WHITEPAPER

RFID: Automatic Identification Evolves

DATAMAX®

Radio Frequency Identification (RFID)

Automatic Identification and Data Collection (AIDC) technologies have been used for decades to increase accuracy and efficiency in the data collection process for many activities including supply chain management, logistics tracking, and retail point-of-sale. The bar code is the form factor of choice for data collection activities. It allows users to achieve highly accurate fast reads of encoded data. The bar code was developed as a data carrier that enables fast and accurate data collection. While the bar code has its limitations it has done a remarkable job of remaining current as technology has evolved at its fastest rate ever in history. The following technological evolutions have all been supported by the bar code:

- Mainframe to PC computing
- Database development technology
- Enterprise Resource Planning (ERP) systems and their derivatives
  Increased trading partner collaboration to streamline supply chains as a competitive advantage necessary to compete in today's hyper-competitive commerce landscape

RFID technology was first used to identify friend-or-foe aircrafts during WWII so that Allied forces could determine the status of approaching planes. RFID has evolved into many other uses but it has not yet penetrated the supply chain and collaborative commerce arena to the levels of the bar code. The technology infrastructure to support RFID tracking applications use is still in its infancy relative to bar code support. The advantages of RFID and its technology infrastructure are developing to a point where its use can enhance supply chain and collaborative commerce purposes.

This white paper will offer a basic explanation of the technology behind Radio Frequency Identification especially as it relates to current AIDC solutions. Selecting RFID as the most appropriate technology solution for a given AIDC application will be a challenge for users. A key point of discussion in this white paper is how to identify appropriate smart label applications.

What is RFID?

Radio Frequency Identification is a form of automatic identification technology that uses radio waves to communicate among a system of integrated circuits, tags, readers and software to identify items. Radio waves transmitted from an antenna interact with an integrated circuit embedded on an RF tag, which sends radio waves back to a reader. The reader turns those waves into digital information, allowing the item that responded to be instantly identified. Each of the system components are identified as follows:

Tag

An RFID tag can take on many form factors and power levels. The tag consists of an integrated circuit incorporated into a form factor that includes its own antenna. The unique identifier is encoded onto the integrated circuit and travels with this data. The data on the RFID IC is transmitted to a reader through the antenna incorporated onto the tag. RFID tags can be as tiny as an ant's head, larger than the palm of an adult hand, or any size in between. The form factor that the RFID tag takes is dictated by factors including power, durability, and lifetime requirements. Tag characteristics are defined by the application, and can vary in power requirements, read/write capability, and frequency.

Power

RFID tags use a small amount of power, but the amount differs among the types of tags available.

Active tags incorporate a battery into the RFID tag component so that the tag can continuously interact with the host system. Because the RFID component includes a battery, active tags are generally the most expensive and largest types of tags available. To counter this, they also provide the longest read ranges and the tags can help create very effective locating capabilities through their interactive features. Active tags are generally constructed to have a lifespan that helps justify the increased cost. Active tags are often used for applications such as toll collection, real-time locating systems for yard management activities, and other applications where interactivity and a long read range is required.

Semi-passive tags incorporate batteries, but the battery power is only used to power the IC's circuitry, not to enhance communications with the host system reader. These tags are less common, but are an emerging solution that combines the longer read ranges of active tags with the lower cost of passive tags.

Passive tags do not incorporate a battery into the RFID tag. The tags are essentially woken up when they come in range of a host reader that sends out radio wave queries through its own antenna. The passive tag uses this power to send back a response to the reader, and then goes back to sleep. These tags are generally the cheapest since they do not include a battery and they can be very small. Shorter read ranges limit passive tags since their communication capabilities rely on the power transmission from the host query.

Chips

The IC contains an actual microchip where data is stored. Chips are available in many sizes and configurations. They can be extremely small to be incorporated into small form factor RFID tags. The chips' capability to carry data and have that data amended or updated is defined by their Read/Write characteristics.

Read-Only

Read-Only contain an identification such as a serial number that is programmed onto the chip during its manufacture. This identifier remains constant throughout the chip's useful life; neither additional data nor overwriting the identifier is possible. Read-Only chips are generally the least expensive but have the limitation of acting like a license plate, much like a bar code acts. It should be noted that some RFID microchips can use electrically erasable programmable read-only memory (EEPROM) that would allow the user to erase and reprogram data on the chip through an electronic process. However, this is a different process than the one used in RFID applications.

Write-Once Read Many (WORM)

A Write-Once Read Many (WORM) chip allows users to add data onto the chip beyond the unique identifier, but data can be added only once. There is virtually no limit to how many times the data can be read.

Read-Write

Read-Write chips are open to data manipulation by the user's system without restrictions. These chips will still contain a unique identifier from the chip manufacturer, but can also carry an updateable memory store where data can be added to the chip. Read-Write chips are generally more expensive than read-only or WORM chips because of their versatility.

Frequency

Besides power and read-write characteristics, an important component of an RFID system is the frequency used for communication protocols. Frequency will be defined by the protocol used in the RFID system, once the adoption of RFID technology becomes widespread throughout industry. Currently there are many standards under development or already released relative to RFID applications, including RFID smart label applications. Future standards are to be released relative to the EPC (Electronic Product Code) network, which will drive many smart label applications through the supply chain of major companies.

Each frequency has advantages and disadvantages relative to its capabilities. Generally a lower frequency means a lower read range, slower data read rate, but increased capabilities for reading near or through metal or liquid surfaces that distort radio waves.

Low Frequency (LF)

Low Frequency tags operate at or near 125 kHz and have a read range of less than half of a meter. They have a relatively slow data transfer rate and read range of about half a meter, but are generally cheaper and less sensitive to interference than higher frequency options. These tags are generally used for applications such as access control, animal tracking, vehicle immobilizers, and point-of-sale such as the Mobil Speed Pass. The LF spectrum is not considered a truly global application because of slight differences in frequency and power levels throughout the world.

High Frequency (HF)

High Frequency systems operate throughout the world at 13.56 MHz, creating a truly global solution. Read ranges for HF systems are about one meter and they can transmit data faster than LF tags. HF tags are used in various applications, including tracking items such as library books, corpses, costumes, and food trays. There are several standards concerning HF systems, including the ISO 15693 standard used for tracking items. There is also an EPCglobal HF standard.

Ultra High Frequency (UHF)

Ultra High Frequency systems operate in a range between 860-940 MHz depending on geographic location around the world. The North American market operates at or near 915 MHz, much of Western Europe is at the low end of the spectrum, and several Asian countries recently opened the higher end of the spectrum to RFID usage. UHF tags can be read up to three meters away, and generally operate at greater speeds than HF tags. However, metal and liquid substances are concrete barriers for this frequency and more testing is needed to address these shortcomings. UHF is currently being tested in field applications for supply chain visibility, and is the frequency chosen for the EPC network driven by the Auto-ID Center and EPCGlobal.

AIDC & RFID

Knowledge of how an RFID system works is more than half the battle. The challenge now exists to incorporate this understanding of RFID into addressing business challenges. For AIDC opportunities, smart labels can enhance an existing technology solution, or help to create efficiencies where cost centers exist.

Smart Labels

Smart labels are traditional labels that incorporate an RFID tag, known as an inlay, into the form factor, and are then printed on and encoded by a dual-purpose printer. In the case of smart labels for tracking items, thermal printers have long been seen as superior in terms of their ability to produce a quality printed image on a variety of materials at a low operating cost.

RFID capabilities are a logical extension of a thermal printer's capabilities. The Datamax I-Class product line has been established around the world as a leading industrial printer able to withstand rigorous environments and printing performance requirements. The I-Class RFID printer expands this successful printing platform to include the ability to encode data onto RFID tags while simultaneously printing a graphical image - bar code, text, graphic - onto the label. This simple and elegant solution allows users to incorporate the benefits of RFID into their current data capture applications while developing new systems to fully exploit the power of this new technology.

Benefits

Smart labels add capabilities to data tracking systems not available with bar codes. These benefits can increase a company's efficiency by orders of magnitude, or their results could be merely incremental based on current technology sophistication and usage levels. Smart labels also enable cost reduction activities, a key topic for many in today's highly competitive marketplace. The main benefits of smart labels are instantaneous identification, no line-of-sight requirement, the ability to update or supplement data on the smart label, and expanded data capacity.

Items can be instantaneously identified once within range of the reader/antenna. The RFID tags do not have to be individually scanned due to anti-collision and individual identification capabilities among readers and software solutions. The sophistication of the technology allows multiple objects to be identified virtually immediately, with the background software acknowledging each individual item through a process of elimination.

The sophisticated software system supporting RFID technology and the fact that data travels through the air and many objects removes the line-of-sight requirement that limits bar codes. Bar codes require that a scanner be directed directly at them and are often adversely affected by ambient lighting levels. With RFID communication, however, the data travels through the air, and it is not required that the reader or antenna be able to physically view the tag for communication to occur.

Bar codes are basically a license plate identifier, a number that identifies a product or item based on the database identifiers within the host system. However, with RFID and the amount of data that can be carried on a tag, the smart label can become a minimized database itself. With read-write capabilities, data about the item can be updated throughout the product or the tag's life cycle. This expanded capability enables enhanced tracking that exists right on the item. Updateable information is certainly available within a bar coding system, but the updates take place within the host database. With RFID the database remains with the item and in the host system, allowing for a backup in case problems occur with accessing the host information.

Even in situations where updating the database that resides on an item is not feasible or required, RFID tags enable a larger amount of data to be carried on the item relative to bar codes. Some RFID microchips are able to carry upwards of 2k of dynamic data, which is more than the average linear bar code.

Drawbacks

All is not rosy in the world of smart labels, however. Despite their benefits, there are several impediments to adopting this technology, requiring end users and their systems integrators/developers to carefully review the benefits of RFID against what long term plans for the system. Any company implementing RFID as a result of compliance requirements must keep current on developments - including standards and protocols - to ultimately develop the system that meets their needs now and into the future. Implementation barriers include standards development, cost, and infrastructure.

Standards used to define RFID systems are varied in their levels of acceptance globally. For HF systems, the ISO 15693 standard is currently accepted globally and allows users to develop tracking systems within this frequency immediately. Systems built within the ISO 15693 standard will be restricted due to inherent limitations of the 13.56 MHz frequency in terms of read range and data transfer speed. For many applications, the HF frequency will be an ideal solution. For those that require higher performance, there are several standards being developed for UHF systems. EPCglobal is commercializing the most high-profile standard development work in the UHF spectrum. This standard will reside in the UHF spectrum and offer users the higher data transfer rates and longer read ranges required for high speed applications. However, there is a current ISO standard for UHF systems (ISO 18000-6) and there is still much maneuvering taking place to establish what will eventually become the UHF standard among companies worldwide.

Smart Label Applications

With the potential benefits that RFID can add to an existing or future system, the applications for smart labels are endless. Virtually any users that require item tracking, whether for inventory or management purposes can enhance their system by using smart labels with RFID technology. With technology that is in the early adopter stage, it is important for users to clearly identify expectations and processes to be used. With these definitions in hand, a system can be developed that achieves their goals with the most appropriate technology. It could potentially be very easy for a customer to get oversold on RFID with all of the interest surrounding the technology. Systems integrators/developers must become familiar with its advantages and disadvantages to be able to create the best system for their customers. This is no different than any other technology under consideration or use within commerce today.

Supply Chain Management

Large corporations and their desire to further remove costs and inefficiencies in their supply chain operations are driving much of the recent interest in RFID and smart label technology. The idea of scanning pallets as they arrive in distribution centers or back store docks and instantly updating the system with all of the contents of the pallet is appealing to many companies that are currently paying a small army of people to accomplish this task as a full time job. Reallocating those personnel resources could potentially provide a substantial increase in productivity and efficiency for these operations.

Baggage Handling

The travel industry has faced serious problems in the past five years, compounded by world events, leaving the industry reeling and in need of a positive image now more than ever. Most airlines currently use bar coding systems in their baggage handling operations, but unfortunately baggage still arrives at the wrong location on occasion. Airlines are developing RFID tags embedded into the bar coded baggage tags to interact with the conveyance systems. These RFID systems ensure that baggage reaches its intended location the first time.

Library Information Systems

Many libraries around the world are currently using a first generation RFID system for tracking books and other properties. These items were tagged with a separate RFID tag, but the item still contains a separate label for checkout and return date information. Many libraries are interested in achieving the next evolution of this system that would allow them to apply a smart label to a book and accomplish both identification processes simultaneously. Books with RFID tags allow library patrons accelerated checkout, and they help control theft. Walk-through antennae are placed at all entrances and exits to the building. A book with an active RFID tag inside will set off an alarm alerting the library that a book is leaving the premises without being entered into the system. Even if the book is not recovered, the system is automatically updated to show that it is not available for checkout.

Patient Accounting

The healthcare industry has been working on adopting automatic identification and data capture technologies for a variety of reasons, including the recent spotlights on patient safety and privacy. One issue facing healthcare providers that does not get a lot of media attention is inaccurate accounting. Most hospitals use paper charts to annotate all of the procedures that a patient undergoes during his/her stay in the hospital. However, these charts are updated by hand and errors can occur, such as omissions, inaccurate description of procedures, or allocating procedures to the wrong patient. All of these errors mean that hospitals are providing services that are being reimbursed incorrectly from the patient's insurance provider. Use of RFID encoded wristbands can allow patient database charts to be instantly updated to accurately reflect all procedures for a particular patient.

RFID Into the Future

Will RFID pick up where current AIDC technologies leave off? There is not a simple answer to this question, but it is highly possible that RFID is going to be incorporated into business processes in the coming years. The technology allows companies to take another step toward real-time visibility of assets, people, items and products. For many companies, this capability does not hold significant interest and the current cost levels of RFID will remove it from consideration in their infrastructure. Other companies, however, will see great value in moving toward instant identification capabilities, especially for those where competitive situations or high-value properties makes the cost justification question irrelevant.

The RFID technology sector is expected to grow in the coming years. According to Venture Development Corporation (VDC), the RFID market is expected to grow 21% through 2005 with that growth being driven by consumer goods and retail companies. These are the companies that could see great benefits from the technology, if the pricing and infrastructure exist to support the technology.

Datamax believes that innovation is important to remaining on the cutting edge in any industry. Innovation comes in the form of product development just as much as in system development. Companies that are willing to invest in their infrastructure often find themselves with a competitive advantage directly related to the technological sophistication they achieve. RFID is injecting the possibility for innovation into the AIDC technologies that have remained static for over 30 years.

Visit www.datamaxcorp.com for more information on Datamax products and solutions.

Datamax specializes in the design, manufacture, and marketing of products for bar code and RFID labeling including thermal demand printers, label, ticket and tag materials, and thermal transfer ribbons. Headquartered in Orlando, Florida, Datamax has sales representative offices in Singapore, China, and Harlow, England, as well as label converting and preprinting facilities in Robinson, Illinois. Datamax markets its products exclusively through a network of resellers in more than 100 countries worldwide.

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