WHITE PAPER

Understanding the Key Issues in Radio Frequency Identification (RFID)

Radio frequency identification (RFID) is an automated data collection (ADC) system that enables businesses to wirelessly capture and move data using radio waves. A typical system consists of "tags" with an embedded, unique identifier for the product or object being moved; "readers" designed to decode the data on the tag; and a host system or server that processes and manages the abundance of information gathered.

What is RFID? Radio frequency identification enables companies to assign unique identifiers to individual products or items. From the time a product is manufactured to when it is consumed, RFID offers real-time visibility into shipments and inventory in motion. Using radio waves, data is captured and moved wirelessly to and from the point of business activity — in real time. This unique identification is utilized to match information about the product with the information from a company's database or host system.

With RFID, items can be read or tracked with minimal human intervention. This has the potential to reduce supply chain inventory levels, operating expenses and provide unequaled supply chain visibility. These aspects — expense reduction and real-time visibility — have attracted companies to deploying RFID systems.

Background: An Industry Snapshot

RFID has been successfully deployed since the 1940s and proven to deliver a multitude of benefits depending on the specific application. During World War II, the technology emerged as an identification of friend or foe (IFF) program, integrating RFID tags onto military aircraft. In the late 1960s, RFID technology was used to identify and monitor nuclear or other hazardous materials.

In the 1980s, research for RFID technology began to explore cost and size reduction in addition to performance issues such as power requirements and read ranges. It marks the beginning step to transform RFID into a more widely used technology.

In the 1990s, proponents began developing tag and reader products using RFID technologies. Millions of RFID tags were sold into applications including container tracking, toll roads and entry access cards. The biggest push to adopt RFID came more recently, when both the U.S. Department of Defense (DoD) and Wal-Mart® issued mandates requiring their suppliers to use EPC open standard RFID tagging on pallets, cases, containers and parts, by January 2005. Although these two organizations come from seemingly different worlds, RFID empowers both entities to uniquely identify products in their inventory, realize lower costs and increase supply chain efficiencies. Today's challenge is primarily in scaling this powerful technology for enterprise-level deployments across a variety of industries.

Electronic Product Code (EPC) — the RFID Standard

EPCglobal™ is a joint venture between the Uniform Code Council (UCC) and the European Article Numbering (EAN) Association. This is the main organizational body involved in the standardization of the electronic product code (EPC), which is widely used and accepted for RFID systems. Figure 1 illustrates the EPC numbering system that is distinguished by its ability to easily incorporate a unique identifier at the individual product level. In addition to this serial number, the EPC data structure or global tag data format includes a header, manufacturer or company responsible and the product's object class.

Initially, two classes of EPC tags — Class 0 and Class 1 — existed. An important development has occurred; EPCglobal member companies have defined a single tag standard — UHF Class 1 Generation 2 (commonly referred to as Gen 2).

EPC is also an open standard that serves two important purposes. Suppliers of the technology can develop products — tags and readers — to one standard, which makes it more affordable to deploy. Customers have more vendor choices and are assured that the products conforming to the EPC standard are truly interoperable.

EPC benefits to customers

The development of EPC standards is one of the critical events in RFID. Adoption of these standards delivers the vision of an EPC-compliant RFID market that is both highly executable and drives the adoption forward, lowering costs with increased volume. EPC is — without a doubt — RFID's unique identification standard of the future. Key benefits of EPC standards include:

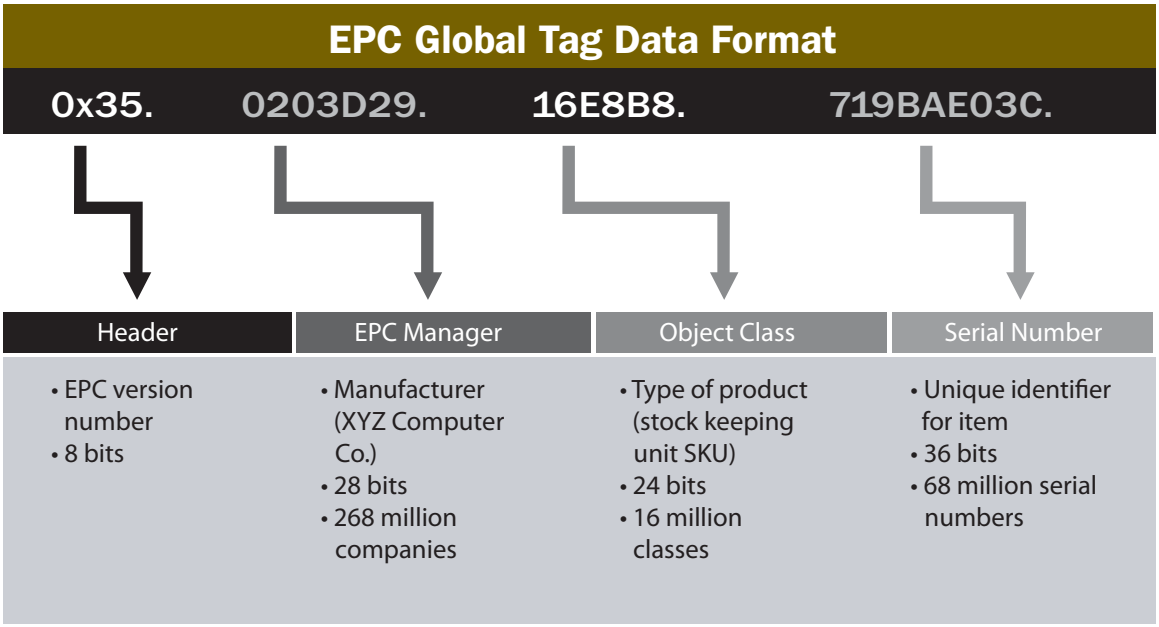
- Multiple sources of products
- Increased innovation and performance
- Lower prices

How Does EPC-RFID Work?

RFID tags (transponders) — affixed to cases, pallets, cartons, units or other objects — begin to transmit radio frequency signals when in the read zone of a stationary or mobile reader (interrogator). The reader picks up the signal and decodes the unique EPC that identifies, using 96 bits, the name, class and serial number of the product. This information is then matched with record data in the host computer system and database application, as shown in Figure 2.

RFID tags contain a silicon chip that holds data or information about the product which is carrying the tag. When near an RFID reader, an antenna transmits radio waves with the data to the reader. Data from the EPC is decoded by the reader and matched with a record in the database application. Around the chip and antenna is an enclosure that acts as a protective casing and enables the tag to be attached to an object.

Figure 1



EPC differs from UPC bar code. UPC = a class of product; EPC = specific instance of a product.

Of the tags available today, passive, read-only tags are the focus of most EPC innovation and development today. This is because passive tags cost less than active tags and provide solid functionality.

- **Active:** continuously emit radio signals, contain a battery and are also typically read-write. Generally, these tags are proprietary and more expensive.

- **Passive:** tags that are only activated by the signals of an RFID reader and have no power source.

EPC focus is on UHF passive tags

- **Read-Only (Type 0):** tags that contain permanent data, commonly referred to as "type 0" tags within the EPC standard

- **Read-Write (Type 0+):** a standards-based EPC extension that allows Type 0 tags to be written in real time

- **Read-Write (Type 1):** tags that can be written over by a reader; often referred to as "type 1" tags within the EPC standard

- **Class 1, Generation 2:** Gen 2 tags retain many of the Gen 1 features while offering key performance, capacity, security and RF efficiency advantages over Gen 1 tags

Innovative technical features of tags in the EPC-RFID environment

- Anti-collision algorithms and less expensive, smaller chips provide improved performance and lower prices

- Every EPC-RFID tag has a unique identifier that enables every asset or item of merchandise to have a unique serial number

- Memory capacity is more than sufficient for increased data volume

- Readers read tags within containers, cases or cartons and eliminate line-of-sight requirements

- Read/write capabilities offer dynamic versus static data, making the tags reusable and therefore, more cost effective

Figure 2

Solutions Overview

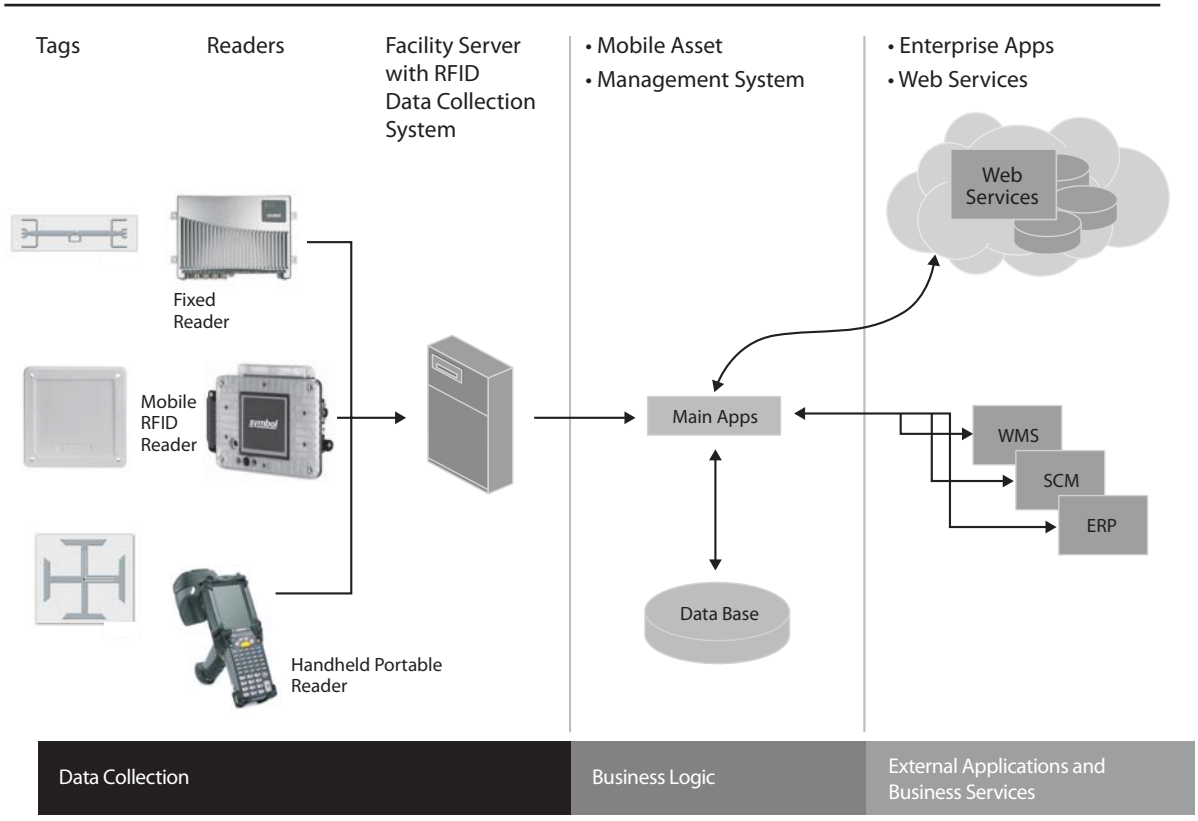


Figure 3

RFID Systems

Handheld RFID reader with integrated bar code and wireless LAN features

High-performance RFID Antenna

Fixed RFID Reader

RFID Cargo Tag

Mobile RFID Reader

Readers

EPC-RFID readers can be either handheld readers, mobile readers or fixed readers. Within these three classes of products, there are several issues to consider as a buyer.

About handhelds: for handheld readers, the device should offer an integrated antenna with good drop-to-concrete characteristics, with integrated bar code, imaging, RFID capabilities, wireless local area networking (LAN) and sound ergonomics for prolonged use.

About fixed readers: fixed reader performance expectations vary with the applications. General application requirements are for readers to survive and function in a harsh industrial environment, to function with continued usage and to read tags on an omni directional basis.

About mobile readers: mobile reader applications include mobile carts or other material handling equipment (such as forklift trucks), conveyor belts, doors and doorways, shrink wrap stations, pallet assembly stations and outside in yards. Mobile readers should offer an integrated antenna and battery and be cable free. They should be rugged enough to withstand dust, vibration and the rigors of industrial environments.

Similar to tags, RFID readers are evolving and providing new and innovative features that are important to effective deployments.

Key developments include:

Innovative technical features of EPC-RFID readers

- Readers that are capable of easily being upgraded with new firmware to read the EPC standards of today and tomorrow
- Readers with dense-reader mode (DRM) that allow a large number of readers to concurrently communicate without interfering with each others' signals
- Readers that support multiple antennas to reduce the cost of deployment
- Readers that are flexible to support various types of deployments as portals and conveyor belts
- Readers from companies that provide for open protocol Ethernet communications with the host computer system

Radio frequencies and global deployment

As noted earlier, EPC-RFID is about providing standards to drive open, standards-based products and low-cost, high-performance solutions. Reflecting that philosophy, EPCglobal has worked to utilize Ultra High Frequency 868 MHz to 950MHz radio standards around the globe.

Gen 2, a truly global, interoperable standard now provides the impetus to enable the real-time and global supply chain. A common technology platform will ultimately reduce the total cost of ownership for all partners of the global supply chain trading network.

EPC-RFID: Deploying a New Technology to Create a New Information Architecture

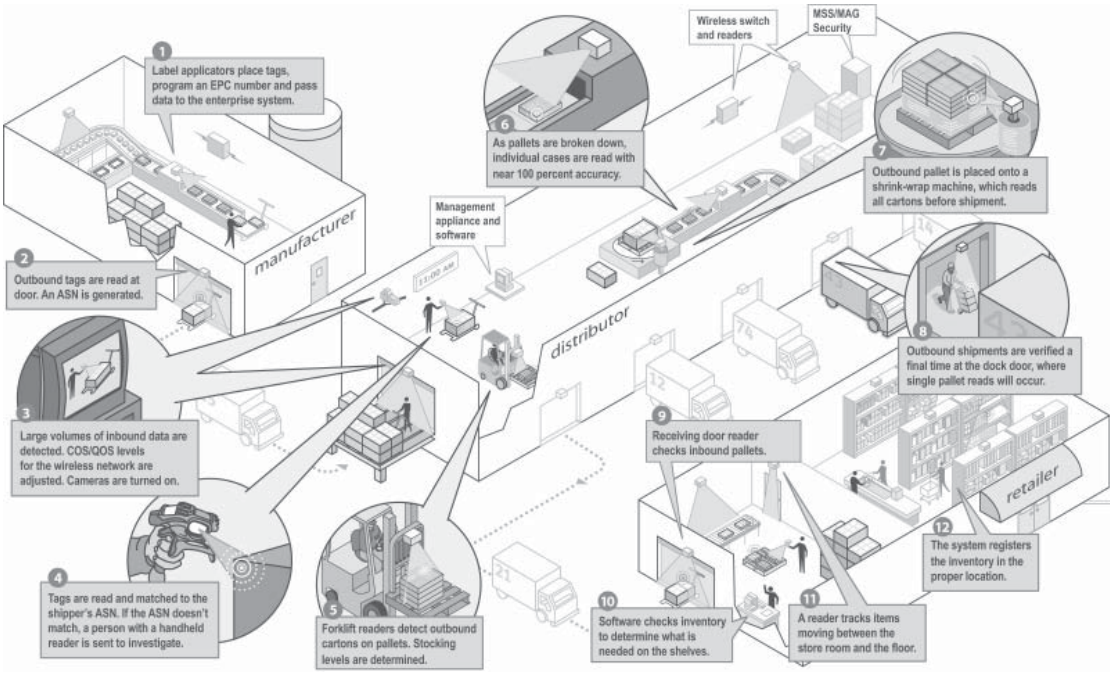
The emerging widespread adoption of RFID will result in enormous amounts of data. Some estimates range as high as 30 times the amount of data currently generated today. With RFID, the large number of potential "read" points (shown in Figure 4) in a simplified supply chain is significant.

Successful implementation of RFID requires synchronization between RFID readers, data capture networks, data movement and data management. The data management methods employed must be aligned with the underpinning business practices of the organization.
Key questions include:

- What are the economic models or opportunities that could be addressed with real-time RFID information?
- What internal or cooperative systems or processes could be enhanced with RFID- based solutions?
- What are the RFID-based expectations of my customers, and how can I leverage those expectations to expand my business success?

Figure 4

Simplified Supply Chain



Numerous potential read points are estimated to generate up to 30 times the amount of data that is processed today.

Integrating RFID into Information Solutions

To fully leverage the information potential of EPC-RFID, companies need to capture, move and manage volumes of RFID data in real time. Successful implementation of RFID requires:

- Tags and readers to capture information
- Access points and wireless networks to move information
- Scalable mobility management architecture to handle a large number of devices. Motorola designs EPC-RFID solutions that integrate seamlessly with other key technology and product offerings, including advanced data capture devices such as bar code scanners, mobile computers and wireless infrastructure.

Whether you are faced with mandatory compliance or are seeking to achieve the benefits of product visibility in your supply chain, Motorola offers the technology and expertise you need to achieve a successful RFID implementation that delivers maximum value to your enterprise — in terms of strategic benefits and ROI.

For over 30 years, Motorola has been developing and applying innovative technology to help companies of all sizes across multiple industries to capture real-time business information to achieve higher levels of operational efficiency. The undisputable worldwide leader in bar code technology, Motorola leveraged the experience gained from deploying over 7 million bar code scanners and mobile computers worldwide with nearly 20 years of RF experience to become the first company to market and deploy EPC multi-protocol fixed readers, EPC handheld RFID readers, EPC RFID portal systems systems and EPC mobile RFID readers. Motorola is committed to developing RFID technology to meet the needs of today and tomorrow. The result is flexible, high-performance RFID solutions that meet the enterprise-level requirements, Motorola is a leading EPC RFID vendor with RFID readers deployed globally in some of the world's largest retailers and manufacturers.

For more information, contact Motorola at +1.800.722.6234 or +1.631.738.2400, or visit us on the Web at www.motorola.com/rfid

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