RFID Technology for Warehouse and Distribution Operations.

An RFID Primer

RFID Technology for Warehouse and Distribution Operations

Introduction

Interest in using radio frequency identification (RFID) technology in warehouse and distribution operations is at an all-time high. Wireless identification and tracking with RFID represents a new way to conduct operations, which creates new benefits and challenges. Users need to understand RFID's capabilities and limitations to accurately assess the impact it can have on their business.

This white paper will provide an overview of RFID technology and how it may be applied to warehousing and distribution operations. It will describe the technology and its maturity, standards and industry initiatives, and will also provide examples of how RFID technology can be best used in warehouses and distribution centers.

Overview

You've probably heard the acronym "RFID," which stands for radio frequency identification. You may know that RFID tags can contain unique information that identifies whatever they are attached to, and can share that information wirelessly with computer databases and networks so items can be tracked efficiently.

What you may not know is how far the technology has come and what is being developed right now that could help your warehouse or distribution center. To help decide if RFID would be beneficial, consider if any of the following statements apply to your business:

- Processing speed is essential or could provide a competitive advantage;
- We deal in high-value assets that need to be protected;
- A bar code cannot physically survive our processes;
- Areas of our facilities need to be protected from unauthorized access;
- We need more unique information on each item than a bar code can contain;
- We are highly automated and need to minimize human intervention;
- We could benefit by knowing where products are at all times in the supply chain, in real time.

If any of these statements apply to your business, RFID should be given serious consideration in your system design.

How RFID Works

First, the basics: RFID is a means of uniquely identifying an object through a wireless radio link. The identification is accomplished by an interrogator, also called a reader or "master," and a tag, also called a transponder or "slave" that has a unique identification code. Data is exchanged between tags and readers using radio waves between the tag and interrogator, and no direct line of sight is required for the transaction. The interrogator asks the tag for the code, or processes the signal being broadcast by the tag, decodes the transmission and transfers the data to a computer. The computer, in turn, may simply record the reading, or look up the tag ID in a database to direct further action, and may also direct the interrogator to write additional information to the tag.

The latest generation of RFID allows the dozens of individual objects within a group to be uniquely identified at the same time. This is in contrast to bar codes, which must be read one by one, and can be very advantageous in high-speed reading, sorting and material handling applications. Because no line of sight is required between the reader and the tag, unattended reading stations can be set up to identify objects on a conveyor belt or within a transport container. Fast simultaneous processing and unattended reading are the main performance characteristics that set RFID apart from bar code.

This advanced functionality comes with a price, which in the past often made RFID systems cost-prohibitive. Today, however, pricing has come down considerably, with many tags suitable for warehouse and distribution operations costing considerably less than a dollar per. RFID tags are often reusable and can be packaged to be extremely durable, which helps amortize the initial system cost and provides strong total cost of ownership (TCO) advantages compared with identification methods that must continually be replaced.

Tags

The lower-cost tags generally are passive (meaning they have no internal power source), have limited data storage capacity (typically 32 to 128 bits), are read-only (not re-writeable), and have limited read range. Like bar codes, they are usually used as "license

plate" identifiers, i.e., they hold little actual data but serve to identify the object to a database containing larger amounts of information. For example, a tag attached to a product in a work-in-process application would uniquely identify the product each time it passed by a reader. The reading, and any work performed on the assembly, would be recorded in a database. In turn, a conveyor-based sortation system could identify the item and receive routing instructions from a database application, allowing products to reach their loading destination without human intervention.

Higher-cost tags are available for many more complicated longer read applications. They often have their own power source (these are known as active tags), making them heavier than passive tags, and large data storage capacities (upwards of 1M), making them essentially self-contained databases. These higher-capacity tags could, for example, monitor temperature through a process or give operational instructions to a robotic workstation when they arrive attached to their item, then have updated status information appended to the tag when the task is complete. This flexibility does have a cost, however; the internal power source can burn out, giving these tags a life span of 5-10 years.

Frequencies

RFID systems are available in a wide range of frequencies to suit various performance needs. Frequency is an important factor in transmission range and speed. However, bandwidth availability is regulated by telecommunications authorities in each country, and not all frequencies are available for use throughout the world. This is an important consideration when planning logistics and supply chain applications. Most tag frequencies share the ISM (Industrial, Safety and Medical) bands. Compatibility problems are gradually being solved through standardization efforts, particularly in standards sponsored by the ISO.

Most RFID technology used in warehousing and distribution operates at either 13.56MHz (high frequency), 860-930MHz (ultrahigh frequency, or UHF) or the 2.45GHz (microwave) band. Still in use are 125 KHz low-frequency tags, which are used for access control and vehicle identification. Standards that have been ratified or are in development for material handling, logistics and supply chain applications are concentrated in the UHF band and 13.56MHz. Wal-Mart, which will begin requiring its 100 largest suppliers to tag shipments with RFID, has specified the use of draft standards in these frequency bands.

Here is a very brief overview of different RFID frequencies and their performance characteristics.

Low Frequency

Low frequency is defined as between 100 and 500kHz. This frequency band is inexpensive, with a short to medium read range and slower read speed. Typical applications for low-frequency RFID are access control, animal identification, inventory control and car anti-theft (immobilizing) systems. This is an attractive frequency band because such systems do not need to be licensed in many countries. Read range with a

fixed station reader is usually less than 18 inches.

High Frequency

The high frequency, which some call intermediate, band encompasses the 10 to 15MHz range, with 13.56MHz being the most common. Read range with a fixed station reader is around 1 to 3 meters (3 to 10 feet), although the reading speed is higher than the low-frequency band. Sizing of the antennas and tags becomes more critical. More expensive than low frequency, this band has the potential to become more cost-competitive through volume purchase of tags. Typical applications here include access control and smart cards. The first "smart labels" which are RFID tags embedded within adhesive bar code labels, were produced at 13.56MHz, but are now also available in other frequencies.

Ultrahigh Frequency (UHF)

Ultrahigh-frequency RFID encompasses the 850 to 950MHz band and is frequently championed for distribution and logistics applications. The American National Standards Institute (ANSI) standard for RFID identification of returnable transport items, which complements the ANSI MH10.8 bar code shipping label standard, specifies the 902-928MHz band for item identification. The ePC specification (discussed later) supported by Wal-Mart also utilizes the UHF band.

Read range, which as with all frequencies depends on tag size, power output and interference, is up to 10 feet.

Microwave

Some RFID products are also produced in the microwave bandwidth, typically at either 2.45GHz or 5.8GHz. These products offer the highest data read rates., but are also more expensive and have higher power requirements. These are often appropriate in specialized applications.

Read/Write Capabilities

When considering what RFID technology is right for your warehousing or distribution application, it's important to understand the difference between the various types of writing capabilities available. In general, the more versatile, or the more stand alone a system is, the more memory needed, which increases both the size and cost of the tag. Read-only tags have fixed information securely programmed into them when they are manufactured. Write once, read many (WORM) tags may have data written to them once only post-manufacture and are the most popular kind of tag currently used. Re-writeable tags are the most memory- and cost-intensive, but provide flexibility to update data. Rewriteable tags have a shorter writing range than reading range, which must be considered when planning the application.

Standards

The International Organization for Standardization, best known by its acronym ISO, has

undertaken the most RFID standardization projects and focuses on technical standards that are accepted globally. One of its most important subcommittees is JTC 1/SC 31 Automatic Identification and Data Capture Techniques, which is working on a series of RFID standards for item management. ANSI, which coordinates much of its work with the ISO is another important standards body and has established an RFID standard for shipping container identification. The Automotive Industry Action Group (AIAG) and other industry associations are also developing their own RFID standards, which are often based on ANSI and ISO efforts.

The Auto-ID Center at MIT led research to create a specification for RFID for item-level tagging in the consumer goods industry, which it calls the Electronic Product Code (ePC). The Auto-ID Center's work has since been transferred to a new entity, AutoID Inc., which was created by the Uniform Code Council (UCC) and EAN International, which maintain the U.P.C./EAN bar code system and many other standards. See the ePC section for more details and visit the UCC Web site, www.uc-council.org, for the latest information.

Any technology needs standards to gain acceptance, and RFID is no exception. Working to get standards in place can delay that procedure, but too many conflicting standards can have the same consequence. Such as in the case of the current situation regarding UHF, too many standards can be the same as having no standard at all. Further complicating the matter, there are technical standards, which specify performance requirements for interoperability, and application standards, often set by industry associations, that describe how RFID can be used for a specific function.

AIM Global, the trade association for the automatic identification industry, maintains an updated guide to current RFID standards activity on its Web site. Visit www.aimglobal.org for more information about specific standards and proposals. Check with relevant associations and professional societies for specific information about standards in your industry.

Applications

Applications are constantly being developed and refined as the technology advances and the supply chain industry continues to work for the cradle-to-grave data flow that will streamline the product pipeline. Because of the visibility it can provide, and its newfound cost effectiveness, RFID is emerging as an intriguing option to complement data collection and product identification in the supply chain.

Many hardware and software suppliers are just beginning to explore how RFID technology can tie into warehouse management systems (WMS) to produce a warehouse/DC of incredible efficiency. Several WMS providers now support RFID data entry in their software. Here are some potential RFID applications in warehousing and distribution environments:

- Pallet and case tracking, particularly when the pallets are reused within a closed

system.

- Forklift identification. RFID can identify forklift location to allow systems to monitor activity and assign the closest forklift to those pallets needing moved, and serve as a permanent asset ID.

- Access control: Chips embedded in ID cards can control locks and prevent unauthorized entry; chips on products, cases, pallets and equipment can control item movement and sound alarms in case of unauthorized removal.

- Smart shelves: Retailers are experimenting with readers embedded in stocked store shelves to keep track of tagged inventory and notify either the back room or the supplier when stock is low. The application could be modified for use in warehouses and distribution centers for materials management and inventory control.

An RFID Enabled Warehouse or DC

There are several possibilities for how RFID technology can be utilized in warehouse and distribution center, in concert with existing systems and other ADC technologies. Step by step, here's one example of what could happen:

In receiving, items, cases and/or pallets are read by a portal reading unit placed at the dock door as they are unloaded from the truck. Data are transferred into the warehouse management system (WMS), updating its database. The system reconciles its orders and sends back information that will allow some items to be cross docked for immediate transport, while others can be staged and stored. If bar codes were being used here, all received items would have to be scanned, their labels clearly visible, by workers, making the process much more labor-intensive.

When stored on shelves with readers, the readers automatically record what items have been placed there; when they are removed, the action is also automatically recorded. All of this happens without human hands ever touching a scanner, keyboard or clipboard.

If cases are broken up and items repacked, each item is reassigned to a tagged case by scanning the item's bar code or RFID tag and the case/pallet tag. That information transfer initiates an assignment of the pallet or case to a truck or dock. Cases/pallets are moved along conveyor belts, triggering readers along the way that track the movement and also adjust conveyors as needed to redirect the cases/pallets.

Should there be a specific item out there that is needed to fill an order, a worker can go through the aisles, with a handheld reader loaded with the needed unique ID, until the unit beeps, locating the needle in the haystack with keen efficiency.

When cases/pallets are loaded back onto trucks, door-mounted units again record the activity, updating the central database and also initiating a sequence that produces

documentation such as advance shipping notices (ASNs), packing slips, invoices, etc.

Does this scenario fit your warehousing and distribution situation? How would you change it to make it more useable for you?

Item-level tracking

Item-level tracking in supply chain applications has always been a coveted thing. Having each and every item uniquely identified, instead of generally identified with, for example, a U.P.C. symbol- opens up a whole new level of tracking management. The Electronic Product Code, or ePC, being developed by the Auto-ID Center at MIT (see sidebar/addendum) is the latest RFID technology proposed for item-level tracking of consumer goods, and other RFID technologies have also been considered for this application.

While the technology is still being developed and tested, there is much speculation on what applications would be best to use the technology with. The Auto-ID Center sees strong possibilities in warehousing for pallet, case-level and item-level tracking as described in the application section. Numerous studies and analysis by the Center and leading independent consulting firms support this assertion, stating that these types of applications can provide strong return on investment (ROI) in most circumstances.

Some estimate that item-level tracking will not happen for some time, up to 10 years. However, analysts say there are clear business advantages in pursuing pallet- and case-level applications now. "RFID projects yield the biggest immediate benefits when they support order fulfillment and logistics," according to a report by Forrester Research Inc., Cambridge, Mass. "As such, most near-term RFID testing should concentrate on pallets, cases, distribution centers and warehouses--not items and store shelves."

Application Planning Considerations

To design a successful system, you must not only understand what you want the system to do (application), but you also must be very clear about what technologies can be used to deliver the performance you seek. When defining your perfect solution, it is important to ask yourself often, "Am I adding this technology to do it better, or am I simply adding technology?" Reading hundreds of tags per second could easily overwhelm a network or software application. Existing identification systems should be retained where they are sufficient, with RFID used to complement them or eliminate blind spots or bottlenecks in processes.

Part of application evaluation necessarily involves defining what the technologies you are considering can and cannot do. Just like any other technology, RFID has its limitations, and it's important to know what they are.

For example, RFID cannot read tags over great distances, though it can certainly work in concert with technologies that can. Also, because we are talking about radio waves,

interference can be a problem, so metal, liquid, and many tags in close proximity to one another or varying orientations could affect performance. Though cost has come down and will continue to decline, an RFID tag will always be more expensive than a paper bar code label, and we doubt you will ever see five cents per tag in low to medium volumes.

Finally, RFID tags cannot replace bar codes. But the two can work together to provide you with an effective, streamlined, highly productive warehouse and distribution management system.

Conclusion

To remain competitive in today's global, we-want-it-now supply chain, it is imperative to remain open to new technologies and the improvements they can offer your business. RFID is one useful tool to keep in mind for current and future system design.

For additional information on RFID, we suggest you investigate the following resources:

- AIM Global, www.aimglobal.org
- The Uniform Code Council, www.uc-council.org
- Material Handling Industry of America, www.mhia.org
- The RFID Sourcebook, a guide to RFID technology, vendors and applications, www.frontlinetoday.com/rfidonline

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