WHITE PAPER

MATRICS

EPC and Radio Frequency Identification (RFID) Standards

With new technology such as RFID, standards help assimilate the technology into popular culture, defining rules for its use. RFID can dramatically change the way companies do business, but standards are required to ensure that information is shared appropriately and effectively. The EPC was chartered with the intent to establish and oversee defined standards for the emerging RFID market. Matrics, as a key provider of RFID technology, seeks to support the implementation of standards of use. This paper examines the EPC's function and objectives, and explores ways that RFID can be effectively utilized with minimal risk to improve ROI as a proprietary supply chain solution.

Larry Blue - Vice President of Engineering Development, Matrics
Kevin Powel - Sr. Director of Product Development, Matrics

8850 Stanford Boulevard Suite 3000
Columbia, MD 21045
t. 410.872.0300 f. 410.872.0700
www.matrics.com

EPC and Radio Frequency Identification (RFID) Standards

Introduction

Standards govern many parts of our everyday lives. They define sets of rules that we use to communicate with each other, the metrics we use for commerce across the globe and the methods and values we apply to almost everything we do. Standards establish acceptable practices and the metrics we use to quantify those practices. When new technologies surface that affect our lives, standards can help to assimilate those technologies into popular culture by defining the acceptable rules for using those new ideas.

The EPCglobal & EPC

The Auto-ID Center, founded in 1999 and headquartered at the Massachusetts Institute of Technology in Cambridge, was chartered with the intent of defining the standards for the emerging UHF Radio Frequency Identification (RFID) technology. The Auto-ID Center closed on October 26th, 2003 and transferred its technology to EPCglobal (www.epcglobalinc.org), which will administer and develop EPC standards going forward. RFID has the potential to dramatically change the way many companies do business, but only if standards are defined that allow businesses to share information effectively. Information can be shared and used across different businesses only if industry agrees on the content and format of that information, and that is the role assumed by the EPCglobal for RFID.

Radio Frequency Identification (RFID)

RFID technology uses radio waves to automatically identify products or assets up and down logistics chains, in security applications, and throughout business processes. A typical RFID system consists of three main components:

- RFID tags comprised of a microchip (that stores the unique ID number that identifies an individual product) and tag antenna (that enables the microchip to transmit ID information to a reader),
- Reader network components (readers, antennas, cables, etc.) that power and communicate with the tags, converting radio waves returned from the tags into computer-readable format, and
- System management software that runs on a host computer and collects tag data automatically from the reader network.

RFID tags can be purchased in the form of thin, flexible, silicon-based inlays or finished labels to attach or embed in containers, pallets, boxes, trays, etc., to create a "people-free" wireless environment for tracking products as they travel through the supply chain. As a tagged item moves past a read point in a facility, its unique ID is automatically communicated back to a central database, allowing businesses to make real-time logistical decisions.

RFID Readers provide all of the RF and control functions required to power and communicate with the RFID tags. The Reader sends digital data to the tag (through one antenna at any given time), demodulates the identification signal received from the tag, and then sends the data to your host computer.

RFID Tag Classes

To assist business in understanding and using RFID, the EPCglobal has broadly defined a set of functional groups or "Classes" of tags. The table below outlines those Classes.

CLASSIFICATION	FUNCTIONAL DESCRIPTION
Passive Identity Tag	Passive tag containing only the Electronic Product Code (EPC™) in an unalterable form and a CRC for transmission error detection. Also referred to as a "license plate."
Passive Functional Tag	Broad category that includes any tag with functions over and above the elementary tag. Examples of such functions or features include User Writable memory, sensors, and encryption.
Semi-Passive Tag	Any tag that embeds battery technology to assist in providing power for the tag (i.e., the battery is not the sole source of energy for the tag.)
Active Tag	Any tag where a battery is the sole source of energy for the tag.

Passive tags are tags that "harvest" their power from the RF energy incident on the tag antenna. Passive tags convert that incident RF energy into power that activates the chip embedded in the tag. Semi-Passive tags use both passive energy harvesting techniques and battery back up, or assist, techniques to provide power to the tag IC. Active tags are solely battery powered, only using their antennas as data transmission mechanisms.

Tag Standards Today

As in any emerging market, the definition of early standards is a difficult and sometimes confusing task. As technologies come to market, different companies apply those technologies in many

different methods and data formats. Past examples include the VHS and Beta standards for videocassette recorders and the multitude of solutions and formats for read/write compact disks (CDR.) The RFID market is no different. The EPCglobal has recently released the first generation of RFID protocol standards.

Generation 1 Class 0 and Class 1 Protocol

Two Classes of tags are defined in Generation 1: Class 0 and Class 1. Both Class 0 and Class 1 define "Identity" tag functionality – that is, they contain ONLY unalterable, or "write once" EPC codes. While functionally equivalent under the EPCglobal classification system, Class 0 and Class 1 use different hardware technologies to implement the Identity tag functionality. Class 0 tags are programmed when they are manufactured (referred to as "Read-Only" or "R/O"), assuring uniqueness of the tag ID. Class 1 tags can be programmed once (referred to as "Write Once, Read Many" or "WORM") by the user, providing operational flexibility. Class 0 and Class 1 tags also use different protocols, or "air interfaces" to communicate. So, while both Identity tag implementations perform the required functions, they cannot communicate with each other. Tags of both classes can co-exist in an environment, but require readers that "speak their language" to be identified.

Generation 1 Class 2 Protocol

Functional tags, defined as "Class 2" in the EPCglobal lexicon, are also starting to enter the market from multiple suppliers. These tags include "Write-Many" capabilities as well as increased memory space for additional user data storage requirements. Generation 1, Class 2 (C2g1) functionality tags are available in both of the air interface protocols today.

Multi-Protocol Readers

While the lack of tag interoperability in Generation 1 may be viewed as a liability to some, the ultimate impact of the different protocols can be minimized by the development of multi-protocol readers. Multi-protocol readers capable of interrogating all Generation 1 tag protocols provide the same functionality as the master key in a building – the multi-protocol reader can "unlock" all of the tags, allowing end-users to pick the tag and the protocol best suited for their business application. An analogous situation occurred in the consumer DVD market as DVD players were developed that could read multiple CD/DVD disk formats. Multiple companies are already developing and demonstrating reader products with this "master key" capability.

Generation 2 Protocol

Emerging markets, such as UHF RFID, tend to embrace technology improvements quickly, requiring an evolutionary standards process. The EPCglobal has addressed the rapid RFID technology development and adoption with a generational view of the UHF RFID standards. The EPCglobal has begun the definition of a "Generation 2" standard – the next step in the continuing evolution of RFID standards.

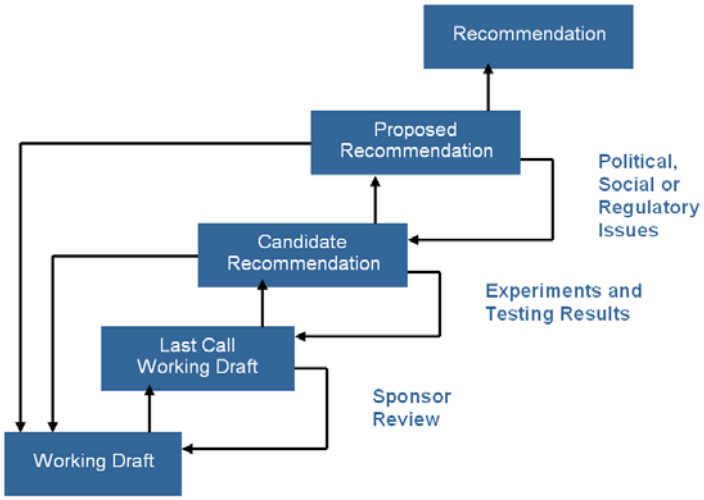
Recently, a "Last Call Working Draft" of the Generation 2 protocol has been released for industry review and comment (see "EPC Radio Frequency Identity Protocols Generation 2 Identity Tag (Class 1): Protocol for Communications at 860Mhz – 960MHz, 10-23-2003.") In this draft proposal, the EPCglobal has proposed a common air interface protocol intended for use across all classes of Generation 2 tags. The initial draft is labeled as a Class 1, G2 protocol, but with the intent of using the same air interface across Classes 1 to 4 of the tag functional hierarchy. The Generation 2 air interface is also defined as "orthogonal" to the existing air interfaces of Generation 1 – meaning

it will not interfere with existing tags, but it is also not compatible with them.

Tag Standards Tomorrow

The release of a Generation 2 Candidate Recommendation should not be cause for delay in adopting RFID in your business. Because of the impact a new standard can have, the standards development process needs to be deliberate, considering all of the aspects and effects a change to a standard might cause. The Generation 1 standard definition and approval occurred over a two and a half year period. RFID users can expect a similar adoption cycle for the Generation 2 standard.

To ensure the proper deliberation and review of new standards, the EPCglobal has defined a review and approval process in a white paper entitled "A Proposal for a Standard Process for the EPCglobal" (published 02/01/02 by Prof. Sanjay Sarma.) The figure below shows the standards approval process as defined by the EPCglobal in its paper.



Recommendation Track

Promotion of the proposal from "Last Call Working Draft" to "Candidate Recommendation" is expected to occur relatively quickly. Once the Candidate Recommendation has been released, hardware artifacts executing the new protocol will be designed and built by tag and reader companies to the proposed recommendation and tested across multiple application environments. These tests are intended to verify the operation, performance and vendor interoperability of products built to the Generation 2

specification. After operational verification, a Standards Recommendation is made, which is then reviewed for regulatory and social acceptance before a Final Recommendation is put up for vote. RFID users who delay their decision to deploy RFID solutions until the availability of Generation 2-based products may well find themselves at a two-year disadvantage to their "first-mover" competitors. Additionally, during the latter stages of this approval process, the inexorable progress of technology will assure that Generation 3 of the standard will start to be defined before the ink is dry on the approval signatures for Generation 2.

Conclusion

Recently established UHF RFID standards have encouraged a wave of new evaluations and implementations as the business risk of single-sourced, proprietary supply chain solutions is minimized. The present Generation 1 standards provide for stable, robust and reliable RFID solutions. Systems based on this standard are being rolled out in production today. Evolution of standards is a fact of life in many markets, and should not be viewed as a barrier to adoption. Infrastructure investment and tag selection risks can and should be mitigated with multi-protocol readers that can support future Generation 2 requirements. Those requirements have also been recently described in EPCglobal documents. The technology and the standards are available today that can realize all the benefits of UHF RFID.

About Matrics

Matrics Inc., based in Columbia, Maryland, is a provider of EPC™-compliant RFID technology and visibility solutions for supply chain, asset management and security and an EPCglobal US Founding Subscriber. Patented wireless tracking technologies provide users with the most reliable and cost effective solutions to provide the comprehensive visibility of assets throughout the enterprise. Current customers include International Paper and McCarran Airport. Matrics is presently engaged in roll-out applications with several Fortune 100 companies. For more information, visit Matrics on the web at www.matrics.com.