RFID Frequently Asked Questions

General RFID Information

What is automatic identification?
Automatic identification, or auto ID for short, is the broad term given to a host of technologies that are used to help machines identify objects. Auto identification is often coupled with automatic data capture. That is, companies want to identify items, capture information about them and somehow get the data into a computer without having employees type it in. The aim of most auto-ID systems is to increase efficiency, reduce data entry errors and free up staff to perform more value-added functions, such as providing customer service. There is a host of technologies that fall under the auto-ID umbrella. These include bar codes, smart cards, voice recognition, some biometric technologies (retinal scans, for instance), optical character recognition (OCR) and radio frequency identification (RFID).

What is RFID?
Radio frequency identification, or RFID, is a generic term for technologies that use radio waves to automatically identify people or objects. There are several methods of identification, but the most common is to store a serial number that identifies a person or object, and perhaps other information, on a microchip that is attached to an antenna (the chip and the antenna together are called an RFID transponder or an RFID tag). The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves reflected back from the RFID tag into digital information that can then be passed on to computers that can make use of it.

Is RFID better than using bar codes?
RFID is not necessarily "better" than bar codes. The two are different technologies and have different applications, which sometimes overlap. The big difference between the two is bar codes are line-of-sight technology. That is, a scanner has to "see" the bar code to read it, which means people usually have to orient the bar code toward a scanner for it to be read. Radio frequency identification, by contrast, doesn't require line of sight. RFID tags can be read as long as they are within range of a reader. Bar codes have other shortcomings as well. If a label is ripped or soiled or has fallen off, there is no way to scan the item, and standard bar codes identify only the manufacturer and product, not the unique item. The bar code on one milk carton is the same as every other, making it impossible to identify which one might pass its expiration date first.

Will RFID replace bar codes?
It's very unlikely. Bar codes are inexpensive and effective for certain tasks, but RFID and bar codes will coexist for many years.

Is RFID new?
RFID is a proven technology that's been around since at least the 1970's. Up to now, it's been too expensive and too limited to be practical for many commercial applications. But if tags can be made cheaply enough, they can solve many of the problems associated with bar codes. Radio waves travel through most non-metallic materials, so they can be embedded in packaging or encased in protective plastic for weatherproofing and greater durability. And tags have microchips that can store a unique serial number for every product manufactured around the world.

If RFID has been around so long and is so great, why aren't all companies using it?
Many companies have invested in RFID to get the advantages it offers. These investments are usually made in closed-loop systems—that is, when a company is tracking goods that never leave its own control. That's because some existing RFID systems use proprietary technology, which means that if company A puts an RFID tag on a product, it can't be read by Company B unless they both use the same RFID system from the same vendor. Another reason is the price. If a company tracks assets within its own four walls, it can reuse the tags over and over again, which is cost-effective. But for a system to work in an open supply chain, it has to be cheap because the company that puts the tag on a case or pallet is unlikely to be able to reuse it.

What has prevented RFID from taking off until now?
One issue is standards. There are well-developed standards for low- and high-frequency RFID systems, but most companies want to use UHF in the supply chain because it offers longer read range—up to 20 feet under good conditions. UHF technology is relatively new, and standards weren't established until recently. Another issue is cost. RFID readers typically cost $1,000 or more. Companies would need thousands of readers to cover all their factories, warehouses and stores. RFID tags are also fairly expensive—20 cents or more—which makes them impractical for identifying millions of items that cost only a few dollars.

What are some of the most common applications for RFID?
RFID is used for everything from tracking cows and pets to triggering equipment down oil wells. It may sound trite, but the applications are limited only by people's imagination. The most common applications are payment systems (Mobil Speedpass and toll collection systems, for instance), access control and asset tracking. Increasingly, retail/CPG and pharma companies are looking to use RFID to track goods within their supply chain, to work in process and for other applications.

What have the initial benefits of RFID technology been?
RFID technology can deliver benefits in many areas, from tracking work in process to speeding up throughput in a warehouse. Visit RFID Journal's section to see how companies are using the technology's potential in manufacturing and other areas. As the technology becomes standardized, it will be used more and more to track goods in the supply chain. The aim is to reduce administrative error, labor costs associated with scanning bar codes, internal theft, errors in shipping goods and overall inventory levels.

RFID TECHNOLOGY

How does an RFID system work?
An RFID system consists of a tag made up of a microchip with an antenna, and an interrogator or reader with an antenna. The reader sends out electromagnetic waves. The tag antenna is tuned to receive these waves. A passive RFID tag draws power from the field created by the reader and uses it to power the microchip's circuits. The chip then modulates the waves that the tag sends back to the reader, which converts the new waves into digital data.

What is the difference between low-, high-, and ultra-high frequencies?
Just as your radio tunes in to different frequencies to hear different channels, RFID tags and readers have to be tuned to the same frequency to communicate. RFID systems use many different frequencies, but generally the most common are low-frequency (around 125 KHz), high-frequency (13.56 MHz) and ultra-high-frequency or UHF (860-960 MHz). Microwave (2.45 GHz) is also used in some applications. Radio waves behave differently at different frequencies, so you have to choose the right frequency for the right application.

Do all countries use the same frequencies?
No. Different countries have allotted different parts of the radio spectrum for RFID, so no single technology optimally satisfies all the requirements of existing and potential markets. The industry has worked diligently to standardize three main RF bands: low frequency (LF), 125 to 134 kHz; high frequency (HF), 13.56 MHz; and ultrahigh frequency (UHF), 860 to 960 MHz. Most countries have assigned the 125 or 134 kHz areas of the spectrum for low-frequency systems, and 13.56 MHz is used around the world for high-frequency systems (with a few exceptions), but UHF systems have only been around since the mid-1990s, and countries have not agreed on a single area of the UHF spectrum for RFID. UHF bandwidth across the European Union ranges from 865 to 868 MHz, with interrogators able to transmit at maximum power (2 watts ERP) at the center of that bandwidth (865.6 to 867.6 MHz). RFID UHF bandwidth in North America ranges from 902 to 928 MHz, with readers able to transmit at maximum power (1 watt ERP) for most of that bandwidth. Australia has allotted the 920 to 926 MHz range for UHF RFID technology. And European transmission channels are restricted to a maximum of 200 kHz in bandwidth, versus 500 kHz in North America. China has approved bandwidth in the 840.25 to 844.75 MHz and 920.25 to 924.75 MHz ranges for UHF tags and interrogators used in that country. Until recently, Japan did not allow any UHF spectrum for RFID, but it is looking to open up the 960 MHz area. Many other devices use the UHF spectrum, so it will take years for all governments to agree on a single UHF band for RFID.

RFID TAGS

How much information can an RFID tag store?
It depends on the vendor and the application, but typically a tag carries no more than 2KB of data—enough to store some basic information about the item it is on. Companies are now looking at using a simple "license plate" tag that contains only a 96-bit serial number. The simple tags are cheaper to manufacture and are more useful for applications where the tag will be disposed of with the product packaging.

What's the difference between read-only and read-write RFID tags?
Microchips in RFID tags can be read-write, read-only or "write once, read many" (WORM). With read-write chips, you can add information to the tag or write over existing information when the tag is within range of a reader. Read-write tags usually have a serial number that can't be written over. Additional blocks of data can be used to store additional information about the items the tag is attached to (these can usually be locked to prevent overwriting of data). Read-only microchips have information stored on them during the manufacturing process. The information on such chips can never be changed. WORM tags can have a serial number written to them once, and that information cannot be overwritten later.

What's the difference between passive and active tags?
Active RFID tags have a transmitter and their own power source (typically a battery). The power source is used to run the microchip's circuitry and to broadcast a signal to a reader (the way a cell phone transmits signals to a base station). Passive tags have no battery. Instead, they draw power from the reader, which sends out electromagnetic waves that induce a current in the tag's antenna. Semi-passive tags use a battery to run the chip's circuitry, but communicate by drawing power from the reader. Active and semi-passive tags are useful for tracking high-value goods that need to be scanned over long ranges, such as railway cars on a track, but they cost more than passive tags, which means they can't be used on low-cost items. (There are companies developing technology that could make active tags far less expensive than they are today.) End-users are focusing on passive UHF tags, which cost less than 40 cents today in volumes of 1 million tags or more. Their read range isn't as far—typically less than 20 feet vs. 100 feet or more for active tags—but they are far less expensive than active tags and can be disposed of with the product packaging.

What is the read range for a typical RFID tag?
There really is no such thing as a "typical" RFID tag, and the read range of passive tags depends on many factors: the frequency of operation, the power of the reader, interference from other RF devices and so on. In general, low-frequency tags are read from a foot (0.33 meter) or less. High-frequency tags are read from about three feet (1 meter) and UHF tags are read from 10 to 20 feet. Where longer ranges are needed, such as for tracking railway cars, active tags use batteries to boost read ranges to 300 feet (100 meters) or more.

What is tag collision?
Tag collision occurs when more than one transponder reflects back a signal at the same time, confusing the reader. Different vendors have developed different systems for having the tags respond to the reader one at a time. These involve using algorithms to "singulate" the tags. Since each tag can be read in milliseconds, it appears that all the tags are being read simultaneously.

What is energy harvesting?
Most passive RFID tags simply reflect back waves from the reader. Energy harvesting is a technique in which energy from the reader is gathered by the tag, stored momentarily and transmitted back at a different frequency. This method may improve the performance of passive RFID tags dramatically.

What information is stored on RFID tags?
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From how far away can a typical RFID tag be read?
The distance from which a tag can be read is called its read range. Read range depends on a number of factors, including the frequency of the radio waves uses for tag-reader communication, the size of the tag antenna, the power output of the reader, and whether the tags have a battery to broadcast a signal or gather energy from a reader and merely reflect a weak signal back to the reader. Battery-powered tags typically have a read range of 300 feet (100 meters). These are the kinds of tags used in toll collection systems. High-frequency tags, which are often used in smart cards, have a read range of three feet or less. UHF tags-the kind used on pallets and cases of goods in the supply chain-have a read range of 20 to 30 feet under ideal conditions. If the tags are attached to products with water or metal, the read range can be significantly less. If the size of the UHF antenna is reduced, that will also dramatically reduce the read range. Increasing the power output could increase the range, but most governments restrict the output of readers so that they don't interfere with other RF devices, such as cordless phones.

RFID STANDARDS
What is the EPCIS standard?
EPCIS (the Electronic Product Code Information Service) is a specification for a standard interface for accessing EPC-related information. Electronic Product Codes allow for unique serial numbers for each individual object, enabling companies to track them independently and collect real-time data about each, as well as store and act upon that information. EPCIS enables supply-chain partners to share and exchange information efficiently, providing a standard interface for trading partners. The result is reduced time spent on integration, since all involved parties can use the same interface, regardless of the different database types used for storing that data.

Are there any standards for RFID?
Yes. International standards have been adopted for some very specific applications, such as for tracking animals and for smart cards, which require encryption to keep data secure. Many other standards initiatives are under way. The International Organization for Standardization (ISO) is working on standards for tracking goods in the supply chain using high-frequency tags (ISO 18000-3) and ultra-high frequency tags (ISO 18000-6). EPCglobal, a joint venture set up to commercialize Electronic Product Code technologies, has its own standards process, which was used to create bar code standards. EPCglobal has submitted the second-generation UHF EPC protocols to ISO, and it has been approved as ISO 18000-6C, an international standards.

Are EPC standards finalized?
No. The standards development process is ongoing. The Auto-ID Center developed Class 1 and Class 0 specifications for EPC tags and handed these off to EPCglobal in September 2003. In June 2004, these two specifications completed EPCglobal's standardization process and became the first EPC standards. In Dec. 2004, EPCglobal's board approved a single second-generation standard that will eventually replace Class 1 and Class 2. In 2005, EPCglobal ratified the Application-Level Events (ALE) standard for managing EPC data; ALE software, which can process tag data from Gen 1 or Gen 2 EPC tags, provides an interface for filtering and consolidating EPC data from interrogators. EPCglobal also ratified a standard for the Electronic Product Code Information Services (EPCIS), a framework that will allow trading partners to access and share EPC-related information on the EPCglobal Network; as well as an electronic pedigree (e-pedigree) standard, intended to provide the pharmaceutical industry with a common format that supply-chain partners can use to collect pedigree information for tracking medications. EPCIS was ratified in April 2007, while the e-pedigree standard was ratified in January 2007. Additional standards will be created for high-frequency tags and for other applications as the need arises.

What is EPC Gen 2?
Gen 2 is the shorthand name given to EPCglobal's second-generation EPC protocol. It was designed to work internationally and has other enhancements such as a dense reader mode of operation, which prevents readers from interfering with one another when many are used in close proximity to one another.

What's the difference between ISO and EPC?
The Electronic Product Code is a standard created by EPCglobal, designed as a global standard for use in many industries. In July 2006, the EPC Gen 2 protocol was approved and adopted by the International Standards Organization as the ISO 18000-6C standard. ISO has created many standards for RFID that deal with both the air-interface protocol and applications for RFID. EPC deals with more than just how tags and readers communicate. EPCglobal wants to create network standards to govern how EPC data is shared among companies and other organizations.

THE ELECTRONIC PRODUCT CODE
What is the Electronic Product Code?
The Electronic Product Code (EPC) was created by the Auto-ID Center as an eventual successor to the bar code. The aim was to create a low-cost method of tracking goods using RFID technology. The benefit of RFID is that it doesn't require line-of-site, which means goods can be scanned through packaging and without needing people to scan items. EPC tags were designed to identify each item manufactured, as opposed to just the manufacturer and class of products, as bar codes do today.

How does the EPC work?
The EPC is a string of numbers and letters, consisting of a header and three sets of data partitions. The first partition identifies the manufacturer. The second identifies the product type (stock keeping unit) and the third is the serial number unique to the item. By separating the data into partitions, readers can search for items with a particular manufacturer's code or product code. Readers can also be programmed to search for EPC's with the same manufacturer and product code, but which have unique numbers in a certain sequence. This makes it possible, for example, to quickly find products that might be nearing their expiration date or that need to be recalled.

Why is EPC technology important?
EPC technology could dramatically improve efficiencies within the supply chain. The vision is to create near-perfect supply chain visibility—the ability to track every item anywhere in the supply chain securely and in real time. RFID can dramatically reduce human error. Instead of typing information into a database or scanning the wrong bar code, goods will communicate directly with inventory systems. Readers installed in factories, distribution centers, and storerooms and on store shelves will automatically record the movement of goods from the production line to the consumer.

Will there be just one type of EPC?
No. The Auto-ID Center originally proposed EPC's of 64-, 96- and 128-bits. Eventually, there could be more. The 96-bit number is the one the center believed would be most common. It chose 96 bits as a compromise between the desire to ensure that all objects have a unique EPC and the need to keep the cost of the tag down (the less information on the microchip the cheaper the cost of producing the chip). The 96-bit EPC provides unique identifiers for 268 million companies. Each manufacturer can have 16 million object classes and 68 billion serial numbers in each class, more than enough to cover all products manufactured worldwide for years to come. Since there is no need for that many serial numbers at this time, the center has proposed an interim 64-bit code. The smaller code will help keep the price of the RFID chips down initially (the simpler the chip, the cheaper the tag), while providing more than enough unique EPC's for current needs. The center foresees using a 128-bit code to cover all the items made around the world.