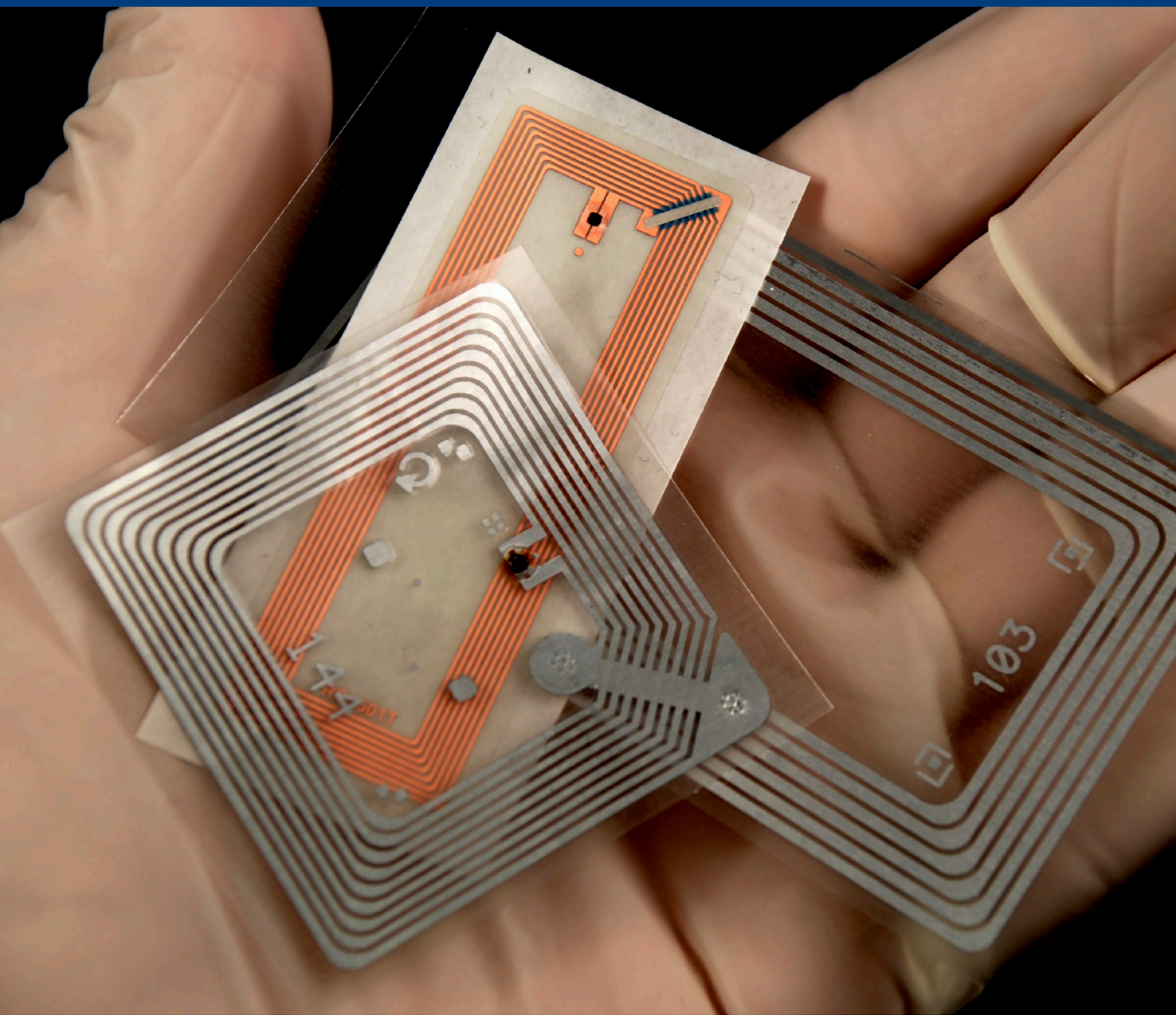
Introduction to RFID



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Radio frequency identification

Radio Frequency Identification, or RFID technology, has been around longer than barcode technology, but is only now being brought to the surface because of new mandates being set by large retailers such as Wal*Mart and large government agencies such as the Department of Defense. RFID is a data collection method that utilizes low power radio waves to send and receive data between tags and readers. By using radio signals, RFID eliminates the need for a direct line of sight to the tag in order to read it. RFID readers can simultaneously read and write to hundreds of tags within their read field.

How do these tags and readers work?

RFID tags

It is quite possible that you have seen RFID tags, even used RFID tags, during the course of your day without even knowing it. Such an example would be EZPass, a system for paying tolls without having to stop and physically hand someone money. Your information is held on an EZPass tag that is placed on your windshield. That information is transmitted using radio-signals to an RFID reader which in turn will tell the toll plaza's main computers to debit your account the amount of the toll. This system helps to reduce the amount of toll booth attendees that need to work at the toll plaza, while allowing you to avoid long lines.

What is in your EZPass tag that makes it work?

An RFID tag, similar to your EZPass tag, consists of an integrated circuit (IC) which transmits data through an attached antenna. Some tags rely on a reader or interrogator to "wake it up" and to supply the power necessary to respond and transmit data; these are called passive tags. Active tags have their own battery power source and are able to transmit data further distances because they have their own power source. Active tags can transmit data constantly, or periodically like a lighthouse beacon shining a light.

There are three classifications of active and passive tags: read-only, read-write, and a combination of the two. Read-only tags, similar to your EZPass tag, are programmed once and can never be programmed again. Think of this as a music CD you purchase at the store. It is already programmed with music that you can listen to over and over again, but you can't record over that CD.

A read/write tag is similar to a CDRW which you can buy at an office supply store. These CD's allow music and information to be recorded on to them and then read or listened to multiple times. They also allow you to erase discs and reuse them. Read/write tags allow you to write to them multiple times and read that information; they could be permanently placed on pallets and have the contents written to it. Once the pallet reaches its destination and the contents are removed, it can be reprogrammed with information about the new contents that are placed on it.

The third type of tag, which is a combination of both tags, can be written to just one time after it has left the factory. Normally this tag will have key information programmed in at the manufacturing facility, such as an EPC number, and then you can program the tag with more information once it receives it. This would be similar to a CDR disk that you would purchase. You can only write information or music to it once; however, you can read hat information, or listen to that music, over and over once it is programmed.

RFID readers

Now that you have a basic understanding of the tag, you need to have an understanding of the second main component of the system - the reader. If you have ever used

Most mobile computers optionally offer an integrated RFID reader

Radio Frequency Identification *- data collection method that utilizes low power radio waves to send and receive data between tags and readers*

Barcode *- an encoded reference number that a computer uses to look up an associated record which contains descriptive data and other important information*

RFID Tag *- an integrated circuit which transmits data through an attached antenna*

Integrated Circuit (IC) *- a micro-electric semiconductor device comprised of many interconnected transistors and other components (The integrated circuit can be looked at as the "brains" of an RFID tag.)*

Passive Tag *- an RFID tag that relies on a reader to provide it with the power necessary to transmit data*

Active Tag *- an RFID tag that has its own battery power source Read Only Tag - an RFID tag that contains data that cannot be changed*

Read/Write Tag *- an RFID tag that can store data and be reprogrammed (Read/write tags are generally more expensive.)*

Combination Tag *- an RFID tag that can be written to just once*

RFID readers at loading dock doors create a magnetic field that RFID tags pass through.

a barcode scanner, or have seen someone using a barcode scanner, you have a pretty good base for understanding an RFID reader. A barcode scanner uses either a laser or imaging device to obtain information from a barcode. This information is then either interpreted by the reader or sent directly to a main computer to be interpreted and analyzed. An RFID reader does the same thing, only it uses low power radio waves to obtain information from the RFID tag. However, readers can also program RFID tags.

The RFID reader uses an antenna to send and receive signals to and from RFID tags. The antenna can be either an internal or an external addition. In fact, some barcode scanning devices can add an RFID sled on to them to become a reader. Readers can also be fixed mounted; fixed mounted readers can be found at a receiving dock's bay door or at an EZPass toll booth. A fixed reader creates a magnetic field which the tag passes through, allowing the reader to send and receive information. Readers can be incorporated into other equipment such as fork lifts or assembly lines.

Once the information is received by the device, it is processed by its internal computer or sent via your wired network, or wireless LAN system, back to your main database. This data is then processed as they normally would be by your main computer.

Readers have to be able to read in the particular frequency for the tag that you are using, and this is one of the challenges you are faced with when installing an RFID system because there is no set standard for which frequency to use. The three most common frequencies used are low frequency, high frequency, and ultra-high frequency.

There are readers called "frequency agile readers" which will read multiple frequencies. These readers are a good investment if you will need to read different tags. Without a frequency agile reader you will need to have multiple readers at each location where you are reading tags, each reading at a different frequency level.

While readers and tags need to operate at the same frequency, there are several other attributes that they must have in common in order to be fully compatible; these attributes include encryption and decoding algorithms, data content and format, interface protocols, and other technical specifications. You will need to fully understand all of

Frequency Name	*Frequency Level*	*Range*
Low Frequency (LF)	125 KHz	Up to 20"
High Frequency (HF)	13.56 MHz	Up to 10'
Ultra-High Frequency (UHF)	915 MHz or 2.45 GHz	3' to 20'

RFID Reader *- a reader which uses low power radio waves to exchange information with RFID tags*

Antenna *- a coiled element that allows tags and readers to transmit data*

Wireless LAN (Local Area Network) *- a network which transmits and receives data over the air using radio frequency technology Low Frequency - typically operating at 125 Hz (These tags are less expensive but can't transmit data long distances or at high speeds.)*

High Frequency *- typically operating at 13.56MHz (These tags can operate from about 10' away and transmit data faster.) Ultra-High Frequency - typically operating between 866MHz to 930MHz (These tags will transmit data faster and further however, they cannot send data through high water content items such as fruit.)*

Frequency Agile Readers *- RFID readers that can read multiple frequencies*

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these attributes in order to ensure that your readers and tags will be able to interact.

RFID back end system

Well now that you have a basic understanding of RFID tags and readers, that's all you really need to know, right? Well, not quite. RFID allows you to send and receive a lot more information back and forth than you are currently sending with your existing barcode system. With all of this extra information, you need a back end system that can decipher that data and use it as efficiently as possible. This may mean reengineering certain business processes; this will allow you to send and receive more data at a higher rates. By sending more data at higher rates you will gain more control over product information and can have greater automation throughout your facility.

Let's say, for instance, you are a drug manufacturer. With an RFID tag on each bottle of medication that is sent out from your lab, you can have the lot number associated with each bottle as well as other pertinent information. If, in one month after sending out a certain batch of medication you find out that lot was bad, you can easily track that batch, knowing which bottles went to which stores and then pull only those bottles that contained bad medication from the shelves, instead of having to pull all bottles of your medication from the shelves in every store.

With RFID tracking, this scenario is quite possible, but your back end system has to be able to handle this information which may mean re-designing your software programs or creating an entirely new database altogether. This is something that you need to look into before jumping on the RFID bandwagon.

RFID-am I ready?

Ok, so now you understand RFID tags, RFID readers, and the RFID back end system. Are you now ready to install your RFID system and start using it to its full capacity? Yes, and no. It really depends on what you are trying to accomplish with your RFID system. There are two general types of RFID systems you can install: a closed-loop system or an open-looped system.

Closed-loop systems generally have little or no contact with the outside world. Everything is done within one facility or organization and therefore can have their own standards set by the organization.

For instance, an automobile manufacturer may place an RFID tag on a car's frame to track it throughout the entire assembly process. Once that tag leaves the plant, it can be "killed" so that it can never be read again by an RFID reader.

An open-loop system has information that will be shared with outside vendors and/

Closed-Loop System *- an RFID system set up within one organization (Closed-loop systems do not rely on outside standards)*

- *Assembly operations*
- *Manufacturing processes*
- *Work-in-Process*
- *Animal tracking*
- *Health care (inventory & equipment control)*

Open Loop System *- an RFID system that shares information with outside parties (Open loop systems will rely upon set standards in the auto ID community)*

- *Supply chain management*
- *Baggage handling*
- *Returnable container tracking*
- *Rental car control*
- *Toll roads & parking garages*
- *Security & access control*
- *Product security*
- *Shipping*
- *Warehousing*
- *Cashless payment*

By placing RFID tags on medication, pharmaceutical companies can avoid blanket recalls due to one bad batch of medication.

or customers. This could involve tracking containers, monitoring rental cars leaving and returning a location, point-of-sale applications, or baggage handling. The reason open systems are rarely used today is due to the lack of a standard and central database.

The potential an open-loop system brings is tremendous. Being able to track a pallet all the way through the supply chain, or being able to locate a single item anywhere in your warehouse, or even your clients warehouse, has tremendous implications. Unfortunately, a standard needs to be set that is adopted across the board before an open-loop system's potential can be unleashed.

So are you ready for an RFID system to be implemented within your company?

If you are looking at a closed-loop system with specific goals and business processes that you want to improve, then an RFID system may be something you want to begin investing in sooner rather than later.

Standardization

So what are the standards for RFID and who decides what they are? The Electronic Product Code, or EPC, is being designed by a joint venture by the Uniform Code Council

Electronic Product Code (EPC) *- a set of digits to identify the manufacturer, product category, and the individual item*

Uniform Code Council (UCC) *- non-profit organization that oversees the UPC*

Uniform Product Code (UPC) *- the barcode standard used in North America*

European Article Numbering (EAN) *- the barcode standard used in Europe*

ISO *- the International Organization for Standardization is developing an RFID standard to be used worldwide.*

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Class	*Description*
Class 0	Class 0 tags are read only and have 64 or 96 bit memory. These tags operate in the UHF frequency band, or 868-930 range. Class 0 tags are read-only.
Class 0+	Class 0+ tags are offered by Matrics and are the same as Class 0 tags with the additional ability of being re-writable.
Class 1 UHF	Class 1 UHF tags are one-time programmable, meaning they can be programmed once after being received from the factory with their EPC number already programmed. These tags operate in the 868-930 MHz band and have up to 96 bits of memory.
Class 1 HF	Class 1 HF tags are similar to Class 1 UHF tags; however, these tags operate in the high-frequency range at 13.56 MHz.
Gen 2	Generation 2 (Gen 2) tags are quickly becoming the most popular tag available on the market. Offering between 96 and 256 bits of memory per tag and operating in the 860-960 MHz band (UHF), these tags are required by Wal*Mart and the Department of Defense (DoD) in their RFID compliance programs.

Existing standards	
ISO 11784/11785	Animal identification RFID standard
ISO ANSI/NCITS T6 256 - 1999	Item management RFID standard
ISO/IEC 15693-2	13.56 MHz vicinity cards and smart labels RFID standard
ISO/IEC 18000 Part 6	Air interface for item management at (2450 MHz)
ISO/IEC 15961 & 15962	Information interface for object oriented use of RFID in item management
ISO 18185	Electronic seal tags
ISO 22389	RFID read/write for containers
GTAG	On-going RFID global tag initiative
ANSI INCITS 256:2001	American RFID standard for item management
EAN.UCC GTAG	Application standard for use of RFID in the macro supply chain
ANSI MH10.8.4	Application standard for RFID on reusable containers
Automotive Industry Action Group (AIAG) B-11	Tire and wheel identification

(UCC) and EAN international. The EPC is designed to be similar to the UPC barcode that you see on most items sold in retail stores. The EPC will establish a standard that will be adopted by all companies that want to have their products able to interact with other companies RFID systems.

Multiple EPC specifications are differentiated by their class and version. Vendor compliance programs require that specific classes and versions be used.

ISO

The International Organization for Standardization (ISO) is leading the way for standardization worldwide. They are currently working alongside the UCC & EAN to develop a standard that can be used across the board.

RFID Tags, like the one will never be cheaper than a barcode label.

So is this the end of barcoding, and should I now invest in RFID?

So now that RFID is emerging and seems to have great advantages, does that mean that all of the investments you've made in barcoding technology were for nothing? In one word, "No."

Barcoding and RFID are not mutually exclusive technologies; they will interact with each other. In fact, RFID tags are nearly always printed with a barcode as a back-up system. Even the EZPass in your car has several back-up methods in case the battery dies or the tag goes bad. This includes having a barcode printed on the tag itself that can be scanned by a toll attendant.

RFID tags will never be cheaper than a barcode label. While the cost may approach the cost of a barcode label, it will never be cheaper. That doesn't mean the ROI won't

be greater, or the value of an RFID tag isn't greater than a barcode label, but you will still never be able to purchase a roll of RFID tags for less than a roll of barcode labels. You should not rush into purchasing an RFID system simply to comply with a vendor or customer's demands. By taking your RFID requirements one step further and doing a little more investigating, you will obtain a much higher return on your investment. Before you invest in an RFID system, you want to answer these questions:

1. What business problem am I trying to solve?
2. What is the compelling reason to use RFID instead of barcodes?
3. Is the data actionable?
4. What is the benefit to my business?
5. Is my system open or closed?
6. If open, with what standards will I need to comply?
7. Are there any international regulations I need to consider?
8. Can I expect the system to operate the same way anywhere across the country? The world?
9. Have I thoroughly tested the system with a representative range of items?
10. Have I assessed the impact of the "new data" on my existing information system?

So now what?

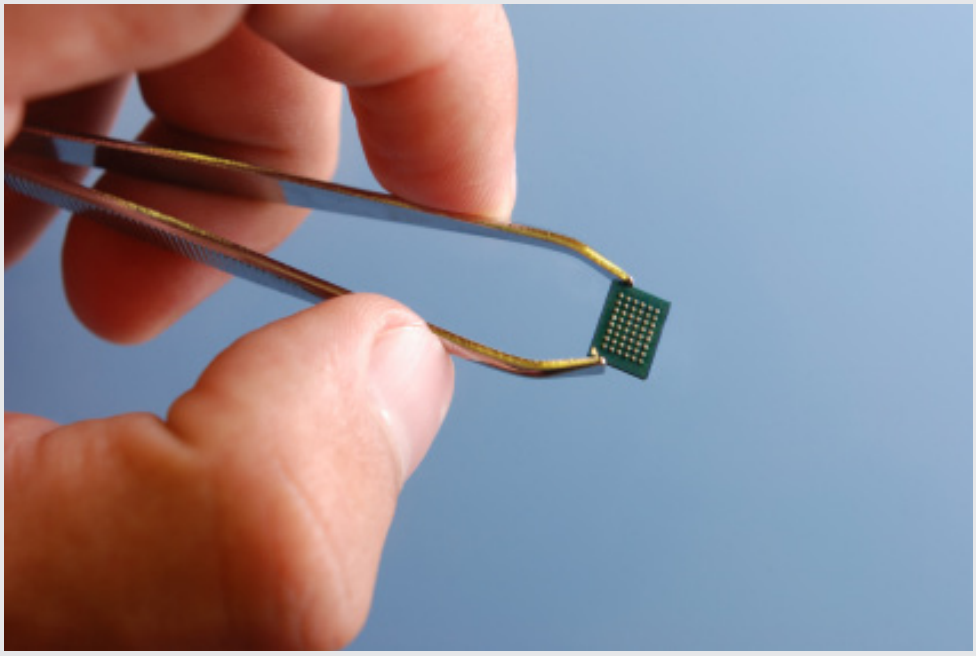
While setting up an RFID system in a lab is easy; setting up an RFID system in your building is much more difficult.

There are many questions to take into consideration:

- Are there any devices using the same frequency that will interfere with the tags and readers?
- Are the tags going to be placed directly on a metal surface that may affect their readability?
- What is the lay-out of the facility?
- Will all of my tags be able to be read by a single reader?

So while you may not want to set up an entire RFID system, it is time to start looking into the technology, understanding the impact it will have on your business, and start to realize the tremendous potential RFID has in helping you save you money and improve your bottom line. You want to be ready for an investment in RFID once standards are set and you feel that it is time to move on to the next step. This is not a decision that you want to make without knowing all of the key information and fully understanding the power of an RFID system.

While lab testing of RFID systems is easy to set up and demonstrate, real-world environments, such as toll-collecting applications, pose a much more difficult setup process.



RFID tags can be as large as a brick or can be smaller than a postage stamp.

Common myths about RFID

RFID is a "talking" barcode.

While an RFID tag does not "talk" to you, it will carry more information than a standard barcode. It can carry a products information, a unique serial number, lot date, manufacturing facility information, and has the ability to be read and written multiple times.

You can read every RFID tag every time.

It is nearly impossible to read every single tag every single time. The laws of physics nearly make this impossible. The readability of every RFID tag depends on tag placement and the contents of the container on which the tag is placed. For instance, RFID tags can be placed on an empty container and be read perfectly; however, fill that container with something, even water, and that tag can now be useless. A good engineering system also has to be designed, and procedures may have to be altered to get the best read rates of your RFID tags.

You can take your entire inventory with the push of a button.

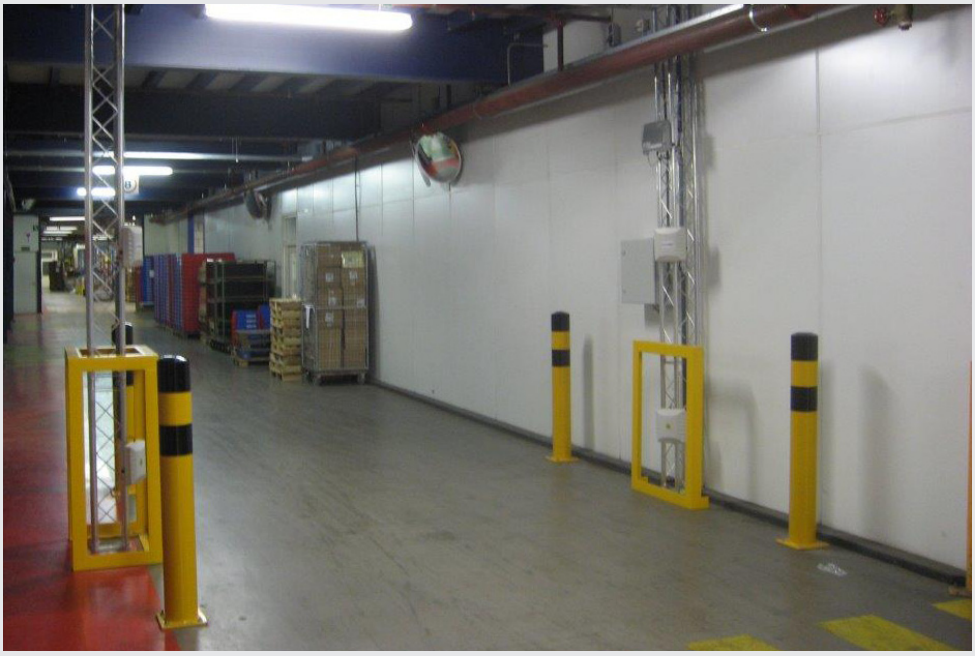
The technology does not exist today to do this; most tags can only be read up to three feet away. Even if the technology did exist it would be so expensive that it would not be worth the investment to do this. The real benefit is in real time inventory tracking: When did the product come in? Where was it placed? Was it moved? Was it shipped?

RFID delivers perfect information.

Not every tag can be read every time, and when it is read it can only deliver the information that was entered into it. So, if bad information is placed on the tag, it will return that same bad information. This opens the door for many faults within the system, including human error, unfriendly materials, poor system design, and poor software design. However, a system can be designed and implemented that provides near flawless information. You will just need to take the time and invest the resources in order to make this possible.

You can buy tags for 5¢.

Even Gillette's purchase of 500M tags from Alien was for about 10¢ per tag. Buying the cheapest tags possible is contingent on the industry buying millions and millions of tags each year. At this point in time, without a standard set in stone, it is not cost effective to purchase mass amounts of tags.



The good news is, however, tags do not need to be that cheap to derive a high ROI. The EZPass tags you use on your cars cost about $20 and rail companies are using $25 tags to track rail cars.

RFID is primarily a supply chain technology.

There are many applications that can effectively use RFID technology outside of the supply chain. Some applications include automobile manufacturing - specifically work in process, access control and security, payment systems for fuel and merchandise, and toll collections. Set up correctly, RFID offers a way to increase value when tracking items.

RFID means the end to privacy.

While RFID does seem to pose a threat to consumer privacy, there are measures that are being taken to ensure this does not happen. "Kill" software is available that will virtually kill an RFID tag. As RFID evolves in the marketplace, so will the privacy protection systems.

RFID is easy to deploy.

While demonstrations in a lab or controlled environment are simply to set-up and show they work, setting up an RFID system in your facility is much more difficult. Interference from phones, microwaves, and existing RF networks need to be considered. There are many factors that need to be considered before deploying an RFID system in your facility, metal shelves, water, and the layout and design of your facility.

I can afford to wait before looking into RFID.

While it is better to wait and derive the most return on your investment than to be first with a system, it would be best to start the process early and slowly. Go step-by-step understanding each part of the system and avoid a rushed catch-up deployment. You don't want to tag items for your customers without finding your own internal benefits first.

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