Radio frequency identification (RFID) at HP

White paper

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Abstract

Although radio frequency identification (RFID) has been used since World War II, employing it to track physical objects is a recent development. Only since the 1990s has the potential of RFID to expedite the operation of supply chains and increase visibility into them been recognized. Thus, standards for its widespread global use in that arena are only now under development. Adding urgency to the development of those standards are recent directives by Wal-Mart and the U.S. Department of Defense that their top suppliers begin RFID-tagging goods starting in January 2005.

HP, which has the world’s ninth largest non-military supply chain, plans to comply with these directives. HP began trials and pilot projects involving RFID technology more than two years ago, both to improve its own supply-chain management and to offer new capabilities to its customers. HP’s work in RFID rests on five pillars, which are described in this paper. This paper also discusses HP’s vision for RFID, its leadership role in global standards development, RFID-related research conducted at HP Labs, internal HP RFID pilot programs, and RFID-related services and facilities available to HP customers.

Introduction

Use of radio frequency (RF) technology dates back to the development of radar during World War II. Recent work using RFID to improve supply chain management began several years ago at the Auto-ID center in Cambridge, Massachusetts. The Auto-ID Center has spun off a separate organization, EPCglobal, to promote worldwide acceptance of an electronic product code (EPC) standard.

HP is a member of EPCglobal, and Richard Lampman, HP senior vice president of research and director of HP Labs, is a member of its board. HP’s support of EPCglobal is part of its effort to promote broad adoption of the standards that will be necessary to secure the position of RFID and the global use of EPC.

HP believes RFID technology will play two major roles:

- It will provide a means of unique object identification at low cost, transforming supply chains and reducing their operational costs dramatically.
- It will be used in combination with other sensing and network technologies to track objects and physical environments for purposes beyond supply chain management—resulting in an electronic infrastructure that is intelligent and aware of its physical environment.

Currently, RFID is in essentially the same position occupied by mobility and wireless technologies a few years ago. At that time, there was great interest in the considerable promise of these technologies but not widespread adoption of them.

In early 2004, HP CEO Carly Fiorina commented, “RFID has huge potential to automate the supply chain, significantly reducing manual intervention and eliminating inefficiencies from the process.” (“Technology at the Rescue,” InformationWeek, February 2, 2004).

Over the past two years, HP has used RFID in the following ways:

- HP internal manufacturing groups have tracked key items in manufacturing.
- HP Services has tracked cassettes of wafers in a customer’s semiconductor wafer fab.
- HP internal RFID pilots have tested RFID tag and reader quality and begun case- and pallet-RFID tagging.
- HP Labs is integrating the technology with other tools—including sensors—to build intelligent monitoring systems.
HP’s current efforts around RFID technology rest on the following five pillars:

- Providing vision and innovation
- Leading the move toward global standards as well as new products and solutions
- Using RFID to achieve internal operational benefits
- Providing RFID-enabled goods, such as printers and printer cassettes, to commercial supply chains
- Providing services that help transform supply chains, including HP’s own

HP supports RFID technology through the following activities and organizations:

- RFID standards support through EPCglobal
- HP Labs’ vision and innovation
- Use of RFID in HP supply chains
- RFID product readiness for our customers
- HP Services’ flexible exploration of RFID capabilities
- Commitment to enhancing the total customer experience (TCE)
- RFID Centers of Excellence

**EPC standards**

Development of RFID technology hinges on two elements: a framework of effective standards and a global technology process. HP’s membership in EPCglobal positions the company strongly to move those objectives forward.

Key to progress in RFID technology development is the ability to identify all elements that can be connected and monitored. This requires a truly global electronic code, as distinct from the optical codes used by today’s character and barcode identification systems.

During the past few years, the Auto-ID center, a private consortium of retail, consumer product, and technology companies and MIT, has created an electronic standard of identification called the electronic product code (EPC). The focus of this effort has been in North America, but during the past year responsibility for the code has moved to the Uniform Code Council (UCC). EPCglobal has assumed responsibility for completing the transition of the code to a commercial, globally connected, and viable system.

The EPCglobal network comprises five elements:

- The electronic product code (EPC)
- The ID system (EPC tags and readers)
- Object name service (ONS)
- Physical markup language (PML)
- Savant data filtering software

The EPC, a code designed to identify a specific item in the supply chain, resides on the RFID tag, which communicates its code to a reader. The reader then passes the code to a computer or local application system known as the object name service (ONS), which tells computer systems where to locate information on the network about objects being tracked.

The common language of the EPCglobal network, used to define data on physical objects, is physical markup language (PML). The central nervous system of the EPCglobal network is Savant software, which manages readers, filters data, and moves information to the target execution system.
HP Labs—vision and innovation

HP Labs conducts research in a variety of RFID-related areas. The Labs’ sentient environments research program develops technologies and secure, end-to-end network architectures for locating, tracking, and monitoring objects and their interactions.

In this area, RFID is used in conjunction with video cameras, indoor localization technologies, and other sensors to provide a richer and more accurate picture of goods stored in warehouses and distribution centers than would otherwise be possible. The underlying adaptive network technology is based on sensor network principles, making it significantly less vulnerable to failure and malicious attacks. The end-to-end security architecture maintains the integrity and privacy of the sensor data. It also contains components that allow intelligent monitoring of the sensing devices and of the objects themselves.

Together, these technologies will result in a more adaptive, secure, and manageable RFID/sensing infrastructure with a lower cost of deployment and maintenance than current products.

Researchers at the Labs are also exploring the use of EPC network-compatible technologies for other applications, ranging from reducing product shrinkage from loss or theft to detecting counterfeit goods.

In addition, HP Labs is conducting research in:

- Nanotechnology and next-generation sensing technologies
- Innovation in business processes and adaptive enterprise
- Enterprise security

HP Labs also funds research projects at leading business and engineering schools.

While much of this research may not bear fruit for several years, the Labs’ vision and its research efforts play a critical role in HP’s RFID strategy.

Internal HP RFID pilots

HP has taken an aggressive approach to pilot testing RFID in live production areas for two reasons:

- A desire to comply with customer requests to provide RFID tags on cases and pallets of product shipments
- Strong management support for developing RFID capability in HP supply chains to gain manufacturing efficiencies

During the last two years, HP has conducted three kinds of pilot projects using RFID tags in two quite different facilities:

1. HP’s Memphis, Tennessee, facility does final packaging and distribution of printers. Here, printer inventory is maintained as a serialized inventory so that each case contains one printer with an associated unique serial number. Product/Case serialization is common in inventorying high-tech electronic products.

2. HP’s Chester, Virginia, facility handles packaging and distribution of inkjet cartridges. Here, cartridge inventory is packed with many cartridges to the case, and neither individual cartridges nor their case shipments are currently treated as serialized inventories.

The Chester model is typical of the inventorying method used in packaging and shipping most types of consumer packaged goods (CPG). However, while the shipping model is common, most CPG products are of considerably lower unit value than inkjet cartridges. Inkjet cartridges more closely
resemble pharmaceutical products in value and, like them, are more likely to be counterfeited or stolen for resale.

RFID applications are important to inventorying higher-value products. Pilots that address these applications are under consideration but are not the focus of work completed to date.

The following pilot tests have been completed or are planned as part of a full RFID implementation at several HP facilities:

- Pallet tagging at the printer distribution center site
- Case and pallet tagging at the inkjet cartridge and printer manufacturing completion sites
- Pallet tagging across the manufacturing/distribution center operations of the two sites

Operational benefits at the printer facility are expected to result from improvements in the cycle time and accuracy of serialized printer inventory at various stages in the process. This includes transfer from the manufacturing facility to the distribution center, improved retrieval of product for rework as well as “shelf-pick” and shipping in the distribution center.

Visibility into these improvements derives in part from working with an existing serialized inventory process. Because the serialization model of EPC-based systems can coexist with and, in the long term, replace existing serialization systems, benefits are expected from an improved and simplified model for this process.

The same serialization method is expected to yield benefits to downstream processes such as customer returns, warranty issues, and ultimately retirement and recycling of products. Early results from the first pilot indicated a reduction in pallet logical build process time from 90 to 11 seconds.

At the inkjet cartridge facility, the clearest benefits from the pilot are expected to result from improvements in the transfer of pallet/case-level inventory between the manufacturing and the distribution center sites. The high value of the inkjet cassettes requires case-level accuracy in verifying this transfer. This accuracy is currently achieved through considerable manual effort in inspection and verification, but RFID tags are expected to expedite this process and improve its accuracy.

HP has found that it is absolutely critical to test RFID within a live manufacturing environment, because factors such as RF reflections and absorption cannot be precisely duplicated in a laboratory environment.

HP learned a number of valuable lessons from these early RFID pilots, including these:

**Tags**
- The need for care in handling to prevent damage from electrostatic discharge
- The need for quality control programs to confirm and address field failure incidents and quickly address issues with suppliers
- The need to seek rapid innovation in integrating existing label and RFID tags

**Readers**
- The need to work closely with vendors to develop units that can be integrated with line operations involving tag application and tag reading
- The need to focus on developing readers that can be managed as wired, PoE and wireless network devices
- The need to lower reader costs and to avoid standardizing on a solution until appropriate cost standards are met

**Servers and infrastructure**
- The need to provide high availability and backup of local servers
- The need to increase reliance on wireless access to readers wherever possible
Integration with execution and enterprise systems

- The need for early solutions that maintain RFID tag data as an island separate from local control systems (HP continues to push for integration at a standards and system level)
- The realization that first efforts at integration should verify that pallet-level product quantity data from standard warehouse management systems match data in RFID tag systems
- The understanding that coordination of key processes such as inventory backflush and case-level “pick and pack” is a critical touchpoint for long-term integration of tag data and current execution systems

In addition, because collaboration and scalability must still be proven, it is important to test collaboration internally prior to shipping to a vendor such as Wal-Mart. HP will test internal collaboration between the ink cartridge site and the product completion site, which integrates cartridges into finished printers.

At all levels, our goal is to identify and implement the best solutions. This requires additional pilot tests by HP and other companies. HP’s pilot strategy involves working with a variety of vendors at all levels, working across projects, and pursuing different vendor combinations across levels of RFID technology. This is a key strategy during a period in which performance, cost, and integration of functions are all undergoing rapid change.

RFID in HP’s global supply chains

HP’s commitment to aggressive RFID testing requires a commitment to both pilot testing and global rollout of capability. The work at active pilot sites described in the previous section has been in process since 2002 and continues.

To support overall readiness for RFID-tagging goods to be shipped, HP has begun programs at sites worldwide, providing them with overall RFID education and preparing project managers to work with the best practices developed at the pilot sites.

Undertaking these pilots and achieving full supply-chain readiness simultaneously requires considerable agility, because RFID technology development is a work in progress.

HP recognizes that, although early pilots may be highly successful, it will still be necessary to plan, execute, and evaluate results before we are ready for global RFID deployment.

Beyond the logistics supply chain

HP operates five quite different supply chains:
- No-/Low-touch contract manufacturing
- Vertically integrated, high volume
- Direct configure-to-order
- Value-added systems and solutions
- Services logistics

Because each of these must be well managed, HP expects RFID to play a major role throughout the end-to-end product lifecycle. Case and pallet pilots in selected sites in the global commercial supply chain are planned for 2004. But while HP is conducting an aggressive program in this area, it is also establishing a framework to determine how best to use RFID throughout the supply chain—from inbound components to manufacturing to end-of-life retirement, including disposal and recycling.
HP understands that being able to identify products and components will create many efficiencies, even though it is still early to use RFID across products’ full lifecycles. For example, in our Sao Paolo, Brazil, facility, HP is automating identification and quality data collection at key stages of the printer production lines in order to gain manufacturing efficiencies.

Enhancing the total customer experience (TCE)

HP embraces technologies such as RFID because they can enhance TCE. With respect to RFID, HP customers experience this commitment to TCE in four major ways:

- **HP retailers:** These customers include some who are already involved in RFID and who look to HP to supply goods for their RFID framework. They range from those who are aggressively implementing RFID to those moving at a more measured pace. HP works with both groups because RFID is a collaborative technology, and collaboration across retailers and suppliers is a key to the successful implementation and use of RFID.

- **HP Services customers:** Our work with HP Services customers may include education and evaluation at RFID Centers of Excellence, hosting discovery seminars, building pilots based on HP’s pilot program experience, or designing across-the-board planning and infrastructure with customers who have committed to outsourcing relationships with HP.

- **HP Advanced Technology briefings:** With its experience in leading HP’s EPCglobal standards participation and its participation in RFID projects and technology monitoring, HP Labs provides vision and leadership that can be shared with customers who require advanced visibility.

- **HP’s individual customers:** HP wants its customers to recognize RFID as a long-term, pervasive, beneficial technology. At the same time, HP recognizes their concerns about its possible invasive aspects. To that end, HP works closely with internal and external bodies to address privacy concerns. HP’s technology leadership philosophy is expressed by Carly Fiorina: “Technology represents options, perhaps the most important thing you can offer an individual.” HP is committed to both individual empowerment and privacy.

The HP Services approach

Most companies seeking to benefit from RFID are at the early stages of the solution lifecycle, which consists of:

- Discovery
- Proof of concept
- Pilot
- Deployment
- Rollout
- Support
- Management

HP Services can acquaint enterprises with HP’s early internal pilot experience in an effort to help them speed implementation. The flexibility of the HP engagement process allows HP Services clients—who are working to comply with their own customers’ mandates—to choose from the following strategies:

- Low-cost early implementation
- Faster compliance by leveraging HP’s internal experiences
- Exploring other uses of RFID in internal operations where there appear to be clear opportunities to increase return on investment (ROI)
HP Services can enable an RFID strategy on a worldwide basis with three different regions and frequency bands. HP Services’ approach to solution enablement is solidly based on the adaptive enterprise, which is HP’s vision of an agile organization that is able to react quickly to new business challenges as they arise. This vision, as applied to the RFID environment, is particularly important because tag, reader, and middleware vendors are expected to consolidate in coming years—and, accordingly, it will be advantageous for customers to employ an RFID architecture that is flexible, scalable, and adaptable to change.

As with HP’s internal efforts, the RFID-related services HP offers must be agile in the face of both evolving technology and our customers’ emerging views of what constitutes “best value.”

HP Services maintains close contact with HP’s internal RFID projects. Our consultants’ broad industry expertise allows them to apply RFID across a wide variety of industries, including these listed here:

- **High tech**—HP’s own efforts provide a good template for work in this area.
- **Consumer Packaged Goods (CPG)**—Note that early RFID implementation is still expensive at the item level. Thus, the lower the item value, the more important solution cost becomes.
- **Pharmaceutical**—Pharmaceutical products are high value but often have a short product life. Thus, counterfeiting, security, and safety are all important issues.
- **Retail**—Because HP provides products and services to the retail industry, we want to foster collaboration in the development of RFID solutions between CPG suppliers and the retailer base.

**HP’s Centers of Excellence**

HP plans to establish RFID Centers of Excellence around the world during 2004. The Center of Excellence in Palo Alto, California, is already open. In the near future, other Centers are planned to open in Bristol, England; Geneva, Switzerland; and Tokyo, Japan.

At these Centers, HP customers can attend workshops; develop their RFID vision; share lessons learned from HP’s internal experience; attend briefings about RFID research at HP Labs; run trials and proofs of concept; and purchase scalable, upgradable RFID solutions once they are ready to take action.

Solution entry points can include any of the following:

- The RFID discovery service—for customers who want to develop their RFID vision
- The RFID adaptive starter kit—a proof-of-concept that is scalable and upgradable to meet the requirements of live environments and architectures
- The RFID readiness assessment and roadmap planning—for customers who are ready to implement an RFID solution

**For more information**

Regardless of your needs with respect to RFID, HP Services can provide a flexible, customized solution. For more information, please e-mail us at rf.id@hp.com.