation should continue to drop over the next several years.

There are costs to both taking action and not taking action – the greater risk may be to ignore the opportunity. We recommend RFID education and development of the business case and pilot to size the potential benefits and adoption efforts. Finally, we recommend the design of an Auto-ID strategy with a focus upon how business processes and the customer experience can be improved.

About the Authors

Michael Sullivan is a Principal Consultant at UPS Supply Chain Solutions. Michael is based in Atlanta, GA and can be reached at msullivan@ups-scs.com

Susan Happek is a Principal Consultant at UPS Supply Chain Solutions. Susan is based in Atlanta, GA and can be reached at shappek@ups-scs.com.

To learn more about how our experience in supply chains and consulting can benefit your business, please contact us:

1.800.742.5727 U.S.
678.746.4365 International
Visit us at ups-scs.com

About UPS Supply Chain Solutions

By aligning a client's business strategies with its operating processes, UPS Supply Chain Solutions can create high-performance supply chains that from inception to implementation generate real, hard-number values and quick benefit realization. This distinguishing capability, our experience in solving real-world challenges, and the resources of UPS enable us to set strategies, design and build solutions as well as implement, operate, manage and synchronize your world of commerce.