Radio Frequency Identification (RFID)
An Overview

How RFID Is Changing the Business Environment Today

Radio frequency identification (RFID) technology has been in use for several decades to track and identify goods, assets and even living things. 3M has been providing an RFID System to libraries for the past several years for the purpose of tracking and inventorying books and other materials. 3M is now offering an RFID File Tracking System to legal firms, court systems, government agencies and insurance companies for managing and tracking physical files.

I. RFID Technology Overview

Generally speaking, RFID is the automatic identification and tracking of items through use of an identification chip or "tag" that sends data to readers through wireless data communication. It is useful to think of an RFID system as one in which these tags enable items to "speak" about their identity, location, activity or history through readers and, ultimately, to application software that can process and utilize this information.

RFID technology is already being used in many applications, such as for toll booth automation and self-service retail processes. From a legal firm standpoint, RFID technology allows tracking and fast retrieval of physical files, thereby increasing overall firm efficiency and productivity.

Currently, most of the focus is on basic identification of an item as it passes from location to location. This is similar to the way bar codes are used, but with important advantages unique to RFID technology. Powering this vision is the prospect of having proactive visibility to the location and unique identity of each file. Additionally, RFID eliminates the errors associated with the manual scanning of bar codes.

The Five Components of an RFID System

There are five key components of an RFID system, though there are many variations of each component and combinations of components. These are described below:

1. Tags (Transponders)

An RFID tag is comprised of a microchip containing identifying information and an antenna that transmits this data wirelessly to a reader. At its most basic, the chip will contain a serialized identifier that uniquely identifies that item, similar to the way many bar codes are used today. A key difference, however, is that RFID tags have a higher data capacity than their bar code counterparts. This increases the options for the type of information that can be encoded on the tag. In fact, an unlimited list of other types of information can be stored on RFID tags, depending on application needs. In law offices, the RFID tag is affixed to individual physical file folders.

Tags come in a variety of types, with a variety of capabilities.

"Read-only" versus "read-write"

There are three options in terms of how data can be encoded on tags:

(1) Read-only tags contain data such as a serialized tracking number, which is pre-written onto them by the tag manufacturer or distributor. These are generally the least expensive tags because they cannot have any additional information included as they move throughout the supply chain. Any updates to that information would have to be maintained in the application software that tracks item movement and activity.

(2) "Write-once" tags enable a user to write data to the tag one time in production or distribution processes. Again, this may include a serial number, but perhaps other data such as a lot or batch number.

(3) Full "read-write" tags allow new data to be written to the tag as needed—and even written over the original data. Examples for the latter capability might include the time and date of ownership transfer or updating the repair history of a fixed asset. While these are the most costly of the three tag types and are not practical for tracking inexpensive items, future standards for electronic product codes (EPC) appear to be headed in this direction.

Data capacity

The amount of data storage on a tag can vary, ranging from 16 bits on the low end to as much as several thousand bits on the high end. Of course, the greater the storage capacity, the higher the price per tag.

Passive versus active

“Passive” tags have no battery and "broadcast" their data only when energized by a reader. That means they must be actively polled to send information. 3M™ RFID Tags are passive tags. "Active" tags are capable of broadcasting their data using their own battery power. In general, this means that the read ranges for active tags are several times greater than they are for passive tags. The extra capability and read ranges of active tags, however, come with a cost; they are several times more expensive than passive tags and batteries have a limited shelf life.

Frequencies
Like all wireless communications, there are a variety of frequencies (low, high or ultra-high frequency) or spectra through which RFID tags can communicate with readers. Again, there are trade-offs among cost, performance and application requirements. For instance, low-frequency tags are cheaper than high frequency or ultra high-frequency (UHF) tags, use less power and are better able to penetrate non metallic substances. They are ideal for scanning objects with high water content, such as fruit, at close range.

UHF frequencies typically offer better range (a read range of 15 feet for passive tags and a read range of 100 feet or more for active tags) and can transfer data faster. But they use more power and are less likely to pass through some materials. UHF tags are typically best suited for use with or near wood, paper, cardboard or clothing products. Compared to low-frequency tags, UHF tags might be better for scanning boxes of goods as they pass through a bay door into a warehouse

2. Readers
The reader/writer sends an RF signal to tags to request the information contained on the chip. Upon receipt of this information, it is translated into a digital form and sent to the application software.

Again, there are a variety of different reading systems and technologies. These include:

(1) Hand-held readers that act much like a hand-held bar code scanner, meaning they are tethered to portable data collection devices or to fixed terminals/PCs running application software

(2) RFID readers embedded into mobile data collection devices. This would typically mean an RFID reader that is internal to a portable wireless data collection device such as those used in warehouses, shop floors and by transportation personnel.

(3) Fixed readers, which are mounted to automatically read tags as product passes by or near them. Examples include readers mounted on conveyor equipment, readers mounted on entry points to the back room of a retail store, "portal readers" placed at dock locations to automatically read tags as product is shipped or received, and readers mounted on material handling equipment.

3. Encoders
Unless a company uses a read-only tag serialized from the tag manufacturer, the capability to write data to the tag will also be necessary—whether this capability is once or many times, depending on the type of tag (as previously described). Readers themselves can and often will serve as the 'write' or encoding mechanism, but not always. Many companies will also use a new generation of traditional bar code printers that can print both human-readable data content and bar codes, while simultaneously writing data (serial number, etc.) to a tag inside the label construction. This can ensure, for example, that the serial number on the label bar code is the same as the serial number on the RFID tag.

4. Middleware
This refers to specialty software that sits between the reader network and the true application software to help process the significant amount of data coming from the tags and readers. For

example, sending only one "transaction" read after a reader submits multiple reads of the same tag. More specifically, RFID middleware provides the following functions:

- **Reader interfaces:** Middleware provides drivers to retrieve data from the readers of various hardware manufacturers.
- **Data filtering:** Not every tag will be read just once, and sometimes a tag is read incorrectly. Middleware uses embedded logic to aggregate, purge and filter tag data thereby 'cleaning' the data feeds to the application software.
- **Reader coordination:** By monitoring multiple readers, middleware can detect the movement of RFID tags as they pass from the read range of one reader to another. This directional movement detection can be captured and passed on to the application software as an inventory movement notification.
- **System monitoring:** Middleware will monitor tag/reader network performance to generate a real-time view of tags being read. It may also capture history and analysis of tag-read events for application tuning and optimization.

5. Application software

To drive value from RFID, or even to manage the process flow for RFID compliance requirements, you must deploy RFID-enabled software that processes RFID data, controls workflows and business transactions, and passes RFID data on to other systems (such as EDI translators or ERP software) as required. Thus far, much of the publicly available information on RFID has been on the hardware aspects of the technology (tags and readers) or the description of business applications at a high level. Yet, the requirements and role of application software to utilize the technology and deliver business value is absolutely critical, whether in an asset tracking or compliance scenario or in driving internal supply chain improvements. Regardless of the type of RFID application(s) you choose to implement, your selections must empower you to deploy RFID quickly and cost-effectively—and without disruption to your existing operations and customer relationships.

The Advantages of RFID Over Bar Coding

1. **No "line of sight" requirements:** Bar code reads can sometimes be limited or problematic due to the need to have a direct "line of sight" between a scanner and a bar code. RFID tags can be read through materials without line of sight.
2. **More automated reading:** RFID tags can be read automatically when a tagged product comes past or near a reader, reducing the labor required to scan product and allowing more proactive, real-time tracking.
3. **Improved read rates:** RFID tags ultimately offer the promise of higher read rates than bar codes, especially in high-speed operations such as carton sorting.
4. **Greater data capacity**: RFID tags can be easily encoded with item details such as lot and batch, weight, etc.
5. **"Write" capabilities:** Because RFID tags can be rewritten with new data as supply chain activities are completed, tagged products carry updated information as they move throughout the supply chain. While "two-dimensional" bar codes like pdf-417 offer this capability to some extent, a new label must be printed and applied at each "event," making multiple "writes" impractical. Furthermore, bar codes cannot be attached to things like sensors to record environmental history.
6. **Durability:** RFID tags are more durable than bar codes, which can become smudged and unreadable.

RFID Benefit Summary

With the advantages derived from RFID, companies adopting RFID-based solutions have several ways to drive ROI and gain additional business benefits. The extent of this benefit will vary depending on your existing level of automation, the planned application environment (e.g., compliance versus closed-loop—in which items begin and end at the same point and are tracked throughout), and other factors.

The adoption of RFID technology is a quantum leap forward in managing files and assets but, with the right solutions it can be implemented easily, with little change to your current workflow.