



Whitepaper

# RFID: From Pilots to Production

## A look at the state of the RFID industry

### Table of Contents

Five Years of Progress	<b>3</b>
A Clear Case for ROI – In and Out of the Supply Chain	<b>3</b>
Learn from Others' Experience	<b>5</b>
What to Look for In Products	<b>6</b>
Readers	<b>6</b>
Tags	<b>7</b>
Get the Most Out of the RFID Transformation	<b>8</b>
RFID Glossary	<b>9</b>

With its origins in WWII-era radar technology, radio frequency identification (RFID) has passed through an explosive evolution in the last nine years.

Starting with the MIT AutoID Center in 1999, whose top goals included tags inexpensive enough to use on consumer goods, the RFID community has created a powerful technology that solves a large and growing number of business problems now. Though RFID has gone through the ups and downs typical of a revolutionary technology, the value chain for RFID is now complete, and users across a variety of industries are using it to save money and enhance competitiveness. This paper surveys the state of the industry and offers suggestions for users to keep in mind as they apply this useful business tool.



The first wave of Electronic Product Code (EPC) RFID adoption was largely driven by retail and government agency mandates. Early EPC technology was expensive and immature and lacked the performance required for many applications. In addition, the value chain of solution providers, software and process knowledge did not yet exist. Many companies applied the tags and installed the portals required to meet external mandates, but they didn't incorporate RFID into their business processes, choosing instead to wait for real-world RFID success stories with documented return-on-investment to show the way.

Less than ten years of rapid and enthusiastic evolution have led to a mature technology based on standards and supported by a deep selection of products and services. RFID's unique capacity for truly automatic data capture reveals it to be not merely a replacement for barcodes, but a unique technology that delivers a clear and rapid return on investment. Performance gains in the most recent wave of Generation 2, or "Gen 2," readers and tags have made EPC RFID preferred for many applications previously served by other technologies.

Examples include:

<b>Application Now Possible with Gen 2 UHF RFID</b>	<b>Technology Formerly Used</b>	<b>Advantage Gained by Moving to UHF Gen 2 RFID</b>
Document Tracking (Legal and financial services firms)	HF RFID, bar codes	Lower cost, better chain of custody and location information
Portable Equipment Tracking (Hospitals)	Active RFID	Lower cost, less maintenance and wider selection of supporting products
Baggage Tagging (Airlines and airports)	Bar code, manual	Higher accuracy and lower labor costs
Work-in-Progress Tracking (IC, textiles and automotive manufacturers)	Bar code, human readable label	Higher accuracy and more accurate order fulfillment
Retail, In-store, Inventory Control (Apparel, books)	Manual count	Faster, lower cost and more accurate

To ensure success, new users of RFID should follow classic guidelines for project management and technology adoption as they move from pilots to commercial implementations:

- › Apply the same investment metrics to RFID as to other essential business technologies
- › Take advantage of education opportunities to become a smart consumer
- › Select an achievable scope, measure results and learn from experience
- › Scale up on the foundation of smaller, successful projects
- › Demand enterprise-class manageability and reliability from hardware vendors
- › Demand flexibility and accountability from service providers



### **Five Years of Progress**

RFID hype was on the rise when Wal-Mart and Department of Defense (DoD) announced their mandates in 2003, but EPC-compliant technology was new. As is typical with the early waves of technology adoption, standards were being developed. In the early years, achieving seamless interoperability and high performance was challenging and integration with enterprise software was labor-intensive. And since RFID wasn't integrated into business processes, many organizations implemented manual processes, such as slap-and-ship tag application, which often devoured potential ROI.

The last five years have seen accelerating progress. Two years of focused development by EPC pioneers and the MIT AutoID Center led to the Gen 2 protocol, a milestone in RFID evolution that has closed all of the major gaps at the hardware level. The second wave of new Gen 2 ICs, tags and readers have advanced to the point that performance is exceptional, costs are dropping and interoperability is a given. Software applications have evolved into sophisticated resource and information managers connected to enterprise software through mature, standards-based interfaces.

Standardization is inevitably good for the customer, as it drives the creation of a wide selection of products at a lower cost, and RFID is no exception. Tag, reader and software vendors have worked closely on interoperability, and as with the second wave of Gen 2 ICs and readers, interoperability among vendors' products is smooth. RFID technology has reached a stable plateau with Gen 2; Gen 2 products and services will deliver effective solutions for years to come. New standards waiting in the wings can and must defer to Gen 2 to maintain backward compatibility.

The entire RFID ecosystem has come of age. Solutions providers have invested in training and lab facilities, and have honed real-world application expertise. RFID software specialists have moved beyond middleware and have begun delivering field-proven, use-case-specific applications that enable rapid generation of working solutions. Encouraged by the development of industry standards, major technology companies such as Microsoft, Intel, Oracle and IBM have made significant investments, which puts standard, interoperable RFID within the grasp of many more users. Major enterprise software applications such as SAP can now access RFID data delivered through popular business software applications from companies like Red Prairie, Oat Systems, GlobeRanger and Tibco.

### **A Clear Case for ROI – In and Out of the Supply Chain**

As RFID products and services have developed, the promise of RFID has become apparent to many inventive solutions providers and users. In this post-mandate wave of RFID implementation, closed loop, non-mandate applications predominate. Though supply chain mandates remain the No. 1 driver of RFID adoption, several other RFID-enabled applications have the attention of more than half of companies surveyed. According to the Aberdeen Group's RFID Benchmark Report of 2007, 66 percent of companies surveyed named material/product tracking in the top five at the No. 2 spot. Also named are security (64 percent), asset management (62 percent) and increased visibility to business events (58 percent).



RFID success examples include:

- › **Apparel Inventory Management.** One large apparel manufacturer identified an 80x reduction in labor expenses by moving from a monthly physical inventory count to an RFID-based inventory system in a group of its retail stores. With RFID, what once took four employees 2.5 days has been reduced to an hour, which allows the retailer to measure inventory more frequently and at a lower cost. To the surprise of the retailer, the implementation of RFID revealed significant accuracy problems in the original manual process, which will reduce stock-outs. The company projects annual cost savings of more than \$10 million per year after system-wide rollout is complete.



- › **Material Process Control.** An Italian textile manufacturer achieved a 30 percent return on investment in just nine months with an RFID fabric-roll tracking application. The manufacturer produces more than 300,000 rolls of fabric every year. Fabric is tracked through the manufacturing process which is complicated by a large number of unique, customer-selectable configurations. In addition to cost savings, the textile manufacturer improved customer satisfaction due to a higher percentage of orders correctly fulfilled and reduced error rates in shipments. The manufacturer attributes lower costs and increased competitiveness to the RFID application.



- › **In-building Tracking of Small Assets.** FileTrail, a west-coast specialist in the management of high-value documents, provides systems to legal firms, the state court systems and financial services companies. Originally based on manual handling and labeling of the assets, FileTrail's solution now incorporates Gen 2 RFID. FileTrail clients have seen remarkable results with automatic data capture: In one instance, FileTrail reduced client time spent tracking lost files for a weekly audit from 38 hours down to 4 hours. In another instance, they cut the time spent requesting and fulfilling files from a central library by 95 percent.





- › Retail Out-of-Stocks. Wal-Mart saw a 16 percent reduction in out-of-stocks by deploying RFID, according to a study conducted by the University of Arkansas. Wal-Mart used RFID reads on cases that entered the backroom to modify their picklist processes so the processes became proactive and automatic. Sales associates no longer had to scan the shelves to determine which products were out of stock, because the system did it for them and verified that the box would be in the backroom when they went to retrieve it.



### **Learn from Others' Experience**

As companies look to transform their businesses processes with RFID, they are well-served by understanding the power of the technology and the lessons learned by the early adopters.

Organizations should apply classic investment and project management disciplines to their RFID project. In the mandate or pilot stages, determining a return on the investment wasn't always required or companies did not have a choice. But today users should apply time-honored methods for evaluating the financial benefits of a project, taking advantage of the growing number of consultants with expertise in applying these disciplines to RFID.

As with most new technology rollouts, the big-bang approach is less than optimal. It's far better to define a controlled scope. Once that initial project is completed and its effectiveness measured, then the company can apply the lessons learned to future projects. Controlling the scope, scale and breadth of deployment is necessary for success.

While the scope of your project should be specific, don't limit it to a one-for-one replacement of existing applications. RFID is not a better replacement for barcodes, for example, but a new and distinctive method for capturing real-time data faster and with lower cost. Because RFID provides data capture at a distance, without line of sight and without human intervention, it enables truly automatic data capture. Look for ways to make your processes better with RFID, rather than just automating the existing process. Take advantage of integrator experience in integrating RFID hardware, software and business process improvement organically.

RFID is a complex and powerful technology that will deliver the greatest benefits to well-educated users. Even organizations that turn to consultants and systems integrators for their RFID expertise can benefit by being smart consumers. There are many excellent venues for education, such as Alien® Academy, offered at the RFID Solutions Center in Dayton, Ohio and several other venues in the U.S., Europe and Asia. Whether you want to develop enough RFID expertise to work closely with your consultants or you want to have the expertise in-house, consider creating a company RFID 'competency center' championed by a senior executive of your company.



### **What to Look for In Products**

More than half of companies surveyed by Aberdeen Research said they planned on implementing corporate-wide programs in the next three years to focus on supply chain visibility and monitoring changes in the status of assets. With RFID becoming such an integral element of business processes, it's no surprise that companies are demanding that the technology be highly flexible, reliable and manageable. Here are some questions to ask vendors of readers and tags.

### **Readers**

As deployments scale to multiple locations, organizations are challenged by the ability to manage, monitor and control increasing number of readers in the most cost-effective way possible. It's important to select readers that can scale to meet these enterprise requirements, and in particular, that can deliver reliable data capture in real-world environments at a low total cost of ownership.



- › How easily does the reader integrate into the environment? Ease of integration with your software environment is essential. The reader should be compatible with major software platforms and RFID middleware products, such as Microsoft BizTalk, IBM WebSphere, Oat, GlobeRanger, Oracle and SAP. A short path to integration with these products will save your organization significant time and money.

Input and output connections enable the reader to integrate with external hardware like sensors and actuators. By integrating the reader with a sensor on a dock door, for example, the reader can turn on and read products as they move out of the distribution center and onto the truck. This can also trigger horns and light stacks that indicate a need for human intervention. Many readers support remedial versions of this input/output (I/O) capability. For demanding applications, look for the "industrial-strength" variety, consisting of optically isolated, noise-resistant, high-capacity connections.

A robust API with a well-documented software development kit (SDK) is essential for custom software interfaces. Even the most powerful reader has limited usefulness if it lacks an SDK when you want to customize it for your specific process. Make sure that your environment is supported. Not all readers support all popular software development environments such as .NET and Java.

- › What's the total cost of ownership? Keep in mind that hardware is only one part of the total cost of each read point. In addition to purchasing the reader, make sure that AC power and a LAN connection are available. Once installed, the reader must be tuned to the environment.





Also consider the ongoing cost of management. A reader that's designed to be easy to install, monitor and manage will save you money in the long term.

The reader should enable management remotely. Make sure your reader hardware can be remotely upgraded with new firmware. The cost of maintenance and acquiring technology improvements can be prohibitive unless it can be done remotely. The ability to monitor and maintain readers remotely is especially important for multi-site deployments to minimize on-site staff involvement and expense.

- › What's the read rate in a noisy environment? Readers should show minimal reduction in read rates in the vicinity of other readers. This requires both that readers emit low levels of noise themselves and have the ability to reject noise from other devices. Noise comes from many sources, including large numbers of readers operating in proximity to each other as well as other electric equipment. Performance in a dense reader environment is particularly important as companies expand the use of RFID more widely.

Look for readers that will perform under real-world conditions, and test the performance yourself. Don't just go by the specs on the data sheet. Evaluate readers in a practical environment such as a dock door or a conveyor where there may be other readers and equipment that can be a contributing factor to noise.

- › How reliable is the reader? Reliability can be measured in several ways, including availability and data collection. Ask the vendor about the reader's mean time between failure (MTBF). Examine how the reader is designed: If the reader has disks, fans or other moving parts, they can negatively impact the MTBF.

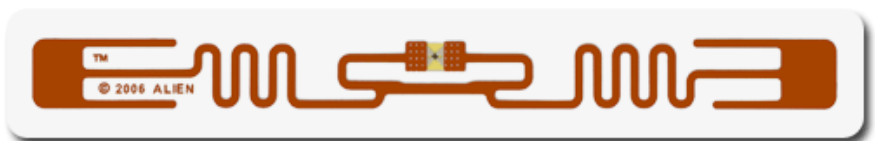
Determine if the reader supports autonomous operation, so that it can continue to collect data if the LAN connection is lost. Some readers use non-volatile memory to protect data in the event of a power failure. In the end the cost of data collection can be reduced if steps are taken to protect the data after capture.

### Tags

As with readers, tag technology has matured. The second wave of

EPC Gen 2 ICs provides enhanced range, which results in higher read rates. Here are some questions to ask potential tag vendors:

- › What sizes are available? The smallest tag isn't necessarily the least expensive. When determining the tag size for your application, consider high volume, mainstream options first and then migrate to high-end or custom options if necessary. Tags optimized for high-volume, 4x6 shipping labels, such as the Alien Squiggle®, pictured below, typically cost less due to economies of scale.
- › What materials do the tags operate with? Look for tags that operate on a variety of materials. Newer tags with flat frequency response maintain sensitivity on a variety of materials. Materials previously considered difficult to tag have become much easier with the use of these World Tags. Be cautious, but not deterred, by concerns about metals and liquids. While metals reflect RF energy, experienced integrators have developed techniques for





using the metals in packaging to restore and even improve tag performance by using the metal like a waveguide or antenna extension. Liquids absorb the RF and have traditionally been hard to tag; however, newer tags and better tag placement techniques have minimized this issue in many applications.

- › What geographies do the tags operate in? There are three main frequency bands in use in EPC RFID applications: 902-928 MHz (Americas and mainland Asia), 865-867 MHz (Europe and many UK Commonwealth countries) and 952-956 MHz (Japan). Many older tags show dramatic performance differences depending on where you use them. To save money on hardware and integration, choose tags that behave similarly wherever you need to use them. Alien World Tags, such as the Squiggle, are designed to operate uniformly around the world, simplifying hardware design and expense at each location.

### **Get the Most Out of the RFID Transformation**

Getting the most out of your RFID initiative is predicated on multiple factors. It's critical to understand the potential and reality of this revolutionary technology so you can envision how to benefit from it. Conduct a thorough analysis of the business value and define a business case backed by a clear return on investment before proceeding. With the help of your experienced partners, define a specific scope for your project with specific, measurable objectives. Get educated—education is critical to being a smart consumer of both hardware and services. When choosing RFID partners, look for real-world experience with name-brand hardware and software.

RFID is a powerful, transforming technology that can deliver process efficiencies with a clear return on investment. To maximize opportunities for success, companies should follow industry best practices for project management and technology adoption as they move from pilots to production implementations: apply the same investment practices to RFID as to other essential business technologies; demand a low cost of ownership; and enterprise-class reliability and flexibility from the RFID system vendors. Users who apply these common-sense disciplines will realize improved competitiveness and lower business expenses when they apply RFID for automatic data capture.





### **RFID Glossary**

EPC Class 0	An early, now obsolete, EPC RFID class characterized by read-only tags.
EPC Class 1 Gen 2	Alternative name for Generation 2, the second generation of the EPCglobal Class 1 specification, featuring a number of advancements that significantly boosted system performance over Class 1 Generation 1.
EPC Class 1	An obsolete, EPC, passive RFID class characterized by the ability to write tags in the field. Also refers to the EPCglobal specification defining the tag-reader protocol for RFID systems of this class.
EPC Class 2	An EPC RFID class characterized by the ability to read and write tags in the field and to support expanded memory structures in the tag. This class is largely obviated by Gen 2, which delivers robust read-write capability and a significant subset of the memory capability found in Class 2. No Class 2 specification has been ratified as a result.
EPC Class 3	An EPC RFID class characterized by passive tags that are battery assisted to enable longer range and the addition of sensors and other external functions such as temperature monitors.
EPC Class 4	The EPC RFID class that corresponds to active transmitter RFID, in which the tag broadcasts first using a battery-powered, active transmitter.
EPC	Electronic Product Code
EPCglobal	The industry association and standards organization consisting of users, academics and hardware, software and services vendors who are committed to providing a standards-based business technology based on RFID.
Gen 2	Generation 2, the second generation of the EPC Class 1 UHF RFID specification, featuring a number of advancements that significantly boosted system performance.
HF	High Frequency, defined as 3 MHz to 30 MHz. In the context of RFID generally refers to products operating at 13.56 MHz.
Mandate	In the context of RFID refers to directives given by Wal-Mart and the United States Department of Defense in 2003 and 2004 that required their suppliers to begin tagging shipments of products shipped to retail stores and distribution centers.
Passive RFID	RFID systems that derive their operating power from the radio beam emitted by the reader, and communicate by bouncing the reader signal back to the reader with added digital data, a process known as backscattering.
Read rate	The percentage of tags successfully captured by the RFID system.
RFID	Radio-Frequency Identification
UHF	Ultra-high frequency, defined as 300 MHz to 3 GHz, but in the context of passive RFID, usually refers to the 860 MHz to 960 MHz band.



Whitepaper:

## RFID: From Pilots to Production



Alien Technology  
18220 Butterfield Blvd.  
Morgan Hill, CA 95037  
866-RFID NOW  
[www.alientechnology.com](http://www.alientechnology.com)

Copyright © December 2007 Alien Technology Corporation. All rights reserved.  
This document is provided "AS IS" and ALL EXPRESS OR IMPLIED CONDITIONS, REPRESENTATIONS AND WARRANTIES, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT, ARE HEREBY DISCLAIMED. This document is protected by copyright and distributed under licenses restricting its use, copying, distribution and decompilation. No part of this document may be reproduced in any form by any means without prior written approval of Alien Technology Corporation.

Alien, Alien Technology, the Alien logo, Squiggle, the Squiggle logo, Nanoblock, FSA, and Gen 2 Ready are trademarks or registered trademarks of Alien Technology Corporation in the United States and other countries. Other product or service names mentioned herein are the trademarks of their respective owners.