Radio Frequency Identification (RFID) In The Consumer Goods Supply Chain:

Mandated Compliance or Remarkable Innovation?

An Industry White Paper

As major retailers such as Wal-Mart demand that their suppliers implement RFID tagging, companies struggle to understand this evolving technology and the role it will play in their future.

This white paper details research done on RFID at Rock-Tenn Company, a leading manufacturer of consumer packaging, promotional displays, and recycled paperboard, and makes recommendations for a sane path through the RFID quagmire.

Rock-Tenn Company

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Table of Contents

Forward

RFID Mandates Turn Up the Heat

RFID. Radio Frequency Identification. Is it a mandate from 800-pound industry gorillas, or a far-reaching innovation for the future of packaging, manufacturing, logistics, retailing, and the overall consumer goods supply chain?

Late in 2003, Wal-Mart announced a mandate requiring its top 100 suppliers to put RFID tags on all cases and pallets they ship to Wal-Mart's first distribution center to pilot RFID beginning in January 2005. Since that time, other retailers including Target, Albertsons, Best Buy, Tesco (U.K.), and the Metro Group (Germany), as well as the U.S. Department of Defense, have all announced RFID mandates of their own. Additionally, Wal-Mart recently announced that their next 200 top suppliers must meet their mandate requirement by January 2006.

In response to the growing number of RFID mandates, consulting firms worldwide are developing competency with RFID so that they can help companies address the complexities of deploying RFID. Meanwhile, RFID technology is changing rapidly as technology suppliers race to address the issues and opportunities associated with today's — and tomorrow's — RFID technology.

On a separate but related track, a few companies are pursuing RFID for gains in internal operating efficiency. Others are striving to differentiate themselves from their competitors by incorporating RFID as part of their product and service offerings. These initiatives include trials with item-level RFID tagging as well as collaboration between packaging and display companies, consumer goods manufacturers, and retailers to deploy smart shelving, intelligent displays, or other RFID-enabled strategic offerings. Companies such as MeadWestvaco, Smurfit-Stone, Georgia Pacific, and LG&P In-Store have all publicized such initiatives.

Questions to Consider

These RFID mandates, internal operating efficiency pursuits, and the drive for competitive differentiation raise a number of questions for businesses looking to take the plunge into RFID, including:

- ➤ When and how should we respond to the increasing number of RFID mandates?
- ➤ How can we justify an investment in RFID to comply with mandates, and who will pay for it?
- ➤ Can we leverage RFID internally, or will complying with RFID mandates add non-value costs to our supply chain?
- ➤ Should we deploy a slap-and-ship model or pursue a more-integrated RFID mandate compliance strategy?
- ➤ How complicated and costly is RFID deployment, and how will technology changes affect this complexity and cost?
- ➤ What are others doing? Is there a competitive advantage or disadvantage to being early? Is it risky to wait?
- ➤ Considering how rapidly RFID standards and technology are evolving, how can companies pursue RFID without great risk?

➤ How do focus, timing, and challenges associated with RFID differ for various businesses in the consumer goods supply chain?

➤ Does RFID offer opportunities for internal operating efficiency and/or competitive differentiation? If so, where?

➤ What's the business justification for RFID?

➤ What role does Information Technology (IT) play in RFID strategy and deployment?

Developing a Realistic Outlook for RFID

To address these and other questions about RFID, Rock-Tenn Company put together an RFID research team to investigate. The team attended conferences, met with consulting firms, read publicly available data on RFID experiences, spoke with our customers and RFID technology suppliers, and reviewed RFID intelligence offered by professional research firms.

We distilled the most relevant data from our research into this document, which we believe presents a practical outlook on RFID. We developed this white paper as a basis for our own strategic planning and now offer it to other companies that are looking to make sensible decisions around RFID. At the very least, we hope this white paper brings some clarity to the question, "RFID in the Consumer Goods Supply Chain: Mandated Compliance or Remarkable Innovation?"

Executive Summary

RFID is coming — major retailers such as Wal-Mart are demanding it. Late in 2003, Wal-Mart announced a mandate requiring its top 100 suppliers to put RFID tags on all cases and pallets they ship to Wal-Mart's first distribution center to pilot RFID beginning in January 2005. Other major retailers followed shortly after with mandates of their own. In the wake of these mandates, companies are struggling to understand whether RFID will simply be an added cost of maintaining business or a remarkable innovation that will transform our supply chain.

What Is RFID?

RFID has been around for years but has only recently been introduced to the consumer goods supply chain. RFID is similar to UPC codes and EDI (electronic data interchange), in the same way cell phones are similar to rotary dial telephones.

The way RFID works is that a tag is programmed with a unique number and attached to a case, pallet, or item. This tag is read by scanners (called *readers*) that do not need line of sight or human intervention. Tags are read just by moving within range of a reader.

RFID will allow an unprecedented sharing of information throughout our supply chain. Each RFID tag will contain a unique electronic product code (EPC) which is the key to all of the information about the tagged product, including what it is, when it was made, and where it has been. Information related to each EPC will be stored in a central location, sent to partners in the supply chain, or both, so that anyone who needs to access the information can get to it via the Internet.

RFID Is in Its Infancy

Does RFID throughout our supply chain sound too good to be true? Right now, in many ways it is. RFID is in its infancy and far from stable. There are many issues to work through, from improving and stabilizing the technology to working out process and data synchronization issues to bringing down the exorbitant cost of today's RFID deployments.

When discussing RFID issues, many point to the cost of RFID tags as their greatest concern. Though tag costs are certainly an issue, if tags were free and 100 percent reliable today, this would not materially change the dilemma most companies face in developing their RFID mandate compliance strategy. Tag cost will continue to decline and tags will become more reliable. Meanwhile, there are greater issues today that make RFID in our supply chain a real conundrum.

To further complicate things, RFID in our supply chain cannot be implemented in a vacuum. Instead, RFID must be deployed in a standardized and synchronized manner across the entire supply chain. It requires the creation and adoption of industry-wide standards, integration with internal business systems, and a significant investment in RFID tagging and reading equipment as well as supporting technology infrastructure.

The Benefits Wal-Mart and Others Expect from RFID

Wal-Mart wants an RFID tag on every case and pallet it receives. With these tags in place, Wal-Mart can eliminate many manual processes, including those in receiving, inventory management, shipping, and payables. Wal-Mart will also be able to reduce inventory shrinkage and out-of-stock situations by automatically tracking product movement. These and many other potential benefits are driving RFID mandates from Wal-Mart, the Department of Defense, and a growing number of retailers worldwide.

RFID Will Not Replace Barcoding

RFID and barcodes are both auto-identification technologies. Though some futurists believe RFID tags will eventually cost pennies and will one day be used for everything, even they agree this vision is years away. In the meantime, manufacturers will continue to use barcoded labels in the absence of RFID tags. While barcoded labels are generally reliable to read, current RFID tags are not always reliable and will not work with some products or in certain situations. Manufacturers will therefore continue to use barcoded tags indefinitely as a fallback for when RFID fails.

Slap-and-Ship May Be the Only Justifiable Choice

Companies have several choices for how to address RFID mandates, from less costly (but still costly) slap-and-ship models to more costly integrated models that incorporate RFID technology into many, and eventually all production or assembly lines. Regardless of the strategy they choose, companies will have to integrate their RFID tagging system with their internal business systems so they can collect, associate, and disseminate EPC data.

Most companies today cannot produce business justification for RFID. As a result, they have no choice but to deploy a slap-and-ship model to comply with RFID mandates.

Focus Is on Core Product Lines, Nothing Else

Many manufacturers in the consumer goods supply chain are developing their own RFID mandate compliance strategies. Invariably, manufacturers seem to be focused exclusively on their core product lines. This includes negotiating with Wal-Mart, other retailers, and the government about which product lines can be reliably RFID tagged at this time.

Virtually everyone we spoke with expressed little to no interest in RFID for promotional displays, multi-packs, or anything other than their core product lines. We believe the same is true for retailers, as everyone appears to be focused on the challenges just with cases and pallets of core consumer products.

Costs for RFID Mandate Compliance

Much of the focus surrounding the cost of RFID has been on the price of RFID chips or tags. But implementing a fully functional RFID system incurs multiple costs, including tags, readers, printers, middleware, infrastructure, consulting, R&D, system changes, implementation, training, change management, and service provider fees. There is also the cost for additional labor that will invariably be needed with today's RFID deployments.

RFID investments can grow considerably as more advanced capabilities are pursued, including more seamless plant floor and warehouse integration of readers and tagging equipment and specialized, network-connected tagging apparatus.

In addition to initial investment costs associated with RFID implementations, companies will also experience several recurring costs, including tags, technology maintenance, additional labor, ongoing R&D, and service provider fees as well as hardware replacements due to rapidly evolving technology.

Though the range of total investment will vary widely between companies based on many factors, in most cases, companies are looking at investments that can easily reach into millions of dollars. Industry analysts predict that typical, large-scale manufacturers in the consumer goods industry will spend from $9 to $25 million annually on RFID mandate compliance.

RFID Mandate Compliance Is the Top Priority, but Other RFID Opportunities Exist

While many companies pursue RFID mandate compliance, a few companies are pursuing RFID for gains in internal operating efficiency. Others are striving to differentiate themselves from their competitors by incorporating RFID as part of their product and service offerings, including trials with item-level RFID tagging, smart shelving, intelligent displays, and other RFID-enabled strategic offerings.

When pursuing these other opportunities, companies must still address technical challenges with today's RFID technology; but they can often avoid issues with industry standards, synchronizing data over the Internet, and disconnects in collaborative processes.

RFID Technology Suppliers and Consulting Firms

No one company can provide everything needed to implement RFID tagging. Instead, early adopters of RFID have essentially become general contractors because they've had to subcontract several aspects of RFID. Several early adopters have even contracted out their general contracting duties to consultants and, in some cases, delegated their RFID project management responsibility.

Choosing among RFID technology suppliers is important, but we believe choosing the right RFID consulting firm is even more critical. A well-chosen RFID consulting firm allows companies to leverage that firm's RFID experiential knowledge. RFID consultants can also help choose the best RFID components and technology suppliers to address the specific needs of each company.

Unfortunately, choosing an RFID consulting firm is as difficult as choosing among RFID technology suppliers. Furthermore, it appears that many consulting firms have very little to no real-world RFID experience and are selling only theories today. Since so much remains unclear, the current priority for many consulting firms seems to be with building their RFID competency in preparation for meeting real business needs in the future.

Issues with Item-Level Tagging Will Be Far More Complex

We speculate that today's complexities and issues with RFID will pale in comparison to those we are likely to see once item-level RFID tagging is pursued across our supply chain. With item-level tagging, the volume of tagging to be done will increase significantly. Accordingly, tag cost will become an even greater issue and slap-and-ship tagging models will become impractical, making inline tagging and speed an even greater issue with respect to RFID tagging apparatus.

Business Justification Not Possible at This Time, but Don't Wait

Long term, we expect RFID will increase revenue, reduce operating costs, facilitate optimization of assets, enhance safety and quality control, and much more. Unfortunately, we do not believe most companies can make a business case for RFID at this time. Instead, we believe meaningful RFID research and development is required before a clear understanding and related business case can be developed. Furthermore, we see a continuous need for R&D as RFID technology evolves and matures.

While every company has the option of taking a wait-and-see approach to RFID, we believe that this approach entails several risks, including:

➤ a company without a clearly articulated business strategy for RFID could see market-share erosion, particularly if its sales force cannot publicize the company's readiness for complying with RFID mandates,

➤ a company who waits may not have time to work through all the issues and challenges of RFID and may have difficulty developing and refining a strategy for complying with RFID mandates, and

➤ a company who waits may be forced to deploy less than optimal and much more costly RFID implementations once the need arises.

We are mindful of the desire to have a compelling business case for investing in RFID and of the inability to make a case at this time. Nonetheless, we believe it would be prudent for companies to spend a relatively small amount for initial RFID technology as a means to further understand the many aspects around the inevitable rise of RFID in our supply chain.

Information Technology (IT) Involvement Needed for RFID

RFID with an EPC-based framework is a business strategy, not an IT strategy. It involves transformation of business processes, market positioning for the sales force, and collaboration with customers, retailers, other supply chain partners, and third-party service providers. Nevertheless, developing and implementing an EPC-based RFID mandate compliance strategy requires heavy IT involvement along with a deep understanding of current business systems, IT infrastructure, and several facets surrounding the exchange of standardized data via the Internet.

We Recommend Getting in the Game

RFID is unlike any technology that we as an industry have seen in the past. It's extremely complicated and very costly, yet we believe it is inevitable that RFID will be a transformation agent throughout our supply chain for packaging, manufacturing, logistics, and retailing.

We believe companies need to develop several strategies for RFID. The first is for complying with RFID mandates. And though this will likely become the focus for most companies in our supply chain, we think it is not too early to at least consider strategies on pursuing RFID for internal operating efficiency and also on pursuing RFID for competitive differentiation.

To address the many obstacles that exist with RFID today, and to support each RFID-enabled strategy, we think companies need to pursue RFID research and development. We believe such a plan will lead to RFID mandate compliance and can also be leveraged for other RFID-enabled strategies.

To develop the best strategies for deploying RFID, we believe companies should consider the following:

➤ **Understand the Challenges:** Before developing an RFID strategy, it's critical that companies understand the challenges of deploying RFID and particularly the volatile state of the RFID industry. We recommend that companies begin building this understanding by forming RFID research teams and by conducting pilot projects.

➤ **Get Started:** Implementing RFID takes time. Waiting until RFID stabilizes or until customers require RFID as a condition of doing business could force companies to rush into less than optimal solutions that cost more and provide greater business disruption. Waiting could also allow competitors to gain competitive advantage by being better positioned to meet RFID mandates.

Costs and complexities related to RFID will be reduced over time, and experiential learning related to RFID projects will make today's hopes for RFID a reality. As with anything new and unproven, each business must choose how and when to adopt RFID.

Waiting for RFID to become 100 percent proven, understood, and standardized may seem to be a safe decision on the surface, but we believe it is also a losing strategy. Instead, we believe it's time to move forward with RFID — using clear business goals as a compass. We do not believe RFID is simply a matter of mandate compliance. Instead, we believe RFID R&D and mandate compliance can ultimately be leveraged for internal operating efficiency and also for competitive advantage.

RFID in the Consumer Goods Supply Chain: A Quick Primer

To participate in the RFID initiative for the consumer goods supply chain, companies cannot just purchase and deploy RFID internally. Instead, this initiative requires that RFID technology be deployed in a standardized and synchronized manner across the entire supply chain, including:

➤ retailers,

➤ manufacturers,

➤ third-party logistics (3PLs) providers,

➤ co-packers, and

➤ packaging and display manufacturers.

It also requires:

➤ the creation and adoption of evolving, industry-wide standards and practices,

➤ integration with and customization and configuration changes to companies' internal business systems, and

➤ widespread deployment of RFID tagging and reading equipment.

Additionally, RFID requires supporting technology infrastructure on the plant floor, in warehouses and distribution centers, and over the Internet. Furthermore, for this initiative to be successful, companies must adapt their processes along with their business systems to share an unprecedented amount of information electronically with their supply chain partners while still being able to accommodate many future changes to evolving standards and practices.

The Electronic Product Code (EPC) Defined

Years ago, a consumer goods industry consortium created the Universal Product Code (UPC). The UPC allows manufacturers, 3PLs, retailers, and others to automatically identify each type of consumer product throughout the supply chain, most notably at checkout in retail.

Now, several years later, this expanded industry consortium has developed the Electronic Product Code (EPC). The EPC differs from the UPC in that it allows every single item to have a unique identifier, even if multiple items are exactly the same (with the same UPC). The EPC also differs from the UPC in that it identifies non-consumer products, such as cases and pallets, which do not have UPCs.

For their standard, Wal-Mart and other retailers have settled on a 96-bit hexadecimal EPC number that contains 24 characters. Each character has a value from 0-9 or A-F. This 24-character number allows for a staggering number of combinations (hundreds of billions for each type of item from each company), which is necessary considering the long-term goal of uniquely identifying items, cases, pallets, trucks, shipping containers, cars, cattle, and — eventually — everything.

The idea behind an industry-standard EPC number is that suppliers can send retailers RFID tags coded with just an EPC number. Retailers and other supply chain partners can then use the EPC number to access details about each EPC, including product, production, and customer order information.

Elements of the EPC Number

EPC numbers have four key elements:

This element …	Identifies …
Header	The length of the EPC number, including the number, type, and version
EPC Manager	The company or entity responsible for managing the next two EPC elements
Object Class	The item (for example, the SKU or consumer unit)
Serial Number	A unique serial number for all items in a given object class

The RFID Process in a Nutshell

The concept behind RFID in our supply chain is this:

1. **Suppliers** apply RFID tags with unique EPC numbers and link business data to each unique EPC number.

2. **Suppliers** send EPC data via the Internet to a centralized EPC service (or perhaps directly to a supply chain partner).

3. The **centralized EPC service** translates the data and transmits it to other supply chain partners, including retailers.

4. From the centralized EPC service or from their internal EPC data hubs, **supply chain partners** retrieve details about every RFID tag read by their RFID readers.

The EPC Information Supply Chain Partners Will Exchange

The EPC strategy presents new opportunities for retailers but places new demands on their supply chain partners. Suppliers are expected to send details for each EPC number, including relationships between case and pallet EPCs (which cases are on which pallet) and, once RFID tagging of items is pursued, relationships between item EPCs and case EPCs.

Likewise, many retailers will want their suppliers to transmit product, production, and customer order information for each EPC, including:

➤ detailed product data,

➤ manufacturing date,

➤ expiration and lot tracking data, and

➤ reference data such as customer item numbers, customer PO numbers, and historical pricing.

Components of an RFID Tag

RFID tags have three basic components:

This component …	Does this …
Silicon Chip	Contains data about the object the tag is attached to
Antenna	Transmits or reflects to an RFID reader radio waves containing data about the object the tag is attached to
Enclosure	Embodies the complete package of silicon chip, antenna (with printed circuit board), and protective casing (such as a label), which is applied to the object

RFID Standards

A consortium of companies throughout our supply chain (including Wal-Mart) has defined standards for several aspects of RFID, including RFID tags, readers, protocols, and frequency ranges. Standardized RFID tags are made by a variety of RFID tag suppliers and vary in cost, size, enclosure, and other attributes. Likewise, other standardized RFID components, including printers and readers, come in many varieties and from various RFID technology suppliers.

In addition to receiving RFID tags on cases and pallets, Wal-Mart expects:

➤ **100 Percent Read Rate** — Wal-Mart expects to be able to read every RFID tag using standardized readers; at 8 mph as pallets move through a 10-foot-wide portal or dock door and at 540 feet per minute as cases move on a conveyor once pallets are broken down.

➤ **Incorporated EPC** — Wal-Mart expects the silicon chip on each RFID tag to contain a unique EPC number.

➤ **Transmission of EPC Data** — Wal-Mart expects the EPC data that correlates with each EPC number on each RFID tag to be transmitted via the Internet.

The Benefits Wal-Mart and Others Expect from RFID

Wal-Mart wants an RFID tag on every case and pallet it receives. With these tags in place, Wal-Mart can eliminate many manual processes, including those in:

➤ receiving,

➤ product movement in warehouses and distribution centers,

➤ shipping to stores, and

➤ paying suppliers.

Wal-Mart will also be able to reduce inventory shrinkage and out-of-stock situations by automatically tracking product movement. These and many other potential benefits are driving RFID mandates from Wal-Mart, the Department of Defense, and a growing number of retailers worldwide. To accomplish its goals, Wal-Mart expects suppliers to affix RFID tags to cases and pallets before shipping them to Wal-Mart distribution centers.

Exchanging EPC vs. EDI Data: Not Quite the Same

In some ways, exchanging EPC data is similar to exchanging electronic data interchange (EDI) data. Both involve exchanging standardized data between supply chain partners and coordination between them to ensure data is correctly translated and synchronized between their respective business systems.

EDI involves the exchange of dozens of standardized transactions in which supply chain partners use EDI translation software to convert data from their internal business systems into industry-standardized formats. Supply chain partners then exchange data directly or indirectly.

EPC data, on the other hand, involves exchanging much more complicated data that goes well beyond transactions. Efforts are ongoing to standardize the EPC data to be exchanged, but for now, each retailer will dictate to its suppliers the data exchange it requires.

When exchanging EPC data, synchronizing data between supply chain partners becomes critical. Product information must be updated on time and accurately within and across enterprises to ensure a perfect match of data between the originator of the data and all users of the data.

Types of Product Data to Be Exchanged

Product data to be exchanged can be categorized into five types:

This type of data …	Provides …
Core	Basic information core to a product's definition (such as an item description)
Market-Specific	Product data unique to the market the product is sold in (such as pallet size)
Category-Specific	Attributes unique to the product category (such as expiration date)
Relationship-Specific	Information unique to a particular product manufacturer and retailer relationship (such as unit price)
Extended Attributes	Additional data or content to help define a product (such as a product image)

Collaborative Data Exchange Initiatives Underway

EPC data goes beyond standardized EDI transactions. And since third-party service providers will be involved with translating and storing EPC data for access by global trading partners, initiatives are underway between industry and third-party organizations to simplify the exchange of EPC and standardized data between companies.

One organization, UCCnet, hopes to become the single item registry for products around the world. Early pilots are currently underway involving the exchange of product information between consumer goods manufacturers and retailers. Also, a few manufacturers are working through their industry digital marketplace (Transora) to exchange product information with retailers. Likewise, a few retailers are working through one of their industry digital marketplaces (such as WWRE -- World Wide Retail Exchange) to exchange product information with consumer goods manufacturers. Both Transora and WWRE are working with UCCnet to coordinate the exchange of standards-based data across the supply chain.

These are just a few of the collaborative initiatives underway for exchanging standards-based data. Due to privacy and other concerns, some companies will bypass third-party organizations in favor of "peer-to-peer" data exchange. As a result, supporting varied initiatives for exchanging data creates many challenges for suppliers. However, consumer goods manufacturers see this as a growing reality of doing business and are passing this reality on to their partner suppliers, such as 3PLs and co-packers. RFID mandates and the need to exchange standardized EPC data is certain to speed the propagation of standardized data exchange.

Since EPC data relates to products, pursuing RFID throughout our supply chain cannot happen without significant product data standardization and synchronization of product data between and among companies.

RFID vs. Barcodes: Different, but We Still Need Both

RFID and barcodes are both auto-identification technologies. Though some futurists believe RFID tags will eventually cost pennies and will one day be used for everything, even they agree this vision is years away. In the meantime, manufacturers will continue to use barcoded labels in the absence of RFID tags. While barcoded labels are generally reliable to read, RFID tags today are not always reliable and will not work with some products or in certain situations. Manufacturers will therefore continue to use barcoded tags indefinitely as a fallback for when RFID fails.

Given that RFID tags will not replace barcoded labels any time soon, it's important to understand the distinct differences between these two auto-identification technologies.

The following chart reflects some of these differences:

Barcoded Labels	RFID Tags
☺ Inexpensive (but not reusable)	☹ Costly (though potentially reusable)
☺ Reliable to read	☹ Not always reliable to read
☺ Work with virtually all products	☹ Work with most products but have trouble with some (such as those containing metals and liquids)
☺ Can be printed before production or printed directly on items	☹ Must be programmed, applied, and verified individually, and data synchronization is usually required
☹ Must be read one at a time and line of sight is required	☺ Many tags can be read simultaneously and no line of sight is required
☹ Written once with limited data	☺ Can potentially be written multiple times, have higher capacity, and can be combined with sensors
☹ Have a limited read range	☺ Can have a longer read range

Addressing RFID Mandates

RFID mandates require consumer goods suppliers to apply RFID tags to cases and pallets before shipping. They also require suppliers to transmit EPC data via the Internet to a centralized service, to consumer goods manufacturers, to retailers, or to any combination of those.

Companies have several choices for how to address RFID mandates, from less costly (but still costly) slap-and-ship models to more costly integrated models that incorporate RFID technology into many, and eventually all production or assembly lines. Regardless of the strategy they choose, companies will have to integrate their RFID tagging system with their internal business systems so they can collect, associate, and disseminate EPC data.

Slap-and-Ship Models

Wal-Mart encourages its suppliers to leverage RFID technology internally and discourages them from pursuing slap-and-ship models. Nonetheless, for many reasons detailed in this document, we believe virtually all consumer goods suppliers will deploy a slap-and-ship model until a significant percentage of their product requires RFID tagging (the tipping point). Until then, many consumer goods suppliers cannot justify the multi-million dollar investment required to deploy a more-integrated RFID tagging model.

A slap-and-ship model requires an additional process for each pallet of finished product. This process typically includes these steps for each pallet:

1. Identify product information for RFID tagging.
2. Break down the pallet.
3. Program and apply RFID case tags.
4. Verify that each RFID case tag can be read.
5. Remake the pallet.
6. Program and apply the RFID pallet tag.
7. Verify that the RFID pallet tag can be read.

Along with these steps, business systems must use predefined, customer-specific business rules to create EPC numbers for each customer and then marry product, production, and customer order data with each EPC number so they can subsequently transmit EPC data via the Internet. This entire effort adds costs for labor, RFID equipment, infrastructure, RFID middleware (to integrate with internal business systems), custom programming and/or configuration changes to internal business systems, and more.

The slap-and-ship model presents several choices, including:

➤ Slap-and-ship before shipping
➤ Slap-and-ship at the end of manufacturing or assembly lines
➤ Hybrid slap-and-ship in finishing

Slap-and-Ship Before Shipping

Due to the speed of manufacturing for most consumer goods companies, many companies selecting a slap-and-ship model will implement RFID tagging in their warehouses or distribution centers just before shipping. This choice allows for a relatively lower investment in RFID technology, since it isolates tagging and reading equipment to a single area in each warehouse or distribution center. But this model could create serious bottlenecks for delivery of product as RFID tagging requirements grow.

Slap-and-Ship at the End of Manufacturing or Assembly Lines

If speed is not an issue, consumer goods companies can deploy a slap-and-ship model at the end of each manufacturing or assembly line, before palletizing. Applying tags before palletizing eliminates the need to break down and remake each pallet as RFID tags could be programmed, applied, and verified as part of the case finishing process. However, this option increases costs for RFID equipment and labor because it requires multiple tagging stations.

Hybrid Slap-and-Ship in Finishing

Companies can deploy a hybrid slap-and-ship model in which manufacturing or assembly lines share RFID tagging equipment. RFID equipment can be mobile and rolled from line to line (tagging before palletizing) or centralized for sharing among several lines (tagging after palletizing). The latter necessitates pallet breakdowns and remakes but might be less expensive than outfitting several lines with RFID equipment and labor.

Slap-and-Ship May Be the Only Justifiable Choice

At one RFID conference, several presenters suggested a slap-and-ship model is the only justifiable choice most suppliers have, due to:

- the high cost of RFID infrastructure,
- rapidly changing RFID technology,
- lack of agreed-upon RFID standards,
- lagging RFID adoption,
- RFID deployment complexity, and
- widespread uncertainty about many aspects of RFID.

A keynote speaker from Forrester, an independent technology research firm, stated that most companies today cannot produce business justification for RFID. As a result, they have no choice but to deploy a slap-and-ship model to comply with RFID mandates. This same speaker stated that even the cheapest slap-and-ship model will be very costly and that companies must have experience with RFID to fully understand and address deployment issues.

More-Integrated Models

For the largest consumer goods suppliers shipping millions of cases to Wal-Mart each year, their desired option for complying with RFID mandates might be a more-integrated model. Ironically, even if suppliers are willing to spend millions for a more-integrated option today, the high speed of manufacturing machinery coupled with the immaturity of RFID technology might prevent them from choosing this option. The result will be millions in additional costs for major consumer goods manufacturers and increased cycle time for RFID tagging and data synchronization if they cannot achieve full inline integration with their manufacturing equipment.

Companies should consider several issues when deploying a more-integrated RFID model, including:

Immaturity of RFID Tag Printing and Tag Application

Some believe the greatest RFID breakthroughs will be in printing and applying RFID tags. Unlike other types of printers, RFID tag printers must program a tag with a unique EPC number before or after applying the tag. To avoid having to apply tags manually, tag printing must be incorporated into customized tag application apparatus. Likewise, the tagging solution must be able to attach RFID tags to various types and sizes of objects without damaging tag antennae.

Also, tagging solutions must be able to verify each tag to ensure a 100 percent read rate and must be able initiate appropriate action when read errors occur. To drive down the staggering cost of RFID deployments, tag printing and application apparatus must evolve so that RFID tagging can occur inline with manufacturing machinery. Inline tagging becomes especially important when companies are required to tag individual items.

Today's RFID tag printing and application apparatus don't come close to meeting inline requirements for most major consumer goods manufacturers.

Combining Barcodes with RFID Tags

Barcoded labeling is here to stay for the foreseeable future, so manufacturers need to continue to print barcodes as they add RFID tagging capabilities. Ideally, the barcoded label and RFID tag would be applied in the same step, simplifying data synchronization downstream and supplying a built-in backup for RFID. Likewise, having one printer that could produce whichever auto-identification was required for each order would be ideal. A few RFID tag printer suppliers have released introductory models that offer combined barcoded label and tag printing functions, but this capability is still considered to be immature. Technological advances are sure to come in this critical RFID component area.

Slap-and-Ship Station Still Needed in Shipping

Even if companies pursue a more-integrated RFID model, they will still need a slap-and-ship station in shipping to replace tags that cannot be read. Tags can be damaged during warehouse movements or during final stages of shipping preparation. Using both slap-and-ship and inline tagging models introduces complexity, particularly in ensuring that EPC numbers remain unique across multiple tagging methods.

Balancing the Desire to Leverage RFID Internally with the Slow Pace of RFID Adoption

Companies are desperately trying to envision a way to leverage the cost of RFID internally rather than adding non-value cost to their products. Besides addressing issues with today's RFID technology and the exorbitant cost of deployment, companies trying to leverage RFID internally must implement RFID tagging much faster than required by their customers. Unless significant internal operating efficiencies can be found, this path is costly and risky. Yet suppliers potentially risk market-share erosion if they do not position themselves as market leaders in RFID tagging, especially if their competitors tout a more aggressive and leveraged strategy for complying with RFID mandates.

Integration with Internal Business Systems

All suppliers deploying RFID for mandate compliance, regardless of whether they choose a slap-and-ship or more-integrated model, must change their internal business systems. Specifically, business systems must be able to generate unique EPC numbers according to each customer's business rules. It's even likely that some consumer goods manufacturers will give their supply chain partners a block of serial numbers to use for each product SKU to ensure EPC number uniqueness when multiple supply chain partners are involved with manufacturing or assembly for the same product.

Likewise, product, production, and customer order data must then be married with each EPC number and transmitted via the Internet to third-party service providers and/or proprietary EPC data hubs. Over time, it's expected that detailed EPC data transmission requirements will grow as RFID adoption increases and manufacturers and retailers increase their leveraging of RFID technology.

The cost and complexity of RFID will lessen over time, suggesting that a minimal investment is more prudent for many suppliers than investing significantly early on. Likewise, as RFID technology evolves rapidly, the risk of technology obsolescence remains high with early investments.

The Supply Chain and RFID: Anything but Stable

RFID technology has been around for years, but it has only recently been introduced to the consumer goods supply chain. Due to the potential for enormous benefits (primarily for retailers), few question its inevitable widespread adoption. But RFID in our supply chain today is anything but stable. It is therefore critical to understand the many challenges, barriers, and issues with RFID deployment while developing an RFID mandate compliance strategy.

When discussing RFID issues, many point to the cost of RFID tags as their greatest concern. Though tag costs are certainly an issue, if tags were free and 100 percent reliable today, this would not materially change the dilemma most companies face in developing their RFID mandate compliance strategy. Tag cost will continue to decline, and tags will become more reliable. Meanwhile, there are greater issues today that make RFID in our supply chain a real conundrum. Following is an overview of many of these issues.

Technology Issues

Issues with RFID Tags

RFID tags come in many varieties. Most are passive (powered by RFID readers), while others are semi-active or active (containing battery-powered components). The issues associated with today's RFID tags include:

➤ **Defective and Poorly Performing RFID Tags:** Though tag reliability today is considered relatively high by early adopters, RFID tag manufacturers continue to produce faulty tags. Failure rates in early RFID pilots have been as high as 20 to 30 percent. Unfortunately, "relatively high reliability" is unacceptable if an RFID mandate calls for a 100 percent read rate.

Poorly performing tags are also an issue. Tag performance differs depending on many factors, including what materials are adjacent to each tag and environmental conditions such as temperature and humidity. RFID tags are not one-tag-fits-all. Companies must use a variety of RFID tags to meet the needs for a variety of products being tagged.

➤ **Damaged RFID Tags:** RFID tags come in a variety of shapes and sizes with various types of enclosures, so issues vary from tag to tag. Yet every type of tag can become damaged somewhere in the supply chain.

For manufacturers who will be paid when retailers receive their product, damaged tags could result in retailers receiving product that is not detected by their RFID readers. Since tag reading happens automatically without line of sight and no human interaction, it can be difficult to know when certain tags are not read. This becomes a serious issue for business applications built around RFID if 100 percent read rates are implicit as part of the core business application design.

Business applications can address this issue to some extent by using business rules to predict when reads seem incomplete (for example, knowing how many cases are normally expected on a pallet for each product or knowing when a case is read without a corresponding pallet read).

➤ **Tag Cost:** For manufacturers who ship millions of cases to retailers each year, tag cost is very much an issue when considering widespread RFID deployment. Higher-functioning tags cost as much as $5 to $6 per tag, while passive tags being mandated today can fall in the $0.20 to $1.25 per tag range.

Even if the cost were just pennies per tag, the cost could still be significant for high-volume manufacturers. When manufacturers are required to tag individual items, the tag cost issue will grow substantially, even if the cost of tags decline significantly.

➤ **Changing Tag Standards:** Wal-Mart and other retailers have chosen to use passive RFID tags. In the future, some retailers will use higher-functioning passive tags or even semi-active and active tags for higher-priced items or items needing tags with additional sensors.

Changing tag standards will bring changes to RFID infrastructure, including multi-protocol, multi-frequency tag readers that can read many types of tags. This reality of constant change will surely bring about quicker technology obsolescence for early RFID deployments.

Issues with RFID Readers, Frequencies, and Protocols

RFID readers come in several broad categories, including conveyor, portal, forklift, and handheld. Within each category come many varieties. Each reader is manufactured to read certain tags (such as passive, semi-active, or active) using specific frequency ranges (such as low, high, UHF, or microwave) and is configured to read certain protocols.

Wal-Mart has decided to use passive tags along with the EPCglobal 96-bit EPC standard. They will be using readers manufactured to work with a specific UHF frequency range (902 to 928 MHz). These aspects of RFID present a number of issues today, including:

➤ **False Negatives and False Positives:** RFID readers often experience false negatives and false positives. A false negative occurs when a valid tag passes within the prescribed range of an RFID reader, but the reader does not read the tag. This can happen for many reasons, including:

- a case tag is buried deep inside a pallet,

- reader signals are blocked or absorbed by substances such as metal or water, or

- a case tag is not oriented properly (tag reads are more successful when tags are perpendicular to reader signals).

A false positive occurs when a tag accidentally passes within range of an RFID reader but was not intended to be read. False negatives and false positives often occur with closely packed items where multiple tags in close proximity "shadow" each other.

➢ **Malfunctioning RFID Readers:** RFID readers malfunction — that's a fact. The key is in knowing when malfunctions occur and being able to address problems as they arise. Companies must plan fallback procedures for when readers do not function properly and develop strategies for knowing when readers are malfunctioning. Though a few reader suppliers have recently announced the capability to detect reader failures and alert workers when failures occur, today that's easier said than done.

➢ **Frequency Clashing:** RFID readers are manufactured to use a certain frequency range. Early RFID pilots have shown that other radio frequency (RF)-based technologies often clash with RFID readers when frequency ranges overlap. As a result, companies have experienced difficulties during RFID pilots with barcode scanners, cordless phones, push-to-talk devices, wireless networks, security systems, and other RF-based technologies.

➢ **Variations in RFID Frequency Standards:** Though Wal-Mart and others in the U.S. and Canada have agreed on a standard frequency range for RFID, Europe has announced its own standard frequency range (862 to 870 MHz). Other parts of the world have also announced frequency ranges of their own, and some are different from both the U.S. and European standard. As a result, companies shipping internationally must be aware of the different frequency ranges as they test their RFID capabilities.

➢ **Future Changes in RFID Protocol Standards:** In choosing the current RFID protocol standard, Wal-Mart and others were limited to what today's technology can support. EPCglobal has identified several classes of RFID tags but has finalized protocols for only two of them (both passive). As RFID technology evolves, standard protocols will be finalized for higher-functioning passive tags and for semi-active and active tags. As a result, different retailers will select and mandate different RFID protocol standards.

Varying protocol standards will have significant ramifications for others in the supply chain, including possible overnight obsolescence of today's RFID tags and readers. Companies must therefore proceed cautiously before investing in bulk purchases of RFID tags and readers. Ironically, bulk purchases of RFID tags and readers are exactly what the industry needs to reduce the cost of tags and readers.

➢ **Reader Obsolescence:** Even if RFID standards stayed the same for years, suppliers continue to improve RFID readers. Tomorrow's readers will be more reliable, faster, ready for future protocols, capable of reading over longer ranges, and smarter about detecting and correcting errors.

In fact, suppliers of RFID readers are currently working on the ability to triangulate the exact location of an RFID tag (think GPS). By detecting the timing differences of repeat tag reads of the same tag from multiple readers, future RFID deployments will know the distance of each tag from each reader and therefore the exact triangulated position of an RFID tag, within inches.

This capability alone could bring about entirely new ways for companies to leverage RFID internally and will therefore likely cause RFID readers to become obsolete quickly under any circumstances. Since readers are one of the costlier components of RFID deployments, quick obsolescence is a big concern for companies having or considering significant early investments in RFID.

Issues with Applying RFID Tags

One of the more perplexing challenges relating to RFID is in how to reliably program, apply, and verify RFID tags in a single integrated step. Currently, there is no RFID technology supplier that provides all that's required to perform all of these actions in a single step. Instead, components from multiple RFID suppliers must be used together for today's RFID tagging solutions.

While development in this area continues, suppliers of manufacturing machinery themselves are partnering with suppliers of RFID tags, readers, and middleware to build integrated, network-attached RFID tag printing and application apparatus that can be used on the plant floor. Many of these solutions today are conveyor enabled, though the idea is to evolve these solutions into a more inline (or near inline) manufacturing solution.

How tags are created and applied may be the area that changes the most over the next few years, raising issues companies need to consider, including:

➤ **Ideal RFID Tagging Technology Not Available Today:** When deploying RFID, the last thing manufacturers want is to increase manufacturing cycle time. They also want to avoid additional labor costs and new production or shipping bottlenecks. The ideal scenario is to be able to predictably and reliably program, apply, and verify RFID tags inline as product is manufactured or assembled. This would also necessitate deployment of RFID technology at different places depending on what's being tagged (items, cases, or pallets).

Unfortunately for most manufacturers, inline tagging is not possible with today's RFID technology. The biggest issue is speed. Remember that tags must be programmed with a unique, serialized EPC number based on business rules for each customer (which requires integration with internal business systems). Tags must also be applied to an object, read for verification purposes to ensure 100 percent readability, and subsequently synchronized with product, production, and customer-order data. Although suppliers of manufacturing machinery are beginning to pilot multi-function, conveyer-connected RFID workstations, we previewed this emerging capability at a recent RFID conference, and speed is just not an option today.

➤ **Immature Options for Combining Barcodes with RFID Tags:** The need for RFID tags does not eliminate the need for barcoded labeling, especially since barcodes will likely be the fallback for RFID tag or reader failures. Early deployments of RFID have simply added steps for RFID tagging to steps for barcoding.

Barcoded label suppliers have begun incorporating RFID tagging capability into some of their existing barcoded label printers, but early options being tested in the market are still lacking with respect to speed, flexibility, and automated controls. Ideally, manufacturers would like to have the option of doing one or both options in a seamless, integrated step that's controlled by business rules from internal business systems. Many manufacturers and partner suppliers are waiting for this technology to evolve before investing heavily in RFID tagging equipment.

Issues with RFID Middleware, Integration, and Data Exchange

RFID deployments require middleware to program and read tags. They also require internal business systems to be integrated with this middleware so that data can be exchanged (directly or indirectly) with manufacturers, retailers, and other supply chain partners via the Internet. Along with these requirements come a variety of issues, including:

➤ **Evolving RFID Middleware:** Barcode scanners read one barcode at a time using line of sight and human involvement. RFID readers, on the other hand, do not require a line of sight or human involvement and read a couple of hundred RFID tags simultaneously. In fact, RFID readers actually read each tag continuously (multiple times) as tags pass within range of the reader.

One of the functions of RFID middleware is to sort through thousands of redundant tag reads, distilling data into unique occurrences for each RFID tag. EPCglobal (*www.epcglobalinc.org*), the consortium that developed the EPC numbering standard, has announced a robust specification for middleware software vendors to use. While this specification enables a consistent interface for business system integration, the evolving nature of the RFID landscape promises to bring about many changes to middleware products.

The principal challenge here will be to thoroughly understand each middleware upgrade as well as the changes that are also required to maintain integration with internal business systems.

➤ **Need for Flexible Business Rules Within Internal Business Systems Integration:** Internal business systems must support an evolving strategy for complying with RFID mandates, including being able to store each customer's business rules and RFID and EPC numbering requirements. Internal business systems must then be able to pass these requirements to RFID infrastructure via custom-developed integration, including capturing customer specifics for EPC numbering, serialization, and related barcoding requirements. Since standards will vary, the entire system must be developed to support all variations — and there are certain to be many.

➤ **Numerous and Evolving RFID Data Standards:** Though Wal-Mart and other retailers have settled on a 96-bit, 24-character hexadecimal EPC number, the military originally chose a larger EPC number with more characters as their standard. In its latest policy announcement, the Department of Defense has indicated that it will accept a number of EPC standards but will work to phase out the older EPC standards once next-generation tags and readers are available.

The EPC data standards developed by EPCglobal are only one set of data standards being developed. The International Standards Organization (ISO), the Electronic Article Numbering Association (EAN), the Uniform Code Council (UCC), and others have also developed RFID data standards. Additionally, international organizations are developing their own competing standards such as Japan's UID (Ubiquitous ID) and China's NPC (National Product Codes).

Numerous sets of data standards mean that RFID infrastructure, particularly middleware and internal business systems, must accommodate a variable-length EPC number along with customer-specific business rules for creating unique, serialized EPC numbers. Standards organizations are working together to see whether certain standards can be merged. Meanwhile, early RFID deployments must accommodate multiple RFID data standards.

A few of the many national and international RFID data standards evolving today include:

- ISO/IEC 18000 Part 6 — Air interface for item management at UHF

- ISO/IEC 15961 & 15962 — Information interface for object-oriented use of RFID in item management

- ANSI INCITS 256:2001 — American RFID standard for item management

- EAN.UCC GTAG — Application standard for use of RFID in the macro supply chain

- ANSI MH10.8.4 — Application standard for RFID on reusable containers

- ISO/IEC 18000 Part 4, Mode 1 (2450 MHz)

- ISO 18185 Electronic Seal Tags

- Automotive Industry Action Group (AIAG) B-11 Time and Wheel Identification

➤ **Variations for EPC Data Exchange via the Internet:** EPCglobal has also developed a strategy for centralizing EPC data across the supply chain. The thinking is that companies can use the Internet to exchange EPC data with EPCglobal instead of establishing point-to-point connections with every supply chain partner. For a fee, companies can leverage the services of EPCglobal to consolidate and translate EPC data between participating companies.

Some organizations will bypass this third-party service and demand that data be sent directly to them. Therefore internal business systems and technology architecture for RFID must support various Internet data exchange strategies and related protocols. Additionally, some transactions may have to be exchanged with multiple partners, some using EPCglobal and some sent directly to supply chain partners. For example, a co-packer who ships finished product direct to retailers may have to exchange transactions with the consumer goods manufacturer and the retailer.

Most companies will likely choose to use a third-party service provider, yet early RFID mandates aren't clear about this critical and final step.

Process Issues

Issues Related to Failures

Based on the many issues with RFID technology, companies must plan for RFID-related failures throughout the supply chain. This introduces a number of challenging issues with RFID deployment, including:

➤ **Downtime and Restart/Recovery Procedures Unclear:** As with any technology, companies must consider what will happen when systems go down. Some questions companies need to address include:

- If internal business systems are unavailable, can RFID tagging run independently from these systems for a while? If so, how will unique EPC numbering based on customer-specific business rules be handled?

- If RFID tagging systems are inoperable, can companies ship without RFID tags? And if RFID tagging is done offline for a while, how can internal business systems "catch up" with what's been done so that EPC data can be re-synchronized and exchanged with EPCglobal and other companies?

- If tag reads fail in shipping, what's the process for retagging, and how will unique EPC serialization be accomplished with multiple tagging methods?

➤ **Supply Chain Partner Readiness and Agreement Regarding Potential RFID Failures Needed:** Even if suppliers could deploy a faultless RFID strategy, they will still face issues regarding the readiness of their supply chain partners. For example, if an RFID tag is damaged in transit or a Wal-Mart RFID reader fails in their distribution center, how will each issue be resolved, and what are the fallback procedures? What happens if EPCglobal fails to transmit data on demand? Since Wal-Mart just recently began testing RFID with the first suppliers to comply with their mandate, in all likelihood, these scenarios are not yet fully flushed out.

➤ **Plan for Synchronizing Corrections to Data Entry Errors Across the Supply Chain Needed:** As companies define their RFID mandate compliance strategies, they must also consider the human side of RFID. Mistakes happen. They might come while entering product, production, or expiration and lot tracking data. They might also happen with EPC numbering. Consequently, companies must determine how they will correct errors, and strategies are sure to vary based on many factors, including:

- the type of error to be corrected,

- the timing of the correction (for example, has data already been sent to third parties or supply chain partners, and if so, to whom?), and

- the significance of the error to be corrected (for example, product expiration date versus production shift).

Issues with Partially Implementing RFID

A predicament for both suppliers and retailers is that adoption of RFID by all supply chain partners will take time. Unless a company uses a closed-loop RFID system (in which they tag everything even if only for internal use), companies must maintain current processes while they add RFID processes. Accordingly, they will have to use dual processes until RFID becomes the norm rather than the exception.

This issue is exacerbated by the fact that retailers are targeting RFID rollout location by location whereas suppliers are working to comply with retailer mandates product SKU by product SKU.

Partial RFID implementations introduce several issues, including:

➤ **Currently Difficult for Most Suppliers to Leverage RFID Internally:** Unless RFID is used for a majority of products being shipped, most suppliers will find it difficult to leverage RFID internally. Therefore, it's likely that most suppliers will pursue RFID only as needed to satisfy RFID mandates. As a result, RFID will likely mean non-value-added costs and increased cycle time for suppliers until RFID reaches critical mass and many of today's issues are resolved. Only then can suppliers justify full internal RFID implementations and leverage them for internal operating efficiency.

Retailers, on the other hand, can selectively leverage RFID today in their stores in pursuit of theft prevention, out-of-stock detection, and other strategic implementations. Yet even retailers will struggle with mixed processes for receiving, distribution, payment, and so on. As a result, retailers will also have to continue traditional processes for products received without RFID tags, including many products that contain metals and liquids.

➤ **Increased Chance for Errors with Different Plant Floor and Warehouse Processes:** Since RFID will affect only certain shipments for certain suppliers, plant floor and warehouse processes will be different for RFID tagged shipments than for non-RFID shipments. Dual processes introduces additional complexities that could easily increase errors, so companies must design their business systems, processes, and training programs with additional error checks to help prevent new errors from occurring.

➤ **Difficulties When Mixing RFID Tagged Products with Non-RFID Products:** Both suppliers and retailers must consider the fact that only certain products will have RFID tags. This introduces many questions that must be addressed, including:

  ▪ Will suppliers be allowed to ship RFID tagged products and non-RFID products on the same truck to retailer distribution centers?

  ▪ Will retailers separate RFID tagged products from non-RFID products when shipping from their distribution centers to their stores, making it easier to process shipments into and out of their distribution centers?

  ▪ Will retailers announce a surcharge for processing products without RFID tags?

Issues with Internal and External Business Processes

Potential issues relating to how RFID tagging will affect internal and external business processes include:

➤ **Cases and Pallets with Mixed Product:** Though not the norm, many consumer goods suppliers ship cases and pallets containing a mixture of product, such as product in different colors or sizes or entirely different products on the same pallet. Problems could therefore result if internal business systems expect a single product SKU to be associated with a case or pallet EPC. Even if suppliers address this issue within their internal business systems, other supply chain partners may still have issues with mixed product within their internal business systems. Consequently, case and pallet shipping practices for certain customers may have to be modified as RFID tagging for cases and pallets is deployed.

This issue raises a related question for suppliers where multiple items are part of the finished product being shipped. For example, will business systems for supply chain partners be able to decode EPC numbers for point-of-purchase displays, multi-packs, and other promotional materials where a single RFID tag with a unique EPC number will relate to a finished product that can be further broken down into an item-level bill of materials?

➤ **Cases and Pallets with Partial Quantities:** Many companies ship partial cases or pallets at times. Accordingly, this too must be considered if the expectation is that standard packing quantities will be associated with different SKUs. Consequently, if this practice is to continue, companies must confirm that packing quantities can be different and then include explicit packing quantity detail in the EPC data to be exchanged. Moreover, agreement on this issue must be reached with all involved supply chain partners.

Data Synchronization Issues

Issues with Exchanging Non-Standardized Data

Early RFID tagging pilots have focused on requirements for tagging, reading, and creation of EPC data. Yet few companies have planned beyond the mechanics of transmitting EPC data via the Internet. Recent RFID testing between retailers and suppliers have brought to light several issues relating to the exchange of non-standardized data between companies, including:

➤ **Missing Data Attributes:** Some data attributes desired by retailers are missing in some supplier business systems. It's not enough for consumer goods manufacturers and other suppliers to transmit EPC data to EPCglobal (or proprietary EPC data hubs). They must also be able to transmit the exact data attributes specified in customer RFID mandates. Therefore suppliers may have to change their business systems to address RFID mandates. This issue grows more complicated when different customer RFID mandates specify different data attributes to be exchanged. As a result, each new customer RFID mandate could generate one or more IT projects to capture missing data required for that customer.

➤ **Dissimilar Data Characteristics:** Even when companies are able to exchange required data attributes, data attributes to be exchanged could have dissimilar characteristics between companies. For example, field sizes could be different, date fields could be arranged differently (yy/mm/dd vs. mm/dd/yy), text fields could be aligned differently (left justified vs. right justified), or numeric fields could be formatted differently (zero suppressed vs. leading zeros). Once again, this issue multiplies with multiple customer mandates.

➤ **Different Organizational Nomenclature:** Even when companies are able to exchange required data attributes with the exact same data characteristics, companies might use different nomenclature for valid field values. As a result, valid data exchanged from one business system might be rejected as invalid by another business system. This issue is particularly significant if a supply chain partner's business system expects specific values in certain fields to trigger downstream processing.

Ongoing Issues with Exchanging Standardized Data

Data synchronization will actually be a continuing issue because companies continuously change their business systems and corresponding business rules. This results in ongoing issues with exchanging standardized data, including:

➤ **Coordination of Business System and Standardized Data Changes Across the Supply Chain:** When customers change their business systems or valid data values within their business systems, they need to coordinate changes with supply chain partners with whom they exchange data. As in the EDI world, suppliers have to change their business systems to support upcoming changes to their customers' business systems or valid data values. Suppliers must also ensure proper synchronization with their customers when planning a cutover to a new system.

Additionally, suppliers may have to use both old and new methods for exchanging data when multiple customer locations implement a change in phases. As with EDI, manufacturers, retailers, and other supply chain partners will have to coordinate ongoing changes that affect the exchange of standardized EPC data.

➤ **Retrofitting Changes to Previously Exchanged EPC Data:** When customers change business systems, supply chain partners must consider the effect on previously exchanged non-transaction EPC data (such as product data) that may reside in the systems of third-party service providers (such as EPCglobal, UCCnet, Transora, and WWRE). Accordingly, when customers make system changes that affect EPC data, suppliers and third-party service providers may have to alter current EPC data for that customer in their respective business systems. This issue can also potentially affect suppliers that change their business systems if the change affects the format or values of previously exchanged EPC data.

Issues with Data Exchange Processes

As customers pursue strategies for data exchange with their suppliers, each will choose their own process. This is likely to create several issues for supply chain partners, including:

➤ **Supporting Third-Party vs. Peer-to-Peer vs. a Hybrid Data Exchange Model:** Some retailers and manufacturers will choose to leverage a myriad of third-party organizations for help with standardized data exchange. Accordingly, a single customer/supplier data exchange initiative could involve:

- a retailer using WWRE,

- a manufacturer using Transora,

- both third parties using UCCnet and EPCglobal to facilitate standardized data exchange, and

- other participating supply chain partners, such as a 3PL and a co-packer.

Meanwhile, other retailers may bypass third parties and require manufacturers and partner suppliers to exchange standardized data directly with them. Still other retailers may choose a hybrid of these models using only one or two third-party organizations. This creates the potential for a mixture of initiatives with multiple standardized data exchange models, meaning many changes to internal business systems for suppliers to support these various models.

➤ **Resolving Issues When Multiple Organizations Are Exchanging Data:** Besides the coordination challenges companies will face when dealing with a number of organizations involved with their data exchange initiatives, trying to resolve issues that arise with these initiatives can be quite perplexing. Issues may relate to timing problems between organizations, or they may relate to a number of potential problems within business systems across many organizations.

Since most standardized data exchange initiatives are in the early pilot stages, complexities with issue resolution across multiple organizations have only recently begun appearing. As a result, it's hard to estimate the time and cost associated with standardized data exchange initiatives because each initiative will be unique with its own set of challenges.

These are just some of the technology, process, and data synchronization issues that companies are facing today as they develop their RFID mandate compliance strategies.

Despite these issues, RFID is unstoppable for the consumer goods supply chain. Over time, each of these issues will be addressed, only to be replaced with new issues that aren't even on the radar today. For this reason, companies should expect the challenges of developing and evolving their RFID mandate compliance strategy to be never-ending. And as things in the world of RFID continue to change, companies need to continue to reassess their various RFID-related strategies.

Consumer Goods Manufacturers' Perspective on RFID Mandate Compliance

With so much discussion and speculation around RFID, we thought it would be important to hear what consumer goods manufacturers (our customers) had to say about RFID mandate compliance. We asked some of our largest customers about their RFID efforts and upcoming supply chain partner requirements. For the most part, we found similar perspectives.

Focus Is on Core Product Lines, Nothing Else

Most of our customers are developing their own RFID mandate compliance strategies. More importantly, they seem to be focused exclusively on their core product lines. This includes negotiating with Wal-Mart, other retailers, and the government about which product lines can be reliably RFID tagged at this time.

A few of Wal-Mart's largest suppliers, including P&G, Unilever, Johnson & Johnson, Nestle, Kraft, and Gillette, have just begun to publicize their trial shipments of specific product lines to Wal-Mart's pilot distribution centers in Texas. Our customers are dealing with many of the same RFID issues and are facing multi-million dollar investments with their RFID mandate compliance programs, including several million dollars annually just for case and pallet RFID tags.

At this time, virtually all of the customers we spoke with expressed little to no interest in RFID for promotional displays, multi-packs, or anything other than their core product lines. We believe the same is true for retailers, as everyone appears to be focused on the challenges just with cases and pallets of core consumer products.

Nonetheless, we believe it would be a mistake to wait for specific demands for RFID tagging for non-core consumer products shipped directly or indirectly to retail. Our thinking is as follows:

➤ Manufacturers and retailers will take many months, if not years, to resolve the issues surrounding today's RFID implementations. However, shortly after many of today's most critical issues are resolved for core consumer products, we believe suppliers of non-core consumer products will be expected to comply with RFID mandates.

➤ Suppliers face similar challenges with their RFID implementations, but each supplier will also face challenges specific to their unique situations and therefore must develop their own strategy for complying with RFID mandates. One challenge sure to be different for each company is customizing, re-configuring, and integrating RFID with internal business systems. Companies with custom-developed business systems will certainly face this challenge, but so will companies with purchased business systems since each company uniquely configures its purchased systems.

➤ Other differences between companies are their speed of manufacturing or assembling, the quantity of products to be RFID tagged, and the form and substance of their products to be tagged. These are significant factors to be considered when developing a strategy for complying with RFID mandates. There are also differences in physical building structures and other environmental characteristics that affect the ability, accuracy, and cost of tagging, reading, and other RFID infrastructure.

➤ In many cases, our customer contacts were unaware of their company's RFID initiatives, including their plan for complying with RFID mandates. Since many of our customer contacts are not responsible for actually shipping core consumer products to retail, this is not surprising. If retailers and consumer product manufacturers are in fact consumed with issues related to RFID tagging for their core product lines, it stands to reason that many of our customer contacts procuring point-of-purchase displays, multi-packs, and other promotional products might not be aware of internal RFID mandate compliance efforts at this time.

➤ Though RFID mandate compliance is a driver for most internal RFID projects today, these initial RFID projects provide valuable research and development that can be leveraged for more strategic RFID initiatives. Accordingly, we believe RFID mandate compliance is the more visible driver for initial investments in RFID, but the more strategic need is for RFID R&D. More on this perspective follows later in this document.

Be Aware of Over-Zealous RFID Project Managers

While the focus of most of our customers remains on RFID mandate compliance for their core product lines, a couple of our customers have begun to discuss the need for pilot RFID tagging projects for non-core products. While we welcome the opportunity to collaborate with our customers on pilot RFID projects, we have yet to see clear evidence of our customer's senior management support for anything other than core product lines at this time.

More importantly, when the time comes for RFID tagging of non-core consumer products, we believe it's prudent to ensure that alignment exists downstream before pilot work begins. Specifically, if tagging is to be done on behalf of a retailer, all supply chain partners should ensure that the retailer is ready for tagged non-core products, especially as it relates to the transmission of EPC data for those products.

The Cost of RFID Mandate Compliance

Investment Costs for RFID Mandate Compliance

Much of the focus surrounding the cost of RFID has been on the price of RFID chips or tags. But implementing a fully functional RFID system incurs multiple costs. These costs include the following:

➤ The **cost of tags** will vary for each company depending on the amount purchased. Tags have the potential for being the greatest single cost line item for major consumer goods companies shipping millions of cases and pallets each year to Wal-Mart and other retailers with RFID mandates.

➤ The **cost of tag readers** will vary from as low as $1,000 to several thousand dollars for higher-functioning models. The number of readers will also vary depending on many factors, including the scope of RFID deployment.

➤ The **cost of tag printers** will vary over a range of up to several thousand dollars per printer. The number of printer will also vary depending on many factors, including the scope of RFID deployment.

➤ The **cost of RFID middleware** will vary over a very wide range from as little as $25,000 for a small operation to several hundred thousand dollars for an enterprise-wide solution.

➤ The **cost of technology infrastructure capable of supporting and managing RFID-related data** will vary depending on the number of locations for deployment, environmental conditions at each location, and other complexities. RFID technology infrastructure is another potentially significant cost.

➤ The **cost for RFID strategy and technology consulting** will vary where cost is incurred in multiple phases as RFID initiatives are conceived and pilots are conducted. Initial consulting could be as little as $50,000 but can easily ramp up into hundreds of thousands and possible millions depending on the scope of RFID deployment.

➤ The **cost for RFID research and development** will vary based on the appetite for R&D and includes costs such as labor, testing equipment, and consulting.

➤ The **cost for changes to internal business systems** will vary based on many factors and includes costs such as software upgrades, internal resource cost, and optional third-party cost for custom-development and/or system configuration changes required for each mandate. Also included is the cost for integration with RFID middleware, which is difficult to estimate but could be one of the costlier aspects of RFID deployment, especially for larger consumer goods companies.

➤ The **cost for implementation, training, and change management** is another potentially significant cost but will be different for every company.

➤ The **cost for third-party service provider fees** is another likely cost that includes annual sales-based subscription fee for EPCglobal ($75,000 for annual sales of $1 to $10 billion) and UCCnet ($40,000 for annual sales of $1 to $3 billion), as well as subscription fees for other optional third-party service providers, such as Transora, and WWRE.

➤ The **cost for additional labor** will invariably be needed with today's RFID deployments since suppliers cannot achieve full inline integration with their manufacturing equipment. This cost will vary depending on the volume of tagging and the number of tagging stations.

RFID investments can grow considerably as more advanced capabilities are pursued, including:

➤ The **cost for equipment and/or engineering work around the placement of readers and tagging equipment throughout the plant floor and warehouse** could be significant if more seamless integration is desired with conveyors, portals, transporting vehicles, and such.

➤ The **cost for specialized, network-connected tagging apparatus** that are offered by various suppliers, including plant floor machinery manufacturers, could be significant if these specialized apparatus are desired.

Recurring Costs for RFID Mandate Compliance

In addition to initial investment costs associated with RFID implementations, companies will also experience several recurring costs, including:

➤ The **recurring cost for tags** will vary greatly between companies. This cost is certain to be reduced over time as tag costs continue to decline.

➤ The **recurring cost for technology maintenance** for RFID components and related infrastructure is typically 15-20 percent of the acquisition cost.

➤ The **recurring cost for third-party service provider fees** includes renewal fees for EPCglobal (20 percent of the initial fee) and UCCnet (same annual fee), as well as renewal fees for other optional third-party service providers, such as Transora, and WWRE.

➤ The **recurring cost for additional labor** is certain to be required when deploying a slap-and-ship tagging model and will vary depending on the volume of tagging and the number of tagging stations.

➤ The **recurring cost for RFID research and development** will be an ongoing cost simply due to the evolving nature of RFID today.

Other Cost Considerations

We believe many early adopters have underestimated the cost of implementing RFID. Moreover, quicker than usual technology obsolescence should make RFID costly still as additional investments will be required to leverage evolving capabilities.

We also believe RFID technology infrastructure costs required to capture and manage an unprecedented amount of data could grow significantly as RFID becomes more widespread.

For early adopters, we think it's likely that implementations will prove to be more costly in the beginning stages of adoption, given the likelihood of first-time mistakes and the lack of industry best practices.

Though the range of total investment will vary widely between companies based on many factors, in most cases, companies are looking at investments that can easily reach into millions of dollars.

Other Opportunities for Using RFID

Currently, many companies are focused on addressing the challenges of complying with RFID mandates. Meanwhile, several companies are pursuing RFID to gain internal operating efficiency, and others are striving for competitive differentiation by incorporating RFID as part of their strategic product and service offering. Accordingly, many companies will develop more than just an RFID mandate compliance strategy.

RFID for Internal Operating Efficiency (Closed-Loop Systems)

Several companies are looking to RFID to gain internal operating efficiency. Generally, internal RFID initiatives result in closed-loop systems that are easier to implement. Though implementing any type of RFID initiative means addressing many of today's RFID issues, internal closed-loop systems avoid issues with industry standards, synchronizing data over the Internet, and disconnects in collaborative processes.

Internal closed-loop system initiatives using RFID can be found across many industries. Examples include:

➤ **International Paper:** International Paper highly publicized the implementing of RFID in one of its paper mills. They RFID tagged roll stock in this mill and used the tags for tracking and process control. They claim this innovation eliminated lost rolls and shipping errors and made moving and shipping roll stock more efficient.

➤ **Nestle:** Nestle is experimenting with RFID tags attached to reusable trays on which confectionaries are stored as they pass through various stages of production and packaging. RFID is used to monitor hygiene, ensuring that trays are cleaned regularly.

➤ **Siemens Dematic:** Siemens Dematic integrated RFID technology into the conveyor/sorting environment they use in their distribution and warehouse operations. They claim significant improvements over the barcode scanning technology they used previously.

➤ **Best Buy:** Best Buy has experimented with in-store DVD and CD RFID tagging to help improve product management and reduce inventory shrinkage. They believe labor savings alone can justify the expense if store clerks know immediately when product is in the wrong place or out of stock.

➤ **The Gap, Benetton, Abercrombie & Fitch:** The Gap is experimenting with the RFID tagging of denim apparel to improve customer service. RFID allows them to manage their inventory better by reducing out-of-stock situations on their store shelves. Benetton and Abercrombie & Fitch have also experimented with the RFID tagging of clothing.

➤ **Club Car:** Club Car, a maker of golf carts and utility vehicles, began putting an active RFID tag on every vehicle on the factory floor. At every stop in the assembly process, they use the RFID tag to retrieve assembly requirements and the custom options ordered for each vehicle. The tag sends back to the system the time each vehicle spends at each stop. Club Car claims this new system reduced their time to manufacture by almost 50 percent.

➤ **CHEP:** Chep, a pallet and container pooling services provider, uses RFID tags to track when units are lost, stolen, or damaged.

➤ **General Motors, Toyota, Ford:** General Motors and Toyota both RFID tag each automobile frame and then use the tags to track each frame as they move through stages of assembly. Ford does the same with its engines.

➤ **Michelin North America:** Michelin put RFID tags on some of its tires to track their performance and wear over time.

➤ **Harley Davidson:** Harley Davidson put RFID tags on motorcycle frames and tracks each frame through various stages of assembly.

➤ **Marks & Spencer:** Marks & Spencer, a U.K. retailer, is using RFID in its Food and Logistics division to track reusable trays, dollies, and roll cages used throughout its refrigerated food supply chain. They state that RFID has reduced the time to read a stack of multiple trays by 80 percent when compared with barcoding and that truck unload times have been reduced from an average of 18 minutes to 3 minutes. They have also been able to reduce reusable tray shrinkage considerably.

➤ **TrenStar:** TrenStar, a U.K. brewery, uses RFID tags to track the company's beer kegs as they move through the supply chain. Because kegs have unique identities, the brewery is able to determine many things about each keg, including when kegs are purchased in bulk by larger customers who then sell them for a profit to smaller customers.

➤ **U.S. Department of Defense:** The U.S. Department of Defense RFID tagged large shipping containers as part of its deployment to the Middle East. They claim RFID tagging allowed them to get equipment to the right places in a significantly shorter time.

➤ **Food and Drug Administration:** The FDA has recommended that pharmaceutical producers, wholesalers, and retailers use RFID tags to thwart counterfeiting. As a result, several pharmaceutical products in retail today have RFID tags; some that are manually applied at the store. RFID tags are also being used to prevent shoplifting of higher-priced items.

➤ **Las Vegas and Other Airports:** Las Vegas and other airports are experimenting with the RFID tagging of luggage to ensure each bag is sent to the correct airport and airline. Airlines will also be able to determine in real-time if corresponding luggage has been loaded for all boarded passengers.

Each of these initiatives purportedly has or soon will improve internal operating efficiencies, but each came with a significant cost as well. Each initiative likely required several iterations to deal with the issues that arose, and many of them came with a multi-million dollar investment. In some cases, iterations continue and investments are growing as organizations strive to resolve issues. In other cases, business justification for a more expanded rollout just didn't exist.

Only these organizations know for sure whether their early investments brought a desired return.

RFID for Competitive Differentiation (Supply Chain Collaboration)

A few companies have publicized collaborative initiatives in which they are fusing RFID with product and service offerings to achieve competitive differentiation. Some of these initiatives involve collaborating between packaging and display suppliers, consumer goods manufacturers, and retailers to deploy smart shelving, intelligent displays, or other RFID-enabled strategic offerings. Examples of companies with collaborative RFID-enabled initiatives include:

➤ **International Paper / Revlon:** Conducted a smart-shelf pilot using RFID tags on high-end cosmetics. Store clerks were alerted in real-time when Revlon items needed to be restocked or repositioned on the shelf.

➤ **MeadWestvaco / Gillette / Tesco:** Conducted a smart-shelf pilot within Tesco stores in Europe using item-level RFID tags on high-shrinkage goods such as razor blades and batteries. Tags were also places on cases and pallets of these products. Tesco subsequently extended its trial to DVDs to facilitate automatic replenishment as DVDs are removed from store shelves.

➤ **Metro AG / Several Suppliers:** Metro AG, a large German retailer, opened what it referred to as a "store of the future," which is a concept store designed to test RFID in the supply chain and on the store floor. The store has been equipped with smart shelves, RFID checkout systems, kiosks, and smart scales. Customers can use the new systems or shop the traditional way. Several suppliers are participating and have implemented RFID readers at the dock doors in their manufacturing facilities and distribution centers. The primary goal is to see if the system can reduce stock outages. In addition, cosmetics and food products are being tagged to track real-time inventory data and expiration dates. Shopping carts have also been RFID tagged and readers at store doors tell store management the number of carts that have entered or left the store, allowing store management to fluctuate the number of open checkout lines.

➤ **Tibbett & Britten / Unilever / Safeway:** Conducted a supply chain trial in the U.K. where six-packs of deodorant were tagged and tracked from the factory floor, through the supply chain, and then to three Safeway stores. The thinking was that item-level tracking would allow for tighter inventory control and reductions in inventory, thus creating a more efficient supply chain. Though the pilot was considered successful, the project was put on hold until a solid business case could be developed.

➤ **International Paper / Procter & Gamble / Wal-Mart:** Conducted in-store RFID tagging of cosmetics. Store employees were alerted in real-time when items needed to be restocked or when shoplifting was potentially occurring. This smart shelf pilot also tracked the speed that items left the shelves and fed fulfillment algorithms to calculate how much product needed to be ordered to prevent outages while at the same time keeping inventory relatively low.

RFID for Internal Operating Efficiency vs. Competitive Differentiation

Sometimes, Not That Different

RFID initiatives that target internal operating efficiency and those that strive for competitive differentiation are sometimes similar. Almost all of the initiatives we've heard about focus on operating efficiency somewhere in the supply chain. Often, the only meaningful differences seem to be in:

➤ which companies are enabling the operating efficiency to be achieved (internal or external),

➤ whether or not differentiating technology is being used, and

➤ whether or not external data synchronization is involved.

When internal resources deploy ubiquitous RFID components as part of their initiative, the company implementing RFID is said to be pursuing internal operating efficiency. However, when the initiative involves collaboration with a supply chain partner, often using newly developed, propriety technology, the external supply chain partner is said to be pursuing competitive differentiation while the company initiating RFID is said to be pursuing internal operating efficiency (which itself could be a competitive differentiator). For both types of initiatives, the result from early pilots has typically been a closed-loop system for the company implementing the initiative.

Since many of these early pilots result in a closed-loop system within a single company, the need to synchronize data externally is minimal or non-existent. This is important because eliminating the need to synchronize data externally eliminates many critical issues with RFID deployment.

On the other hand, a few pilots are focused on pure competitive advantage where the targeted benefit is increasing revenue (if the benefactor is another company) or increasing convenience (if the benefactor is an individual consumer).

While only a few initiatives using RFID to achieve competitive differentiation have been announced, it's probable that many more are underway that have not yet been publicized. None of these initiatives have widespread deployments, but we suspect this is only a matter of time. And though we have not seen consumer goods manufacturers and partner suppliers publicizing RFID mandate readiness as a competitive advantage, we suspect this market positioning is also inevitable.

Understanding the RFID Technology Supplier and Consulting Landscape

Over the past several months, we met with a number of RFID technology suppliers as well as several RFID consultants to better understand the current RFID situation. Virtually every consultant we met with touted a sense of urgency, citing the complexities involved with RFID as well as the need for every company in our supply chain to "get in the game or be left behind."

While we have been tempted to seek outside help for a pilot project to address RFID mandate compliance, we have been reluctant to engage an RFID consulting firm when we are not yet sure what's required or even what a successful RFID pilot project looks like. Accordingly, we have opted to learn more about RFID and future requirements before proceeding.

After dozens of presentations and discussions with a variety of technology suppliers and consultants offering help with RFID, we have reached several conclusions.

RFID Technology Suppliers (Forget One-Stop Shopping)

The RFID technology supplier landscape may be as confusing as RFID itself. As we researched RFID, it became clear that no one company can provide everything needed to implement RFID tagging. Instead, early adopters of RFID have essentially become general contractors because they've had to subcontract several aspects of RFID. Several early adopters have even contracted out their general contracting duties to consultants and, in some cases, delegated their RFID project management responsibility.

Making things more confusing, some RFID technology suppliers have crossed over into the RFID consulting business, while a few RFID consulting firms have gotten into the RFID technology business by partnering with technology suppliers and offering proprietary solutions that include custom-developed RFID middleware. And in a few cases, early RFID adopters have created RFID consulting businesses to leverage knowledge from their own RFID experiences. It's also important to note that while some RFID suppliers are acquiring other RFID suppliers (such as Symbol's recently announced deal to acquire Matrics), others are deciding whether or not they want to stay in the competitive and changing RFID technology business.

Consequently, as companies develop their own RFID strategies, it's important that they become familiar with the many facets of RFID as well as the myriad of RFID technology suppliers and consulting firms.

Here is a partial list of RFID technology components and corresponding suppliers in today's RFID marketplace:

Companies that supply …	Include …
Chips	IBM, Hitachi, Phillips, AMI, TagSys, RFSaw, and Charterate
Inserts	International Paper, MeadWestvaco, TI, Avery Dennison, SmartTag, Rafsec, Power Paper, and LabID
Printers	Zebra, Printronix, Alien, Intermec, and Toshiba
Tags	Alien, Matrics, Intermec, Phillips, TI, SAMSys, MeadWestvaco, Flint Ink, Hitachi, Siemens, Power Paper, Avery Dennison, TagSys, RFSaw, Savi, Rafsec, FlexChip, Omron, iPico, Identec, Amatech, Tyco, Wavetrend, and LabID
Antennae	Flint Ink, Avery Dennison, Moore, EMS, and Omron
Readers	Alien, Intermec, Matrics, Symbol, TI, SAMSys, Hitachi, Checkpoint, Savi, TagSys, Rafsec, Wavetrend, Feig, Omron, Tyco, Moba, Siemens, InKode, Amatech, Identec, and iPico
Data Aggregation, Filtering Systems	IBM, OATSystems, and ConnectTerra
Middleware	IBM, Accenture, OATSystems, Microsoft, SAP, Oracle, Sun, Savi, Wherenet, Checkpoint, Matrix, Sensormatic, and Genesta
Directory Services	Verisign and Ember

Note: The list above does not include manufacturers of plant floor machinery who have built their own RFID tag printing and application apparatus. Each apparatus is a custom-developed solution. We believe we will see important RFID solutions in this area in the future, especially as the supply chain begins to embrace item-level RFID tagging.

RFID Consulting Firms (Addressing Real Urgency vs. Building RFID Competency)

Like other companies in our supply chain, we have been approached by several consulting firms offering to help us address the growing number of RFID mandates. Choosing among RFID technology suppliers is important, but we believe choosing the right RFID consulting firm is even more critical. A well-chosen RFID consulting firm allows companies to leverage that firm's RFID experiential knowledge. RFID consultants can also help choose the best RFID components and technology suppliers to address the specific needs of each company.

Unfortunately, choosing an RFID consulting firm is as difficult as choosing among RFID technology suppliers. Furthermore, it appears that many consulting firms have very little to no real-world RFID experience and are selling only theories today. Since so much remains unclear, the current priority for many consulting firms seems to be with building their RFID competency in preparation for meeting real business needs in the future.

We believe the real urgency today is for consumer goods manufacturers to evolve their strategies for complying with RFID mandates. We also believe supply chain partners, including 3PLs, co-packers, and packaging and display companies, should begin to build their own competency with RFID tagging. Accordingly, we think it's critical to partner with an experienced RFID consulting firm to build this competency.

Based on the many meetings we've had and presentations we've seen, we have divided RFID consulting firms into the following categories:

Consulting Firms with the Most RFID Experience and Largest RFID Investments

Includes IBM and Accenture

This group includes consulting firms with the most RFID experience to date; the most informative and most impressive presentations; a significant number of white papers and other RFID reading collateral; the most experience actually helping retailers with RFID mandate construction and compliance testing; the most number of references from early RFID adopters, including several closed-loop success stories; an internal center of excellence for RFID, including an R&D lab for client testing of RFID technology; and experience with a variety of competing components across leading RFID technology suppliers.

Members of this group invariably have resources that have participated early on in developing RFID standards with the Auto-ID Lab, MIT, and such. They also typically have a clear presence at RFID conferences and trade shows, both as exhibitors and speakers, and sponsor executive briefings and educational offerings to help attract new business. Members of this group also offer custom-developed RFID middleware for systems integration that's reusable from client to client.

Consulting Firms with Significant Focus on RFID

Includes BearingPoint, Deloitte, EDS, Capgemini, PricewaterhouseCoopers, KPMG, and HP

This group includes consulting firms with a significant focus on RFID, informative presentations, and some white papers and other RFID reading collateral. They have some experience with early RFID adopters, including perhaps a few closed-loop success stories, and some experience with competing components across a few leading RFID technology suppliers.

Members of this group may also have a few resources that have participated early on in developing RFID standards with the Auto-ID Lab, MIT, and such and may occasionally have a presence at RFID conferences and trade shows.

Consulting Firms with Little to No RFID Experience, but a Desire to Grow RFID Competency

Includes several mid-tier and regional consulting firms

This group includes consulting firms with little to no RFID experience but a desire to grow RFID competency. As a result, a small number of resources in these organizations have been given responsibility to learn as much as possible about RFID, to develop educational collateral that can be used to help sell RFID engagements, to publish white papers where possible, and to do whatever can be done to sell RFID pilot projects so the firm can gain experiential knowledge.

It's unlikely that members of this group had any participation early on with developing RFID standards and they typically have little to no exhibitor or speaker presence at RFID conferences and trade shows. It's also likely that members of this group have hitched their wagons to one or more RFID technology suppliers (not necessarily leading suppliers) so that they can sell engagements using their collective knowledge of RFID to meet the needs of their clients, invariably using components from their chosen RFID technology partners.

RFID Technology Suppliers Offering RFID Consulting Services

Includes Intermec, Zebra, TI, Sun, Checkpoint, and SAMSys

This group includes RFID technology suppliers that have crossed over into the RFID consulting arena. These companies are leveraging early adopter successes with their RFID technology components and offering similar solutions to prospective customers with similar needs. Members of this group typically have a few published documents, sometimes passed as neutral white papers, which tout successes and differentiating factors with their own RFID components.

Some of these technology suppliers partner with consulting firms to deliver consulting services. Members of this group count on a strong presence at RFID conferences and trade shows, usually as exhibitors, and may also sponsor executive briefings and educational offerings, with or without partner consulting firms.

Application Software Companies Offering Integrated RFID Capability Along with RFID Consulting Services

Includes SAP, Oracle, Manhattan Associates, RedPrairie, and Manugistics

This group includes software companies with a strong focus on inventory management and distribution that have added RFID tagging capabilities to their core product offering. These companies are focusing on this new capability to sell more software and/or consulting services to existing customers wanting to implement RFID tagging.

Members of this group typically have exclusive partnerships with specific RFID component suppliers and offer turnkey solutions that include their software and RFID technology components from their partner suppliers. Some of these software companies partner with consulting firms to deliver consulting services.

The target market for members of this group are companies that already have their software implemented as well as companies that would consider implementing a new inventory management and/or distribution system, with a focus on RFID tagging capabilities that would come with the new system.

Early Adopters Offering RFID Consulting Services

Includes International Paper

This small group includes early adopters of RFID technology, typically with closed-loop business applications, who are trying to leverage their RFID experience to companies with similar issues or interests. Though executive presentations from this group can be impressive since they share real-world experiences from a familiar business perspective, this group's expertise could be limited to their own experiences and lessons learned with their chosen RFID technology components. Experiential knowledge about systems integration is also likely limited to their internal business systems (and perhaps one or two pilots with consulting clients).

Nevertheless, members of this group should have an easier time connecting with companies in their industry since they understand the nuances of their industry better than a traditional business consultancy would.

Choosing an RFID Consulting Firm

Though these categories are subjective in nature (based on our own interactions and research), we see distinct differences between consulting firms in the first two groups — those who have the most RFID experience — and all the others. With so much uncertainty and complexity around RFID, we believe companies considering RFID would benefit greatly by leveraging experiential knowledge from a consulting firm in the first or second group (assuming competitive fees).

We also believe it would be risky for companies to engage an RFID consulting firm with little to no real-world RFID experience. Likewise, we think it would be a mistake to engage an RFID technology supplier as a principal RFID consultant due to a potential conflict of interest. And though we remain intrigued with the successes of early RFID adopters, we suspect their perspective might be limited to their specific situation and chosen technologies.

It's also important to note that even the largest RFID consulting firms appear to have favorites among RFID technology suppliers. In fact, we see many partnerships between RFID technology suppliers and RFID consulting firms. Therefore, we believe future efforts with RFID should involve working with a principal RFID consulting firm to develop an evolving strategy for complying with RFID mandates as well as investigations and direct working relationships with several RFID technology suppliers to keep up with RFID technology developments and to ensure the most strategic business fit.

From Cases and Pallets to Items:
The Calm Before the Storm

Much of this document addresses the complexities and issues around RFID mandate compliance with a focus on RFID tagging of cases and pallets, as prescribed by these mandates. While companies navigate the many challenges associated with RFID mandate compliance, we speculate that today's complexities and issues will pale in comparison to those we are likely to see once item-level RFID tagging across our supply chain is pursued. Therefore, we think it's important to understand the focus and timing differences that are likely across our supply chain as we embrace RFID mandate compliance in the future.

While major consumer goods manufacturers focus on implementing their RFID mandate compliance strategies, partner suppliers to these manufacturers struggle to understand when and how they will be affected by RFID mandates. Accordingly, we've developed some "broad brushstrokes" on how we believe RFID will affect suppliers who partner with consumer goods manufacturers, including promotional display, co-packing, consumer packaging, other converting, and paperboard operations.

Promotional Display and Co-Packing Businesses

Focus on Complying with RFID Mandates; Prepare to Be Flexible

Businesses offering promotional displays, co-packing, multi-packs, and other promotional offerings ship finished product directly or indirectly to retailers. At some point, these shipments will have to be RFID tagged. We believe the greatest challenge for these types of businesses will be to develop a flexible strategy for efficiently tagging cases and pallets of non-core products. They will also need to effectively synchronize and transmit EPC data to one or more third-party organizations via the Internet (and possibly directly to consumer goods manufacturers and retailers).

We suspect consumer goods manufacturers (i.e., customers of these businesses) will have different needs as they strive to comply with retailer and government RFID mandates, including:

➤ Some customers will ask promotional display and co-packing businesses to control the uniqueness of EPC numbers, while others may assign blocks of serial numbers to each supply chain partner. Besides unique EPC numbers, some customers may require critical data (such as expiration or freshness date) to be programmed onto their tags.

➤ Some customers will want EPC data to be exchanged using a third-party service provider (such as EPCglobal), while others may want data exchanged directly with them. Other customers may want EPC data to be exchanged both using EPCglobal and directly with them, while others may want data to be exchanged with EPCglobal, themselves, and retailers (when product is direct-shipped). Still others may involve third parties such as Transora, WWRE, and UCCnet. Accordingly, standardized data exchange scenarios are likely to be many.

➤ Some customers will be satisfied with a standardized RFID tag, while others may be more specific about which tag and type of enclosure they want to use, particularly if enclosures include other sensors that capture data for further analysis. Some customers may even provide their own tags or enclosures to attach to their products.

➤ Some customers will want only certain products to be RFID tagged, while others may ask that only specific shipments be tagged (for example, only to the ship-to locations that are piloting RFID). Additionally, some customers may specify where the RFID tag should be attached to each case or pallet, while others may stipulate business rules for palletizing RFID tagged cases.

➤ The need to exchange standardized data will likely result in several IT initiatives to change internal business systems in order to comply with individual customer RFID mandates.

When customers of these businesses eventually pursue item-level tagging, challenges for promotional display and co-packing businesses should generally remain the same for some product types (for example, when shipping one display per pallet, nothing changes with the RFID tagging of items). For other product types, volumes (and therefore cost and cycle time) could be significantly higher (for example, for multi-packs and direct mail).

Folding Carton, Plastics, and Other Consumer Packaging Businesses

Focus on Item-Level Tagging; Case and Pallet Tagging Also Likely

Folding carton, plastics, and other consumer packaging businesses will occasionally ship product (such as mailers) direct to retail and therefore will likely be asked to RFID tag cases and pallets for some consumer products. For the most part, though, RFID mandates should not be significant for these businesses until retailers require individual items to be tagged. At that point, folding carton, plastics, and other consumer packaging businesses will probably be expected to apply RFID tags as part of their packaging offerings.

When item-level RFID tagging is finally required by their customers, these businesses will likely face all of the same challenges found with RFID today, plus several additional challenges that should significantly increase the complexity of RFID tagging compared with tagging just cases and pallets. These anticipated additional RFID challenges include the following:

➤ The number of items these businesses will eventually have to tag will be in the billions. This volume, along with the low average unit price for most packaging and the pressure to cut that price even further, will likely make the cost of RFID tags an even greater issue (especially since retailers want RFID tagging without an increase in product and packaging costs).

➤ Once companies begin to tag individual items, a slap-and-ship model becomes impractical for many consumer goods suppliers. It is therefore urgent that RFID tagging be incorporated into the manufacturing or assembly process before many companies can effectively pursue item-level tagging. Some believe the ideal entry point for tagging cartons in a folding carton plant is during printing. Others believe it's easier to incorporate tagging during finishing, lowering the risk of damaging tags during manufacturing.

Still others believe RFID antennae can eventually be printed directly on cartons using conductive inks (Flint Ink, a company in the RFID tag and antenna business, is working on this capability). No matter what the scenario is, we believe item-level RFID tagging will reach critical mass only when it can be integrated in a predictable and reliable manner as part of the packaging manufacturing process.

➤ Strategies that govern EPC numbers for item-level tags have not yet been defined. While promotional display and co-packing businesses will tag items that go to retailers, consumer packaging businesses will be asked to put tags on packaging that goes to manufacturers. One company doing the RFID tagging on packaging while another company fills orders for retailers could create many challenges with data synchronization, including:

- Will consumer packaging businesses need to send EPC data to EPCglobal, to consumer goods manufacturers, or to both?

- How will EPC data from multiple companies become associated with the same EPC number, allowing for complete EPC history?

- Will packaging customers request temporary EPC numbers on their RFID tags to make sure tags are readable but then reprogram the tags as they package product in their plants?

- How will other supply chain partners (including 3PLs) be asked to participate in item-level tagging initiatives and what effect will their participation have regarding synchronization and consolidation of EPC data for retailers?

➤ When considering the number of folding cartons that can be shipped per case and per pallet, reading all tags successfully on all cartons could become an issue. If cartons and therefore RFID tags are packed tightly together, tags could be damaged in transit. It's also not clear whether RFID tag readers will be able to read tags buried deep inside a pallet. For example, will the middle carton in a middle case on a pallet be readable? Similar questions can be raised for Plastics and other consumer packaging businesses.

➤ At some point, consumer packaging businesses will be hit with requests for RFID tagging from many sides. Besides the eventual pursuit of item-level tagging, packaging customers will eventually attempt to leverage their internal RFID investments to make their supply chain more efficient. Accordingly, packaging customers will eventually require tagging of item-level packaging as well as cases and pallets used to ship packaging, and a different strategy for EPC numbering could be required for each. Other customers might require only one or two levels to be tagged. These scenarios highlight how important it is for consumer packaging businesses to develop flexible processes for RFID tagging while ensuring successful order fulfillment despite the many variations that are likely in their future order fulfillment processes.

➤ Once item-level tagging is pursued, some speculate that consumer goods manufacturers might want RFID tags on the product itself rather than on the packaging. However, we believe it's more likely that consumer goods manufacturers will choose to tag the packaging rather than the product for two primary reasons:

- Consumers will continue to be concerned about privacy relating to RFID. Being able to discard the RFID tag along with the packaging is one way to address this concern.

▪ Consumer goods manufacturers will likely want their supply chain partners to absorb the costs of RFID tagging, which would not be possible if tags are placed on the product rather than the package.

The good news for folding carton, plastics, and other consumer packaging businesses is that it appears it will take many months, if not years, before the many issues with case and pallet RFID tagging can be ironed out and it will be even longer before our industry is ready to pursue item-level RFID tagging throughout our supply chain.

Corrugated Businesses

A Hybrid Between Promotional Display / Co-Packing and Consumer Packaging Businesses, but on a Smaller Scale

Promotional display, co-packing, folding carton, plastics, and other consumer packaging businesses will all eventually have significant RFID tagging investments, but RFID is likely to hit the corrugated industry as well. First, many corrugated businesses have elements of the promotional display and co-packing model where they ship finished corrugated displays and other product to retailers (either directly or indirectly). Second, many corrugated businesses also have elements of the consumer packaging business model in that they too manufacture protective consumer packaging that ends up on store shelves.

In addition, similar to consumer packaging businesses, corrugated businesses are also likely to be a target for RFID when consumer goods manufacturers look to leverage their internal RFID investments to make their supply chain more efficient. Accordingly, some corrugated customers will ask that cases and pallets of shipping containers be RFID tagged. The good news is that RFID tagging of shipping containers is probably a couple of years away. The bad news is that retailers will probably require cases and pallets to be tagged much sooner for promotional displays and other products they receive (directly or indirectly) from these businesses.

Paperboard Businesses

Supply Chain Efficiency in the Future, Once Removed

Paper mill customers may also eventually want to leverage their internal RFID investments to make their supply chains more efficient. However, paper mills are mostly suppliers to paperboard packaging manufacturers and not to consumer goods manufacturers (that is, they are once removed in the supply chain). Therefore, we believe this push probably won't come until a few years after similar pushes with consumer packaging businesses that are more directly linked in the consumer goods supply chain.

Recycled Fiber Businesses

Distant Future, Maybe

Although RFID tags could technically be placed on bales of recycled fiber, we see no evidence that this is being considered today. When the cost of RFID tags approaches zero and RFID tagging becomes as effortless and ubiquitous as barcoding, it's conceivable that companies may choose to tag bales of recycled fiber, simply for inventory management efficiencies.

On a separate but related note, concerns are being raised about the potential for metal, plastic, and silicone contamination in the waste paper stream, especially when item-level tagging is pursued. Industry and government studies are currently underway to assess this concern.

# What About Business Justification for RFID?

Eventually, we expect RFID will increase revenue, reduce operating costs, facilitate optimization of assets, enhance safety and quality control, and much more. Unfortunately, we do not believe most companies can make a business case for RFID at this time. Instead, we believe meaningful RFID research and development is required for most companies before a clear understanding and related business case can be developed. Furthermore, we see a continuous need for R&D as RFID technology evolves and matures.

While every company has the option of taking a wait-and-see approach to RFID, we believe that this approach entails several risks, including:

➤ a company without a clearly articulated business strategy for RFID could see market-share erosion, particularly if its sales force cannot publicize the company's readiness for complying with RFID mandates,

➤ a company who waits may not have time to work through all the issues and challenges of RFID and may have difficulty developing and refining a strategy for complying with RFID mandates, and

➤ a company who waits may be forced to deploy less than optimal and much more costly RFID implementations once the need arises.

Aim to Be in the "Early Majority" of Innovation Adopters

We are mindful of the desire to have a compelling business case for investing in RFID and of the inability to make a case at this time. Nonetheless, we believe it would be prudent for companies to spend a relatively small amount for initial RFID technology as a means to further understand the many aspects around the inevitable rise of RFID in our supply chain. We also believe it's wise to be in the "early majority" (i.e., to the left on the graph below) of innovation adopters for RFID with a focus on smaller, less risky R&D investment.

Adoption Rate: Diffusion Theory   Source: Rogers & Shoemaker, *Communication of Innovations*
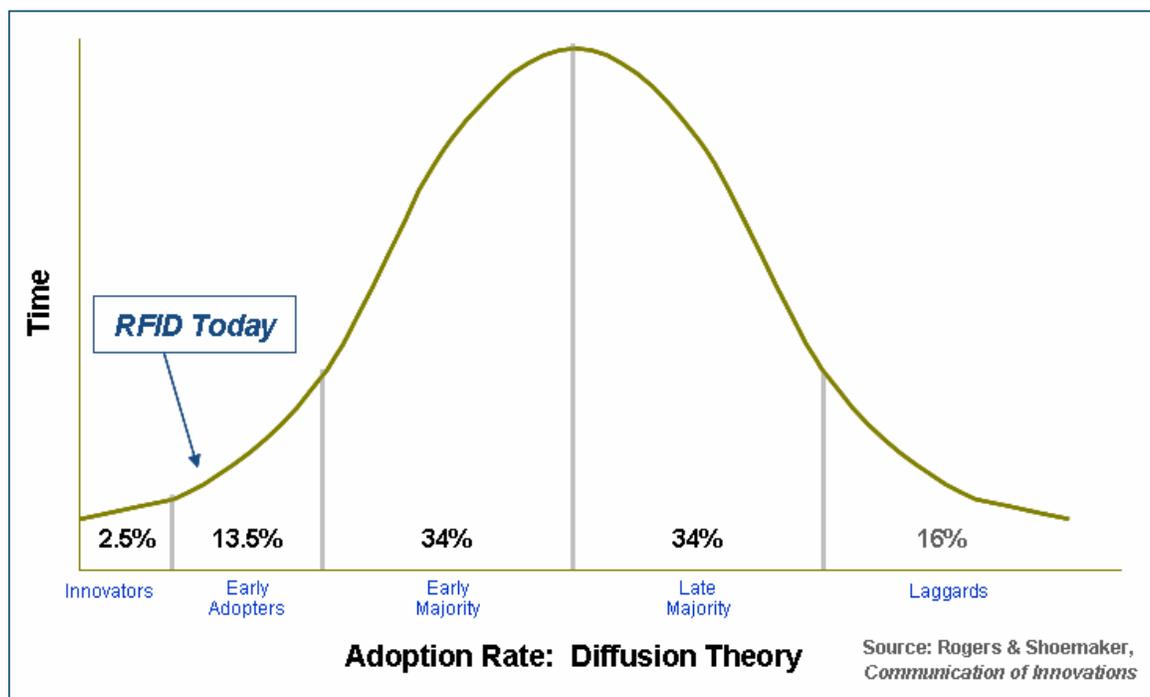
Potential Business Value of RFID

Long term, companies will gain more from RFID than just retaining business by complying with mandates from retailers and the government. RFID will eventually greatly improve data collection through automation across the supply chain — radically changing the competitive landscape of packaging, manufacturing, logistics, and retailing. And as RFID data collection costs become more reasonable, data will be collected at many more points in each process.

As a result, our entire supply chain will have access to a greatly expanded pool of historical data related to things such as:

> ➤ warehouse receipts,
>
> ➤ shipped goods,
>
> ➤ components used in the manufacturing process,
>
> ➤ manufactured goods,
>
> ➤ goods received at the customer site,
>
> ➤ cycle counts, and
>
> ➤ in-store sales.

Companies will then have unlimited options for using this data to make better business decisions and improve business systems and processes. They'll also be able to collaborate with supply chain partners in ways that weren't previously possible or even imaginable. As a result, each partner in our supply chain has the potential to realize significant benefits from RFID, including many that are shown in the table on the following page.

Potential RFID Benefits for Supply Chain Partners

Manufacturers	Logistics Providers	Retailers
Shorter shipment loading times	More efficient order selection	Better store planning, programming, and merchandising with real-time data
Greater shipment accuracy	Better order fill rates	Improved point-of-sale productivity and accuracy at checkout
Better consumer sales data from retailers	Less inventory shrinkage	More accurate returns
Reduced counterfeiting/ diversion	Fewer administrative and other human errors	Improved reverse logistics
Improved support for vendor-managed inventory	Lower labor requirements	Greater inventory accuracy and velocity
Easier product safety recalls	Less vendor fraud	Optimized store in-stock levels
More accurate demand planning	More accurate inventory	Reduced internal and external shrinkage
Shorter order lead times	Less time and lower cost for managing inventory	Lower labor requirements
Less need for safety stock	Higher routing efficiency	Automated receiving, vendor payments, and shipments to store
Better use of labor	Better security for distributing medical products	Better use of reusable assets
Higher sales	Automated receiving, vendor payments, and shipments	Lower detention/demurrage charges
Less time and lower cost of cycle counting, receiving, picking, and shipping	Increased capacity through more efficient operations	Better gray-market containment
Fewer charge-backs for inaccurate deliveries	Fewer penalties for execution errors	Better ways to measure the execution and effectiveness of display programs

Potential Tax Advantages

Tax planning may help any organization making an investment in RFID, since tax savings can help offset the initial investment. Potential tax benefits include research credit incentives and cash or tax-relief grants, which may be available to offset training costs associated with introducing new RFID-enabled technology into the organization. Also, certain sales and use tax exemptions could reduce the cost of RFID infrastructure investments.

Further, an initial investment in RFID may be offset by a variety of federal and state economic and tax incentives. The credits potentially available include:

➤ research credits for developing RFID technologies,

➤ state enterprise zone or economic development credits,

➤ investment tax credits for new technologies,

➤ employee credits for training costs, and

➤ cash or tax-relief credits for value-added technologies.

Sales and use tax exemptions may also be available for purchases of new equipment, machinery, and other tangible personal property associated with RFID technology or general economic expansion. Likewise, property tax abatements or credits may exist for economic development or expansion of new technologies on city, county, and state levels. Early involvement with state and local economic development representatives can result in potentially significant tax savings with accompanying benefits to net income and cash flow.

The Role of Information Technology (IT) in RFID Strategy and Deployment

RFID with an EPC-based framework is a business strategy, not an IT strategy. It involves transformation of business processes, market positioning for the sales force, and collaboration with customers, retailers, other supply chain partners, and third-party service providers. Nevertheless, developing and implementing an EPC-based RFID mandate compliance strategy requires heavy IT involvement along with a deep understanding of current business systems, IT infrastructure, and several facets surrounding the exchange of standardized data via the Internet.

RFID also inherently requires plant floor engineering expertise, especially when RFID deployment involves integration of RFID tagging and reading equipment with plant floor machinery and/or conveyor systems. Likewise, since RFID deployments ultimately affect people, both on the plant floor and in the office, operations management must be heavily involved with planning and execution for any RFID implementation. In addition, when RFID-based initiatives involve collaboration with customers and/or retailers, sales management must be involved in facilitating collaboration and in guiding the team as it relates to nuances and issues with their customers and/or retailers.

Therefore, regardless of the circumstances for each RFID-enabled initiative, a joint team between the business unit and IT – and sales management where applicable – should always be organized to ensure optimal results. Any RFID-enabled initiative pursued by business units without IT involvement (including those using outside consultants and/or RFID technology providers without IT) follows a formula for less than optimal results. Even if things appear to be going well, it's likely that these initiatives will eventually require IT involvement down the road, where the opportunity for more strategic planning (and ultimately less spending) may be lost.

RFID Strategy Recommendation:
Get in the Game

As this document illustrates, there are many facets related to RFID mandate compliance, and early adopters have uncovered many outstanding issues. RFID is unlike any technology that we as an industry have seen in the past. It's extremely complicated and very costly, yet we believe it is inevitable that RFID will be a transformation agent throughout our supply chain for packaging, manufacturing, logistics, and retailing.

We also believe companies need to develop several strategies for RFID. The first is for complying with RFID mandates. And though this will likely become the focus for most companies in our supply chain, we think it is not too early to at least consider strategies on pursuing RFID for internal operating efficiency and also on pursuing RFID for competitive differentiation.

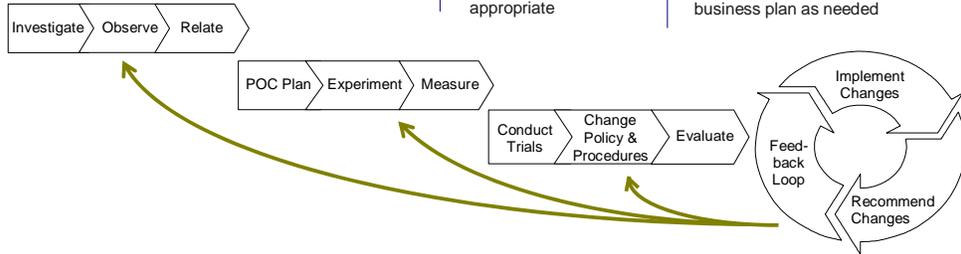For all of these strategies, we see a few common realities:

➤ RFID will bring a unique set of challenges for every company,

➤ RFID requires several iterations before an acceptable plan can be deployed, and

➤ RFID must be experienced to be completely understood.

To address the many obstacles that exists with RFID today, and to support each RFID-enabled strategy, we think companies need to pursue RFID research and development. We believe such a plan will lead to RFID mandate compliance and can also be leveraged for other RFID-enabled strategies.

The following chart shows a sample, multi-phased action plan for RFID R&D, leading into RFID mandate compliance:

Sample Multi-Phased Action Plan for RFID R&D Leading into RFID Mandate Compliance

	Learn / Plan	Experiment / Pilot	Evaluate / Expand Trials	Adopt / Reevaluate
Objectives	• Partner with sales force • Understand customer requirements for RFID • Evaluate and select an RFID consulting partner • Establish relationships with leading RFID technology suppliers • Establish contact with various 3rd party service providers • Learn about various RFID standards organizations • Learn about RFID from other businesses • Gain industry knowledge by attending conferences	• Develop plan for RFID proof of concept project (POC) • Create a short list of RFID technology suppliers -- identify target RFID components • Invest appropriately in RFID technology and outside consulting needed for success in POC • Experiment with RFID (and iterate) until ready for pilot -- execute on POC • Determine issues with integrating RFID with current technology • Begin planning for internal systems change • Pursue pilot candidate customers • Begin developing business case for pilot	• Continue to develop business case for additional RFID investment -- present to senior management • Begin to update process and procedures to ensure proper handling of items with and without RFID tags • Evaluate progress in RFID trials -- conduct new trials as needed • After changes to policy and procedures are understood and stabilized (including successful trials), plan for operational pilots • Reach out to other major customers and retailers to understand evolving RFID requirements • Plan internal systems customization in detail • Conduct additional pilots as needed -- determine when (or if) additional RFID investment is appropriate	• Develop detailed, scalable RFID deployment plan • Finalize decisions related to 3rd party service providers (internally desired, externally mandated) • Finalize RFID technology suppliers and components • Finalize process and procedures -- including specifics related to mixed environments of RFID and non-RFID products • Finalize planning for internal systems customization and integration -- pursue full-scale development • Continue to reevaluate strategy -- including changes due to mandatory compliance, emerging technology, or standards • Revise and resubmit business plan as needed

Key Activities

Investigate > Observe > Relate

POC Plan > Experiment > Measure

Conduct Trials > Change Policy & Procedures > Evaluate

Feed-back Loop — Implement Changes — Recommend Changes

Final Thoughts

RFID is coming — Wal-Mart, the Department of Defense, and other major retailers are demanding it. RFID will undoubtedly become a condition of doing business within the next few years. In addition, RFID has the potential to radically transform our supply chain, bringing significant benefits to all supply chain partners.

Yet RFID in our supply chain today is anything but stable. Moreover, RFID today is exorbitantly expensive, and there's a real risk that today's investments will become obsolete in the near future. Therefore, companies must take the time to understand the many facets surrounding RFID before jumping in. On the other hand, a "wait and see" approach is risky as well, especially since successful RFID implementations take considerable ramp-up time, and there are many lessons to be learned.

To develop the best strategies for deploying RFID, we believe companies should consider the following:

➤ **Understand the Challenges:** Before developing an RFID strategy, it's critical that companies understand the challenges of deploying RFID and particularly the volatile state of the RFID industry. We recommend that companies begin building this understanding by forming RFID research teams and by conducting pilot projects.

➤ **Get Started:** Implementing RFID takes time. Waiting until RFID stabilizes or until customers require RFID as a condition of doing business could force companies to rush into less than optimal solutions that cost more and provide greater business disruption. Waiting could also allow competitors to gain competitive advantage by being better positioned to meet RFID mandates.

Costs and complexities related to RFID will be reduced over time, and experiential learning related to RFID projects will make today's hopes for RFID a reality. As with anything new and unproven, each business must choose how and when to adopt RFID.

Waiting for RFID to become 100 percent proven, understood, and standardized may seem to be a safe decision on the surface, but we believe it is also a losing strategy. Instead, we believe it's time to move forward with RFID — using clear business goals as a compass. We do not believe RFID is simply a matter of mandate compliance. Instead, we believe RFID R&D and mandate compliance can ultimately be leveraged for internal operating efficiency and also for competitive advantage.

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Appendix

Future Breakthrough Innovations in RFID Technology

To achieve the potential business benefits of RFID, technology suppliers must work through the issues with today's RFID technology. We have no doubt that all of these issues will eventually be addressed. In fact, we see many examples of work being done today that should lead to breakthrough innovations in RFID technology, including:

Smart Dust

Researchers at Berkeley have created a tiny wireless micro-electromechanical sensor (MEMS) that can detect everything from light to vibrations. Using recent breakthroughs in silicon and fabrication techniques, a "smart dust" chip integrates sensors, transmitters, computing circuits, bidirectional wireless communications technology, and a power supply onto a platform that measures just 5 square millimeters, or slightly larger than a fleck of glitter.

Proof-of-concepts are underway for inventory control where cartons can talk to shippers, shippers can talk to pallets, pallets can talk to trucks, trucks can talk to warehouses, and trucks and warehouses can talk to the Internet. One clear focus for this technology would be to monitor product quality (such as temperature and humidity).

Chipless RFID Tags

InKode Corporation recently announced a chipless RFID tag that costs less than one cent to produce. Instead of a microchip, antennae as small as 250 angstroms can be embedded directly in the material being tracked (such as glass, rubber, paper, or clothing). Each antenna returns a unique signal, or resonant signature, when a reader sends out a wireless query from as far away as 40 feet. Multiple antennae embedded in one product can produce a unique identifier for that item.

Printable Power

Innovations from a company called Power Paper have enabled the printing of caseless, thin, flexible, and environment-friendly energy cells on a polymer film substrate. The printing is done using simple mass-printing technology and proprietary inks.

Power Paper cells are composed of zinc and manganese dioxide-based cathode and anode layers and can be printed onto virtually any substrate, including specialty papers. Energy cells are manufactured using simple, industry-standard printing, drying, and laminating processes. They can be printed as part of an actual product, facilitating integration into the product manufacturing process. This capability can also be used to support an active RFID tag solution.

Flint Ink has also recently partnered with Thin Battery Technology to expand the market for ultra-thin batteries. At less than one millimeter thick, ultra-thin batteries are ideal for smart labels, RFID tags, and active packaging applications that require an external power source. They serve as an affordable replacement for button batteries in such diverse applications as greeting cards, cereal box giveaways, printed board games, point-of-purchase displays, and credit cards.

Printed RFID Antennae

Conductive inks contain particles of conductive silver and/or carbon that allow them to serve as channels for the wireless flow of electronic signals. Conductive inks are an alternative for the copper in the antennae used in RFID tags. Several companies are innovating in the area of conductive ink solutions. For example, Flint Ink set up a new division called Precisia charged with developing conductive inks that can be used for RFID antennae, printed electronics, and smart packaging. Flint believes its inks can be used to print RFID antennae that deliver up to 90 percent of the read range of copper RFID antennae with as much as 30 percent lower cost.