An Industry Working Group Report on
Jump-Starting RFID/EPC
in the Pharmaceutical Supply Chain

September 2004
Executive Summary
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RFID could be used to create a safe and secure supply chain, streamline reverse logistics, and increase the accuracy and efficiency of distribution and pharmacy operations.

1. Management Overview

A group of companies across the pharmaceutical supply chain came together in 2003 to explore the use of radio frequency identification (RFID) and Electronic Product Code (EPC) technology—a pioneering effort in terms of its practical scope and industry breadth. This working group included the pharmaceutical manufacturers Abbott Laboratories, Barr Laboratories, Johnson & Johnson, Pfizer, and Procter & Gamble; pharmaceutical wholesalers Cardinal Health and McKesson Corp.; retail pharmacies CVS Pharmacy and Rite Aid; and industry trade associations including the Healthcare Distribution Management Association (HDMA) and National Association of Chain Drug Stores (NACDS). Accenture served as program manager for the group.

Together, the participants wanted to assess the business value of emerging RFID/EPC technologies, standards, and processes, and to work toward establishing an industry operating model that addressed pharmaceutical industry business issues. The technology’s use had gathered momentum and uptake in other industries. The project team sought practical experience with RFID/EPC to explore its potential within the pharmaceutical space.

From October 2003 through September 2004, the project team designed, tested, implemented, and verified a complete supply chain solution. The principal objectives were to assess whether RFID/EPC could be used to help create a safe and secure supply chain, streamline reverse logistics, and increase the accuracy and efficiency of distribution and pharmacy operations. A scenario-based approach was used to validate the solution, new processes, and benefits against the related business issues.

In an eight-week test, preceded by an eight-month design period, the 9 participant companies selected 10 products for the project, working through 16 business scenarios in 15 project locations. Nearly 13,500 units of real product were tagged, shipped, received, handled, tracked, and traced through the project’s system, providing the project with first-hand experience in working with tags and EPC reader technologies.

This initiative was a “proof of concept” of RFID/EPC technology in the pharmaceutical distribution channel, and seen as potentially the first step towards broader adoption of RFID/EPC across the value chain. This report summarizes the findings of the organizations involved in the project, collectively known as “Release 1, Group 1.” Five additional companies known as “Release 1, Group 2” later joined the initiative, and will complete their work in late 2004. The findings from the Release 1, Group 2 activities will be published as an addendum to this report.

1See Section 11 for Glossary.

2FDA and EPCglobal representatives also attended key meetings at the Steering Committee level.
Industry Context – The Growth of RFID/EPC

For some time, the consumer products, retail, and transportation industries had taken the lead in researching and applying RFID technologies for widespread use. A comprehensive study of RFID’s potential to enhance pharmaceutical product manufacturing, distribution, and retail operations was a logical extension of those efforts. Some specific regulatory mandates unveiled in 2003 created a sense of urgency for exploring RFID in order for companies to comply. Two notable mandates were:

- The Florida Pharmaceutical “Pedigree Papers” requirements mandate that histories be maintained that identify previous sales and product information dating back to the drug manufacturer.
- Under Georgia’s “Credit for Returned Expired Drugs” regulations, all wholesale drug distributors must make adequate provisions for the return of expired prescription drugs for up to six months after the labeled expiration date for prompt credit or replacement (to be received within 60 days). These regulations place the financial burden of expired product entirely on the wholesale drug distributors.

Building Safe and Secure Supply Chains

As noted in a recent NACDS report, the World Health Organization estimates that 5-8 percent of drugs worldwide are counterfeit—meaning such drugs could represent from $7 billion to $26 billion of the $327 billion global market. The FDA’s current anti-counterfeiting taskforce is investigating methods to secure the pharmaceutical supply chain by examining new technologies that utilize RFID. It has stated that it should be feasible to use RFID to track all drugs at the unit level in 2007. Other healthcare organizations are either advocating RFID or are predicting its inevitability.

Key Findings

At a fundamental level, the project achieved its objectives of demonstrating RFID/EPC’s potential to address industry needs as described below. In assessing the outcomes, however, it is critical to once again note that this project was a proof of concept. It was conducted in a very controlled environment with a limited scope. As would be expected with a project of this nature, it included many manual processes that ultimately will require automation to achieve the desired benefits from this technology. There are many issues yet to be addressed and much more work remains before this technology and the resulting business applications are scaleable and ready for industry-wide adoption.

- Satisfying Increased Regulatory Requirements – The system effectively tracked selected pharmaceutical products from the manufacturer’s distribution facilities through the supply chain to the point of dispensing, thereby helping to show their location on the distribution channel and electronically capturing all necessary “pedigree” information. However, the technology employed must improve significantly and the intra-industry information systems must be built before this requirement can be satisfied.

“RFID tagging of products by manufacturers, wholesalers, and retailers appears to be the most promising approach to reliable product tracking and tracing.”

“Combating Counterfeit Drugs” Report, FDA, February 18, 2004
• Satisfying Increased Trade Channel Requirements — The project demonstrated the ability to manually tag pharmaceutical units and cases for selected products to enable track-and-trace capabilities in a manner similar to those required in emerging retailer mandates.

• Increasing Product Security and Consumer Safety — The system provided individual unit serialization that has the ability to enable track-and-trace functionality that could help prevent counterfeit product from entering the supply chain.

• Increasing Efficiency of Returns and Recalls — Since detailed information such as lot number, expiration date, and transaction date/time/location is available for each individual EPC, the project showed that the effort to identify product location when processing recalls and returns could potentially become less complicated and labor intensive.

• Increasing Labor Productivity — When conducting activities that currently require bar-code scanning of each individual item (such as shipping, receiving, or cycle counting), the project demonstrated the potential of RFID/EPC to increase labor productivity by allowing multiple items to be scanned at one time. Furthermore, since shipping and receiving would be more accurate, the administrative effort to follow up on shipment/receipt discrepancies may be reduced. It should be noted, however, that tag readability and reliability must improve significantly before this process is scaleable. There may be an incremental increase in the labor effort required as a result of changing systems and processes during the initial adoption of RFID/EPC.

• Increasing Order Accuracy — RFID/EPC technologies can provide validation of shipment and arrival at different points in the supply chain, thereby reducing over- or short-shipments of product, and increasing customer satisfaction.

The final sections of this executive summary further discuss this project’s findings. They also outline the considerable challenges ahead that will require a concerted effort by the industry and regulatory bodies alike to work through.
2. Project Approach

The project focused on assessing the ability of RFID and EPC applications to improve specific work processes—what the project team called business scenarios. These scenarios addressed four key categories: EPC Management, Safe and Secure Supply Chain, Streamlined Reverse Logistics, and Accurate Operational Efficiencies. (The sidebar at right shows a complete list of the 16 scenarios.) Ten products and 15 distribution, wholesale, and retail locations were selected for the project.

In order to quickly and cost-effectively plan and execute this project and avoid any business interruption, a separate, standalone parallel process and system were created with no modifications to packaging or production processes and no integration with existing information technology (IT) systems. There was no attempt to validate the system according to FDA electronic records regulations.

Figure 1. Defined Product Flow Path
3. Tag Design

The original design called for a plain tag—chip, antenna, and plain inlay with an EPC number printed on the front label—which would support business processes in lieu of bar codes and enable unit-level serialization. The tag needed to be small enough to be placed on pharmaceutical packaging without covering any existing labeling, it needed to be a UHF tag which is conducive to processes focused on shipping and receiving, and it needed to comply with EPCglobal Class 0 standards. The 1.2” x 1.4” tags selected from Matrics met these requirements. They came with factory-programmed EPC numbers with a known set of test numbers provided by Matrics to serve as a control (manufacturer-specific “real” EPC numbers were not obtained from EPCglobal).

As the project team worked through the design with the participants’ packaging, regulatory, and quality assurance experts—along with EPCglobal and the FDA—a number of issues arose that provoked the need for changes and additional features:

- **Removable Tags and Adhesives** – The project involved tagging trade packages containing real product. Pharmacists typically remove the product from these packages and dispense the medication to patients in vials.3 Even though it was not expected such products would ever be dispensed in the original trade package, to avoid consumer concerns the group worked toward making tags removable to reduce the chances that tagged product would end up in a consumer’s hands. At the same time,

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3There was one exception: one product was in a blister pack and designed to be consumer dispensable.
time, the team needed to find an adhesive that would allow the tags to stay on during handling through the supply chain and avoid potential negative interactions with packaging or drug composition.

A group of specialists in labeling and quality assurance designed an innovative two-ply “coupon-style” tag. A clear base layer remains on the product for its lifetime, but the actual RFID tag, while adhering during the course of normal handling, can still be peeled off. With the two-ply “peel label” solution, manufacturers were able to use an adhesive that had been pre-approved for the clear base. Matrics (who made the tags) and CCL (who converted the tags into the two-ply labels) were able to use an adhesive that was appropriate for the RFID tag and that would have sufficient tack to attach to the base film.

- **Design and Placement** –
  Though tags needed to be small, they also had to be highly visible. Manufacturers wanted to ensure the tags were removed from their products prior to dispensing to consumers. Retailers were similarly keen to avoid consumer concerns. The tag label was designed using a bright orange color to ensure visibility for pharmacists.

- **Tag Label Design** –
  The project team went through several iterations on the information printed on the tag label. This was as a result of the group’s desire to align with the public policy guidelines established by EPCglobal and the fact that the specific approach for implementing the guidelines was still evolving. (Many of the guidelines had originally been developed within the context of consumer packaged goods, which were not appropriate for pharmaceutical products.) Dialogue between the project team, EPCglobal, and the FDA resulted in the final tag label design that included wording (“Inventory control tag. Tag may be removed”), a human-readable EPC number, and the EPCglobal logo.

After the project was completed, the tags were removed from the products, and the products were put back into inventory for normal distribution.

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**Figure 2. Physical Architecture Overview**

![Physical Architecture Overview](image)
4. Technical Design

The goal of the project was to determine if RFID/EPC technology could enable and improve areas where key business issues exist. It did not set out to prove that the project’s technical solution was an exact right fit for each company’s specific situation. The technical infrastructure spanned 10 organizations that collected, analyzed, and acted on data generated by EPC movements. The architecture utilized a distributed network of readers and servers composed of four primary components:

- The **RFID reader and antenna** provided the input for the entire system. This component collected tag data from products and cases. Readers and antennas were located at each node in the supply chain.
- The **local manager** temporarily stored reader tag data, acted as the reader controller, and formatted EPC data so that it could be sent to the central manager. Each company had a local manager that could control many readers.
- The **central manager** was where the bulk of the functional logic resided and where tag data was permanently stored. The central manager was hosted in an Accenture data center, which included the capability to centrally monitor the local managers.
- A **PC with a Web browser** was used to access the application on the local and central managers, and control the readers.

The team advocated a buy (versus build) approach, and sought components aligned with emerging EPCglobal standards and which would allow flexibility for expansion during future releases. The architecture also needed to provide a secure channel for data collection, distribution, and storage.

Manhattan Associates’ solution was selected since it provided the required functional capabilities along with a bundled RFID middleware capability. As discussed earlier, Matrics tags were selected. Consequently, this factor drove the reader selection decision. It should be noted that vendors selected for this implementation were selected based on the specific functional requirements outlined by the project team. No particular preference or vendor qualification beyond the scope of this project is indicated or implied.

The figure above shows the primary components in the project environment and where they fit into the infrastructure.
5. Working with Key Governing Bodies

Given that RFID/EPC is very new to the pharmaceutical space, it was important to understand the direction and policies of key public policymakers such as the FDA and EPCglobal to make the project’s activities effective.

**FDA**

From the project’s outset, participants sought guidance by the FDA on certain regulatory issues such as labeling, electronic records, and the effect of the electromagnetic energy associated with RFID on product quality. Regarding labeling and electronic records, the FDA decided to exercise “enforcement discretion” as applied to this specific project.

However, the FDA did request that manufacturers share the results of any product quality testing they conducted that investigated whether there were any effects of electromagnetic energy on drug efficacy, potency, and strength. The pharmaceutical manufacturers developed and executed a testing protocol for the products and technology involved in this initiative, which was shared with the pharmaceutical industry. Once the analysis was complete, the results were shared with the FDA. As initially expected, based on the measurements taken, no adverse effects were found on the products that were tested, and the team moved forward using live product during this project. Testing proved a valuable exercise, since it provided factual data on the effects of electromagnetic energy on product quality.

**EPCglobal**

In addition to setting industry-driven standards for EPC, EPCglobal is also providing guidelines on the visual appearance of tags and communications for consumer awareness. EPC standards have evolved based on requirements driven by industries such as consumer products and retail. To complete this project, the team coordinated with EPCglobal to adjust the tag’s visual and verbal characteristics, so that they were appropriate for pharmaceutical products. As the industry moves forward with RFID, EPCglobal’s focus and standards will expand and mature to help make RFID projects in the pharmaceutical space more effective.

6. Special Project Decisions

**Inferences Regarding Case Integrity**

Due to the inherent physics limitations of UHF radio waves and their inability to penetrate certain materials (e.g., liquids and metals), initial tests indicated that not all units within a case could be consistently read by a reader. An important component in the project was the decision to make inferences about case integrity and authenticity. That is, even if only a portion of the individual units within a case were read, all the units could be inferred to be within the case by their association with the case tag. Depending on future business requirements and processes, inference logic may be unacceptable. Alternate approaches involving customized packaging/reader antennas, the use of high-frequency tags, and adjustments to processes—as well as matured technical solutions—may need to be leveraged to make unit-level tags trackable nearly 100% of the time.

**Limitations to Data Visibility**

All participants in the project have major concerns with the potential to allow competitors to gain visibility into confidential company data such as inventory levels, shipping/receiving schedules, and prices. The project reinforced the need to establish sound, principle-based data-sharing work processes. For purposes of this proof of concept, the intent was to work with each organization to create a simple solution that demonstrated the project’s ability to restrict confidential data. The final data visibility scheme was developed using three guiding principles:

1. **Visibility was favored over restricted access.** It was understood that in potential future releases, data access and visibility would likely become more restrictive.

2. **Authorization rules were kept simple.** The processing logic behind data access and visibility was such that there was no confusion among users as to why an organization’s visibility was enabled or restricted.

3. **The solution demonstrated the ability to keep sensitive data confidential.** The project exhibited the ability to restrict access to certain data based on the users’ identity and their possession of the appropriate tag information.

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*Only solid dosage form products were subjected to this testing and were used in the project.*
7. Verifying the Solution

Working through the various business scenarios the team had established, and going live with the selected RFID technology to execute them, comprised a stage of work called Verification. Prior to Verification, the team conducted a conference room pilot from April through May 2004, to simulate a real-life supply chain from manufacturer to wholesaler to retailer. This involved testing the system, training users, and creating a demo of the new environment to show interested parties outside the project.

Additional final preparations included:

- **Supply Chain Analysis** – Documenting how and when product would move through the supply chain. To the extent possible, the team wanted to test each scenario for each product at each location. Doing so required the team to conduct a supply chain analysis that laid out step-by-step volume flows describing what, how, and when the nine participant companies’ locations would be shipping to each other.

- **Exception Processing** – In order to make the scenarios as realistic as possible (and to demonstrate how RFID might enable the handling of them), the team planned into Verification a number of exception simulations and forced these exceptions to occur. The five “exception groups” were theft, counterfeit/diverted, logistical error, expired, and recall.

The team conducted a conference room pilot to simulate a real-life supply chain—from manufacturer to wholesaler to retailer.
8. Verification Results

The project was intended to assess the feasibility of leveraging RFID/EPC technology in an end-to-end supply chain context. The Verification stage of the project showed positive movement in that direction in two ways.

First, the Verification stage demonstrated that the RFID/EPC tags and readers were largely successful in and of themselves as mechanisms for tracking and tracing product.

The project team set out to track 10 “real” products (not just empty bottles) through 15 locations. The manufacturers were required to verify the readability of the tags before applying them to the products. Then they were able to commission individual EPC numbers for specific product units and cases. The common hardware components selected for the project were quite reliable. Solid-dose packaging (bottles) as well as blister packaging could be read and tracked. In this limited proof of concept, the system was able to dramatically increase the visibility of the project’s selected products as they moved through the supply chain.

The application tracked tag readability statistics during Verification. The project team was able to read 98.6% of the case tags. In addition, when units were inside a case, the team was able to read 96.8% of the unit tags. Once Verification was complete, 99.9% of returned tags were functioning.

As the project progressed, and as personnel at various locations became more comfortable with the technology and how it worked, read rates improved. In addition, personnel found that success in read rates was often related to 1) time and diligence spent trying to read (e.g., holding the units/cases to reorient the tag in relation to the antenna), and 2) the number of antennas implemented.

Second, the Verification stage demonstrated the ability of this project to use RFID/EPC technology to execute 16 pharmaceutical industry scenarios at all 15 locations for all 10 products—a major undertaking.

The project’s system and processes were able to simulate in a live environment a range of conditions in the supply chain. Nearly 30 participant personnel gained experience in working with the 16 scenarios, which allowed them to see how RFID/EPC can surface information about “suspicious” or irregular shipments such as potentially counterfeit or stolen products. By having continual real-time access to pedigree information on specific units, they were provided with much-improved visibility into where product was at all times and could query the system to track down missing product.
9. Key Conclusions

The project helped establish key facets of an industry operating model.

By creating a proof of concept that engaged major sectors of the supply chain, participants gained insight into what processes and supporting systems need to be in place to construct an industry operating model. The safety and security of the supply chain was a critical focus of the project. The new operating model will ultimately require unit-level serialization of products which could enable systematic detection of counterfeit product if it enters the supply chain, a previously unavailable capability. In addition, the project:

- Assessed the potential for RFID/EPC to electronically address important regulatory mandates such as the Florida Pedigree Requirements. This technology offers the potential to eliminate the need for a paper-based pedigree system, which is labor intensive and unreliable.
- Helped to establish business rules and processes to facilitate returns, and designed a recall process that may provide a more efficient manner to execute this process using RFID/EPC technology.
- Developed and executed testing protocols that provided data indicating that electromagnetic energy did not affect the efficacy, potency, and strength of this project’s solid-dosage products.
- Contributed research and developed workable solutions on tag frequency, label color, size, wording, and location on packages that could represent going-in positions for the industry.

The project allowed participants to rapidly learn and create innovative responses to significant project issues.

The project team addressed and resolved several critical practical matters in this first broad application of RFID/EPC. For example:

- Numerous obstacles on EPC tags were overcome to prove that pharmaceutical products can be tagged at the unit level. The project team showed that human readable numbers can go on tags and be used as a method of redundancy in case the tag is not functioning. It established an innovative two-ply tag system that worked well and satisfied the needs of manufacturers for adhering to the bottle during normal handling, but that could also be removed to reduce the chances of tags getting into the hands of consumers.
- The project arrived at some tentative solutions to address data visibility and security—a practical start in surfacing and exploring an issue that will likely be a key adoption hurdle for RFID/EPC in the industry.

The selected technology suite was completely appropriate and workable for the parameters of this project.

The primary objective was to focus on assessing business value, not on perfecting the technology. Furthermore, the project team needed to choose components that fell within the agreed-upon time and budgetary limits of this project. The team selected commercially available solutions and implemented them so that business scenarios could be run and experiences gained with reasonable effectiveness. It was understood that the solution would not be optimized for each location. For example, the single antenna used in the project was chosen for its simplicity and ease of use. Naturally, in a scaled-up version of the project, there would be multiple antennas throughout the facilities and dramatically enhanced capabilities (e.g., multidirectional reading).

4 Discussions with regulatory bodies would be required to finalize such a capability.
It should be noted that the level of complexity to do a “simple proof of concept” was greater than anticipated given all the different participant companies involved. Such complexity is likely to grow much above what was present in this simple test environment as integration requirements grow.

The project underscored the importance of meeting infrastructure prerequisites to prepare for industry-wide adoption of RFID/EPC.

There are immediate measures that manufacturers, wholesalers, and retailers can take as preconditions for being effective with RFID/EPC technologies. For example, the broader lessons and issues on this project can be addressed through smaller scale initiatives within the four walls of organizations looking to implement RFID/EPC.

Implementing RFID/EPC technology affects many disciplines within an organization, and companies must work on integrating their efforts internally.

Implementing RFID/EPC technologies in any company requires close coordination and involvement across the organization—representatives from information technology, quality assurance, regulatory affairs, public relations, packaging, and operations for manufacturing, distribution, and stores. One specific example was the need to address public perceptions about the industry’s goals in exploring RFID/EPC. Reassuring consumers will be a major task that many functional groups will need to address.

A collaborative, cross-supply-chain approach proved effective in pooling resources and sharing development assets in order to gain benefits.

It is unlikely that any single member of the group could have gone as far as it did, or at the level of cost, without the collective knowledge, experience, assets, and learning of the others. No single firm could test the RFID/EPC technology and duplicate the interaction of the entire supply chain. Manufacturers, wholesalers, and retailers worked well together to address industry issues. The collective voice and collaboration of the supply chain participants were among the advantages to this group approach. For example, the project team identified and brought to the attention of EPCglobal and the FDA the need for standards and business practices relating to the use of RFID/EPC technologies that address the unique needs of the pharmaceutical industry.

The presence of an independent, trusted third party was also essential to keeping the group on a single path—facilitating collaboration, completing the project in accordance with the agreed-upon timeline, and coordinating external communications about the project. The coordination from a technical perspective was also important. Many different organizations and individuals (data center administrators, VPN engineers, facility engineers, network specialists, security specialists, etc.) needed to be orchestrated and move in concert to complete the design, deployment, and support activities.
It is unlikely that any single member of the group could have gone as far as it did, or at the level of cost, without the collective knowledge, experience, assets, and learning of the others.
Full-scale implementation on an industry-wide basis will be more complex than many believe, requiring more time than anticipated to refine issues unique to the pharmaceutical industry. Requirements for systems and packaging—especially in addressing data sharing and consumer concerns—in this highly regulated environment will present greater costs and efforts than those of other industries.

Other key conclusions about RFID/EPC’s future include the following:

The technology must continue to evolve for an effective full-scale industry implementation.

RFID technology is improving every day. Vendors, hearing recent feedback about practical applications of the technology, are responding appropriately and quickly. An example of an issue being addressed by vendors is tag quality. At each step of the process of converting the tag into the label, a sizeable percentage was not usable due to problems with the tags, labels, or printing. The rate of defective finished tag labels (approximately 20%) would not be acceptable outside this project’s limited scope.

Tag manufacturing and converting processes will need to improve significantly to provide tags with defect rates at least as low as other packaging components that pharmaceutical manufacturers currently use. The technology will also need to advance such that tags will function effectively with liquids, biologics, and cold chain products, among others, as well as in mixed-tote shipments. Finally, tag costs need to decrease significantly.

Additional technology issues that must be addressed include:

- In order to support the type of distributed network that an RFID implementation requires, updates will need to be made at all locations to support communications to new RFID data exchange partners.
- The testing of hardware after deployment is critical to ensuring that both networks and hardware are configured properly. This can be a time-consuming activity that needs to be taken into account when multiple organizations are all trying to coordinate and move to the same schedule.

The participants’ understanding and experience in working with RFID/EPC in the pharmaceutical industry has grown tremendously; but they need to keep learning.

The project was highly valuable in how it surfaced issues that the team either did not contemplate going in or did not believe would present difficulties. The highly regulated nature of the industry and privacy concerns drove many of these. For example, time-consuming issues were encountered around tag size, wording, acceptable adhesives, and location, to name a few. Working through these issues has provided valuable insight.

Other issues, however, will require additional study. For example, it will be critical to determine how to devise scaleable solutions that address data security and visibility. So will solidifying the steps to obtain validation for systems and processes, as well as approaching the significant effort to integrate RFID/EPC technology with core transaction systems. The table at right shows the range of potential issues to widespread adoption of RFID/EPC.

The industry needs to continue to actively engage with Federal/state regulatory agencies, standards-setting organizations, and industry trade associations to gain involvement in forthcoming releases of this project.

Creating reasonable consistency of standards globally should be a key goal. It will also be critical to mutually establish timetables that reflect the state and effectiveness of RFID/EPC technology and associated processes, and the pharmaceutical industry’s experience in leveraging them.
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<tr>
<th>Key Project Characteristics</th>
<th>Potential Issues for Widespread Adoption</th>
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<tbody>
<tr>
<td>The solution operated with a centralized system and a single instance for all companies.</td>
<td>What would be the development time and investment implications of creating a decentralized, heterogeneous environment?</td>
</tr>
<tr>
<td>Tags were placed on packages manually, on the exterior, at the manufacturers’ distribution sites.</td>
<td>How could tags either become integral to packaging or at least be applied automatically?</td>
</tr>
<tr>
<td>There was no integration of systems; this system was a standalone, parallel system that required duplicate data entry.</td>
<td>What would be the development time and investment implications of integrating RFID technology and applications with core transaction and other legacy systems?</td>
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<td>There was “full” visibility of information (or more visibility than would probably be permitted outside the project).</td>
<td>What would be the process for sorting through and managing restrictions on visibility—and how would those outcomes impact the value of RFID/EPC?</td>
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<tr>
<td>The team made inferences regarding case integrity.</td>
<td>What steps would be needed to achieve close to 100% readability at the unit level?</td>
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<tr>
<td>The project focused on a subset of processes that when improved by the use of RFID/EPC would provide varying amounts of benefits to each segment of the supply chain.</td>
<td>How could separate components of the supply chain be addressed that do not provide benefits to all supply chain segments—e.g., pharmaceutical retail operations and warehouse management—without undercutting the learning and value of having an end-to-end supply chain involved?</td>
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<tr>
<td>The system was not validated.</td>
<td>What would be the process for obtaining validation?</td>
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<td>Only cases and units were tagged at the manufacturer.</td>
<td>What about pallets, interpacks, and totes? What about co-packers or repackaging occurring at locations other than manufacturers?</td>
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<tr>
<td>Solid dosage products with easy handling requirements were selected.</td>
<td>What about liquids and biologics with “difficult” handling characteristics (e.g., refrigeration requirements)?</td>
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<tr>
<td>EPC test numbers were used.</td>
<td>What happens when “real” EPC numbers are used?</td>
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<td>A single antenna was used in a secluded area of the distribution center.</td>
<td>How would multiple antennas placed in ideal locations (some of which may already have little space, or environments with physically challenging conditions such as susceptibility to extreme temperatures, shock, dirt, and damage) be effectively installed?</td>
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<tr>
<td>The project operated in a virtual team environment, with a central coordinating group working with local contacts at each company.</td>
<td>How would a centralized management structure work, when a larger team and more complex activities would need to occur locally at each company?</td>
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<tr>
<td>Reasonably easy control of consumer privacy issues could be achieved by manually removing tags from packages.</td>
<td>What issues would be involved in mass tagging?</td>
</tr>
<tr>
<td>Given its narrow scope, the project played a very limited role in educating consumers about RFID/EPC.</td>
<td>What effort would be involved in educating consumers about RFID/EPC’s benefits and dispelling misconceptions?</td>
</tr>
<tr>
<td>The project included large companies from three segments of the pharmaceutical supply chain—manufacturers, wholesalers, and chain drug retailers.</td>
<td>How can other segments of the pharmaceutical value chain (biotechs, hospitals, clinics, independent pharmacies, mass merchants, secondary wholesalers, etc.) be included to broaden industry adoption to achieve greater benefits? How can small businesses be involved?</td>
</tr>
</tbody>
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Radio Frequency Identification technology (RFID) is an advanced method to collect product, event, and/or transaction data quickly and easily. Items to be tracked are tagged with a small chip and antenna. When the tag is in close proximity of a reader, it receives a low-powered radio signal and interacts with a reader exchanging identification data and other information. Once data is received by the reader, it can be sent to a computer for processing.

The Electronic Product Code™ (EPC) is an identification scheme for universally identifying physical objects via RFID tags and other means. EPC technology allows everyday objects to be uniquely identified and connected in a dynamic, automated supply chain that joins businesses and consumers together in a mutually beneficial relationship.

Bar coding is a line-of-sight technology, meaning that each individual item has to be handled to scan the bar code with a reader. In addition to being labor intensive and time consuming, this method has potential for error in reading the same unit twice or missing a unit because it is done at the item level, not the serial number level. RFID tags enable automatic, non-line-of-sight identification, reducing the possibility of errors and the labor necessary to achieve the same results. Although the EPC numbering standard uniquely identifies products, its implementation will evolve over time with applications driven by market and consumer demand. Therefore, bar codes and RFID tags will coexist for some time to come.

**11. Glossary**

**RFID**

Radio Frequency Identification technology (RFID) is an advanced method to collect product, event, and/or transaction data quickly and easily. Items to be tracked are tagged with a small chip and antenna. When the tag is in close proximity of a reader, it receives a low-powered radio signal and interacts with a reader exchanging identification data and other information. Once data is received by the reader, it can be sent to a computer for processing.

**EPC**

The Electronic Product Code™ (EPC) is an identification scheme for universally identifying physical objects via RFID tags and other means. EPC technology allows everyday objects to be uniquely identified and connected in a dynamic, automated supply chain that joins businesses and consumers together in a mutually beneficial relationship.

**Bar Coding and RFID/EPC**

Bar coding is a line-of-sight technology, meaning that each individual item has to be handled to scan the bar code with a reader. In addition to being labor intensive and time consuming, this method has potential for error in reading the same unit twice or missing a unit because it is done at the item level, not the serial number level. RFID tags enable automatic, non-line-of-sight identification, reducing the possibility of errors and the labor necessary to achieve the same results. Although the EPC numbering standard uniquely identifies products, its implementation will evolve over time with applications driven by market and consumer demand. Therefore, bar codes and RFID tags will coexist for some time to come.

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5. EPC Tag Data Standards, Version 1.1 Rev. 1.24
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