Radio Frequency Identification (RFID): Its Usage and Libraries

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Abstract

Radio Frequency Identification (RFID) is one of the most exciting technologies that revolutionize the working practices by increasing efficiencies, and improving profitability. The article provides details about RFID, its components, how it works, and its usage in different sectors i.e. retail sales and supply chains, livestock industry, courier services, military and prisons,   automobiles and logistics, entertainment industry, publishing industry, wireless transaction, and, especially, in LIBRARIES. The article also presents an in depth analysis of RFID uses in Libraries with implementation roadmap, its impacts on libraries, and a comparison of major vendors and their products.

Keywords

1. Radio Frequency Identification (RFID)

2. RFID usage

3. RFID in Libraries

1. Introduction

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Radio frequency identification (RFID) is one of today's most exciting and fastest growing technologies for increasing efficiencies and improving profitability. RFID is a combination of a computer chip and a small radio antenna that allows almost any object to "self-identify." Originally developed for use in World War II, the British used it to identify their planes. The new Radio Frequency Identification (RFID) first appeared in the early 1980s where it was used for: item tracking and access control applications. These wireless automatic identification data capture systems allow for non-contact reading or writing of data and are highly effective in manufacturing and other hostile environments where barcode labels can not survive. Since the 1980's, RFID has established itself in a wide range of markets including livestock, retail sales, wireless transactions, courier and logistics, publishing, automated vehicle identification systems, etc.

Chachra (2003) describes RFID as:

Radio Frequency Identification (RFID) is the technology that is slated to replace barcodes in library applications. It is a form of identification that is contact-less and does not require line of sight. The technology, though new to libraries, has been in use in other sectors for more than 20 years. The RFID tags are placed in books and generally covered with a property sticker. Antennas of different sizes, based on application, are used to read the tags and manage the various library functions.

The RFID Solution is a revolutionary application of automatic identification and data capture (AIDC) technology. In a library environment, RFID technology resembles a traditional barcode system in that it provides a means of assigning an ID to an item and reading that ID to perform circulation transactions or to take inventory.

2. Components of an RFID system

A standard RFID system consists of four main parts:

• **RFID Tags** - Applied directly to items. Each RFID tag contains a tiny chip with a capacity of at least 96 bits. The tags can be permanently activated (programmed during
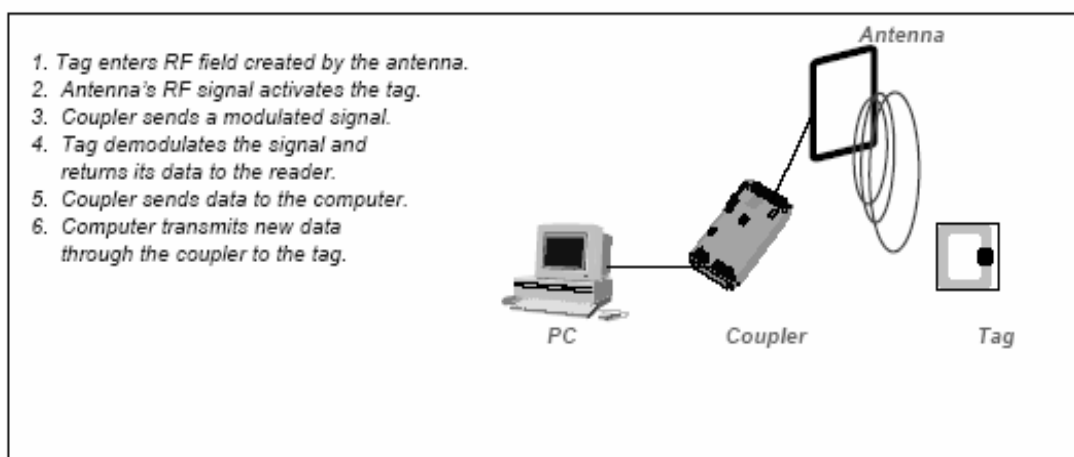
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manufacturing) or, at higher complexity and cost, read-write, both. The tags are electronically programmed with unique information. The size of the tag depends on the size of the antenna, which increases with range of tag and decreases with frequency.

• **Antenna** - also known as sensors, interrogators or readers. A conduit between RFID tags and the coupler. RFID antennas connected to the reader, emit power and data from and to the RFIS tags.

• **Reader/ Coupler** - link between RFID tags and the Server/ PC. The coupler can send information in two directions: It can read information from a tag and send it to the Server/ PC (read mode), or it can read information from the Server and send it to an RFID tag (write mode).

• **Server/ PC**- link between the coupler and your library automation system. The Server/ PC is the heart of a comprehensive RFID system. It is the communications gateway among the various components. It receives the information from the antennae and exchanges information with the circulation database. The server typically includes a transaction database so that reports can be produced.

3. How it work

1. Tag enters RF field created by the antenna.
2. Antenna's RF signal activates the tag.
3. Coupler sends a modulated signal.
4. Tag demodulates the signal and returns its data to the reader.
5. Coupler sends data to the computer.
6. Computer transmits new data through the coupler to the tag.

Antenna

PC   Coupler   Tag

4. RFID usage in different sectors

RFID applications are fueling a quiet business revolution that promises to speed up inventory and payment systems and change our lives. RFID is, in fact, already pervasive in our lives. Used to track everything from pets to prisoners to products.

Booth-Thomas (2003) states that more than 50 million pets worldwide are tagged with RFID chips. At least 20 million livestock have RFID tags to follow them before possible disease breakthrough. US military used it in Iraq to electronically search supplied and keep tabs on hospital patients. A report of IDTechEx titled as "One trillion tags in 2005" (July 14, 2004) forecasted that it may be 2015 before one trillion items are RFID tagged in one year. Another report of IDTechEx titled as "RFID market forecast" (May 24, 2004) stated "Datamonitor forecast a $ 5-20 billion European market for intelligent tags and their equipment in year 2005… The leaders in smart labels are each shipping 60 to 120 million chip tags a year. Philips, a supplier of RFID chips says global consumption for smart labels is around 1.9 billion units in 2004." This report also tells us about a global research conducted by IDTechEX. The research predicts that by 2013 the RFID market will be worth $ 10 billion. The chips plus antenna are now only a couple of millimeters square and can be applied to individual consumer products like books or used in the supply chain on cartons, skids and containers. Unlike bar codes, which require a clear line of sight, these information-rich radio waves can go through walls, clothing or paper, and the technology, theoretically, could be used to identify individually every single one of the trillions of products that circulate in the world, for any and all retail transactions.

4.1 RFID in retail sales/ supply chains

Globally, RIFD is being used for a number of commercial applications, and in particular for grocery stores and retail. The companies most interested in RFID have been drawn to it by the great potential for supply chain management. RFID technology holds the promise of substantial improvements in retail store logistics. The item level tagging is the mount

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everest of the RFID industry. Large department stores like Wal-Mart in USA and Marks & Spencer in the United Kingdom have made aggressive plans for use of RFID in their management of product inventories and sales.

Booth-Thomas (2003) reports that in 1999, the three men with the help of P & G and Gillette, founded the Auto-ID Center at M.I.T. pursuer RFID uses. Today 103 companies are members, including consumer giants like Johnson & Johnson, Kimberly-Clark, Kraft Foods and Unilever. In June Wal-Mart CIO Linda Dillman gave the firm's 100 top suppliers—which provide half the goods on its shelves-a veiled ultimatum about the stuff flowing into its 103 U.S. distribution centers.

Already several companies, such as CHEP (www.CHEP.com) are profitably leasing RFID skids to supermarket, drug store and other retail chains throughout the world to facilitate distribution.

So far, Europeans have made the biggest investments. In England retailer Marks & Spencer has spent the past two years rolling out RFID tracking of its gourmet take home foods supplied to 200 plus stores by 300 providers. The RFID tags are embedded in some 3.5 million food trays and dollies, allowing the company to track the trays and reducing employee hands-on time 80 %. Two European supermarket chains, Tesco and Metro, have announced plans to use RFID starting late this year; and there are tests or discussions underway regarding RFID and EPC's use in food processing and pharmaceuticals.

Collins (2003) reports that Microsoft is testing "its first RFID supply chain management (SCM) pilot project... to develop and test new RFID-capable software that it plans to bring to market next year." The test is being conducted with KiMs, a Danish snack food producer, and will be what in the industry is called a "pallet and case-level test"-- i.e., the RFID chips will be used to track pallets or cases of goods, not individual items. Microsoft's larger aim is to "market its RFID products to similar midsize companies."

"There are 39 million mid-market-sized companies around the world. If we productize what we have developed for KiMs in a good way, we have a huge opportunity," says Bjarne Shon, director of supply chain management with <u>Microsoft Business Solutions Denmark</u>.

4.2 RFID in the global livestock industry

The recent outbreaks of diseases such as BSE (mad-cow disease), FMD (foot and mouth disease) exploded the rate of adoption of RFID technology to tag animals. Napier (2004) states that animal tagging is likely to become one of the worlds largest markets for RFID tags over the next ten years, with around 600 million tags per year being used in the year 2014.

Using RFID in the cattle industry is far from a new idea. Texas Instruments, one of the largest manufacturers of RFID transponders, got into the RFID business after being asked to develop a chip suitable for a cattle-tracking trial in Holland back in 1989. Booth-Thomas (2003) tells that more than 20 million head of cattle have been tagged worldwide. But that number pales when one considers that the United States alone has a population of 98 million head. There are about 1 billion head of cattle worldwide.

The International Organization for Standardization (ISO) has approved standards for animal RFID tags, and the technology has improved in recent years. Adoption is picking up in Europe, Australia and Canada. Sales of animal RFID tags worldwide this year are expected to reach $37 million. The market is expected to grow at a compound annual rate of nearly 30 percent over the next four years.

Last September, Canada announced that it would scrap the bar code system; in January 2005, it will begin requiring a rancher to put RFID tags on cattle as they leave the farm where they were born.

Australia's National Livestock Information Scheme has approved RFID tags and readers for use by Australian beef producers. The largest livestock markets in Australia are the 30 million head cattle industry and 20 million head sheep industry. National Livestock

Information Scheme set up in 1999. It is reported that potential RFID income in the Australian sheep market alone is worth $200 million. There are six electronic devices approved for use under National Livestock Information Scheme, 3 ear tags and 3 rumen boluses. Rumen boluses are not popular in sheep because boluses are considerably more difficult to administer to smaller animals because of its weight, and there are concerns over the effect of boluses on the growth rates of young animals. Aleis International Ply, Ltd is a major player in supplying Australia with RFID tags and readers.

Cattle tagging is being explored by a number of European countries. In Spain, for example, 2,500 cattle farmers in the largest farmers' association in the European Union are using RFID to track 300,000 animals as part of a trial. Europe has not rushed to adopt RFID, reason is that there is already extensive data collection and tracking of individual animals without RFID because of actions taken in response to outbreaks of diseases among member countries. The United Kingdom has operated a cattle-tracking system since 1998. It uses a bar-coded ear tag on the animal. Each ear tag has a unique number that is duplicated on a "cattle passport"—a paper document that has information needed to identify an animal and that lists the movements of that particular animal. The passport remains with the animal throughout its life.

The cattle (bovine) market in Argentina represents the country's largest livestock market, with 50 million head of cattle. The potential revenue from the tagging of this cattle population is up to $40 million per year. As a result of field trials, the State government of Salta has indicated to Advanced ID their intent to use its RFID identification and trace back system for its entire cattle population (~50,000 heads).

4.3 RFID and casino chips

Entertainment is now a significant area for experimentation with technology and social practices. Instant messaging, P2P, and blogging all started out as fun, and have migrated

(or are in the process of migrating) into the workplace. Of course, entertainment is also a big industry, which drives other technological innovations and experiments.

Hecht (2003) reports that casinos are looking at putting RFID tags into their chips. The chips will be launched later in 2004 and will allow casino operators to spot counterfeits and thefts, and also to monitor the behaviour of gamblers.... Counterfeit chips have long been a problem for casinos, and houses routinely mark their chips with inks visible only in infrared or ultraviolet light.

The tags could also help casinos manage large-scale theft. If a large stash of chips goes missing and casinos have to change their entire stock. This is unpopular with gamblers, since any chips that they have not cashed become worthless. RFID tags would allow the casinos to identify stolen chips without the expensive process of restocking.

Casinos are fascinating for their use of technology. Mezrich (2002) describes that casinos have some of the most sophisticated security systems in the world and the industry spends a lot of money keeping track of who plays-- recording high rollers' drink preferences and dogs' names, but also watching who's doing what on the floor. It would be looking at using RFID to keep track of chips, and to help refine their ability to monitor what players are doing, makes perfect sense.

4.4 RFID in courier services

Booth-Thomas (2003) describes that the RFID usage has been implemented to track the shipments worldwide by different Courier Services like DHL, Fedex Express. In Singapore and Helsinki DHL tested it in anticipation of tracking the 160 million packages it ships annually. DHL Worldwide Express, which handles 160 million packages a year, plans to go global soon with RFID tracking.   The program manager Trevor Peirce of DHL said "This is amazing technology when you see it working, and it's all fine-tuned". (Booth-Thomas, 2003)

4.5 RFID in military usage

The biggest user of RFID today is probably the U.S. military, which has plowed $272 million into RFID asset tracking—a system that has been battle tested in Iraq. In Gulf War II, the Navy tracked wounded soldiers "like Fedex tracks packages" cutting down battle field confusion. The Army Materiel Command required all air pallets and commercial shipments for Gulf War II to be digitally tagged so commanders like General Tommy Franks a big supporter of the technology-knew when and where critical cargo like tanks would arrive. Booth-Thomas (2003) states, "RFID technology helps the military track 300,000 containers in 40 countries every day. The Department of Defense (DOD) also tracks humans with RFID. For the first time in a war zone, the Navy's Fleet Hospital 3 kept tabs on wounded soldiers, civilians and POWs at its 116-bed facility in the Iraqi desert by using wristbands with RFID chips. By scanning the wristhands, medical personnel could access treatment and track patients in a central database".

4.6 Automobiles with automated vehicle identification system

By the virtue of RFID, Automated vehicle Identification System has shown remarkable and significant results. People are able to track automobiles of personal use or in logistics. Booth-Thomas (2003) also tells us that traces of RFID use in automobiles goes back to 1993. When companies like Taxes Instruments collaborated with carmakers to deter theft. Taxes Instruments working with the Ford Motor Co., came up with a key that literally talks to a car. Use the wrong key, and the car is immobilized. RFID transponders are now in 7 out of 10 cars, and car theft is down.

4.7 Wireless transaction

Today Taxes Instrument is turning its efforts to consumer application like wireless transactions, helping American Express launch Express Pay, an alternative to cash for purchases where speed and convenience are important, such as at fast food restaurants, gas stations and dry cleaners.

Biever (2003) reports that Advanced Digital Solutions in Palm Beach, Florida, announced a plan to turn its rice-grain-sized Verichips into a method of payment at ID World 2003 in Paris, France. The tags are also already used for making wireless credit card payments. ExxonMobil has attached tags to key-rings, to speed up gas station transactions for its customers. But Advanced Digital Solutions (ADS) is the first company to propose sub-dermal chips as a means to secure or make financial payments.

Booth-Thomas (2003) tells that in China, Shanghai and 44 other cities already use an RFID payment system for public transportation.

4.8 RFID in publishing

At this stage of its development, RFID has both useful and unsettling implications for publishing, but it is clearly a technology worth watching. While the ability to track products through the supply chain makes RFID appealing to the book industry and the price of the chips is steadily declining. Among the issues that need resolving are the need for publishers, distributors, and bookstores to add new software to their systems; the cost and deployment of radio readers; and managing the deluge of data suddenly rushing into companies' systems as cartoons, skids and all other RFID-bearing items move through the distribution chain.

Publishers learned more about this technology through Book Industry Study Group's annual meetings, and BISG is continuing to investigate the technology. Just as Wal-Mart is driving the process in the consumer products market, the distribution companies and bookstore chains are bringing focus to the publishing value chain, at least for use in the distribution process. Intriguing as it is to have each book be able to identify itself as it moves from warehouse (or even printer) to bookstore, shelf and cash register.

5. RFID in libraries

RFID is the new technology that revolutionizes library management and practices. IDTechEX's report 'One trillion tags in 2015' illustrate that 70 million library books have been tagged. Ulfelder (2003) provide details about Singapore Libraries that are using RFID technology with remarkable results. Under the leadership of the National Library Board, Libraries in Singapore aggressively implemented RFID technology in their libraries. In Singapore's library system, all 9 million books, videos and DVDs are embedded with antitheft chips, allowing self-checkout. These libraries offer excellent user friendly environment with self service desk for check-out and check-in.

Libraries in the United States and United Kingdom are also deploying RFID technology. (Artz, 2003; Harris, 2003; Timothy, 2003). Examples of the use of RFID technology in USA can be found in both public and academic libraries. New Hanover County Public Library in North Carolina and City Library at Santa Clara California were among the very early implementers of RFID technology. Others like Sarasota County in Florida are sufficiently pleased with their pilot projects that they are expanding the program to cover all libraries.

RFID tags are already being used on individual books in pilot programs in libraries in the U.S. and Canada. In these cases, grants are covering the cost of implementation by companies like VTL. The fact that books circulate drops the cost per book per use to a reasonable level. Once a person is identified as a library patron, check-out is easy. The patron walks past the check-out reader station, and without stopping the books are recorded as checked out. Similarly, a patron can check in any time just by dumping the books down the return chute, where a reader automatically records their return. A special wand that reads every chip on every book on the shelf allows librarians to know instantly which books are in or out or improperly shelved.

Libraries in Australia, South Korea, New Zealand and Macau have adopted the Island's patented system.

5.1 Advantages in libraries

Some of the main advantages of RFID in Libraries are as follows:

1. It is a new technology with tremendous potential for multiple applications in the future.

2. It is a flexible technology, which combines security and item identification in a single tag and reduces library losses by providing effective library detection systems.

3. It is designed to work efficiently with a materials sorting system, which will automate the check-in and check-out processes.

4. RFID eliminate the applied labor of manual material checkout and return processes. The self-check machines are extremely user-friendly. Multiple items can be checked out at the same time by simply passing the materials over the scanner. There is no need to align or position materials for checkout and all materials (books and a/v) are checked out the same way.

5. Best of all, combining RFID technology at the circulation desk, self-check machines and eventually the Techlogic materials sorting system will free circulation staff to perform direct patron information services (both in person and by telephone) rather than performing repetitive circulation transactions.

6. Improves patron service & staff productivity.

7. Provide efficiency to collection management.

8. Provide wireless inventory management.

9. Eliminate many sources of repetitive stress injuries.

10. It gives better availability of books as the library database is updated in real time.

11. Inventory is 20 time faster than with barcodes.

12. Free librarians to focus on doing what they do best—assisting patrons.

13. RFID has several advantages over barcode, including:

   i. Barcode requires strict, line of sight access, RFID tags can be read through a variety of substances, irrespective of orientation.

ii.   Several RFID tags can be read at one time, further accelerating all scanning activities.

iii.   Barcodes contain a fixed amount of data which RFID tags incorporate, while providing extra rewriteable space for additional data.

iv.   RFID tags are more robust and tamper resistant than barcodes.

5.2 RFID implementation in libraries

The following points should be considered before implementation of a RFID system in a library.

- A privacy policy should be developed, that will encompass implementation of RFID.

- Library users have a right to know that items contain RFID tags and generally where readers are located, technical specifications of those devices. The library must make public its policies and practices involving the use and maintenance of RFID systems, encompassing tags, readers, and the associated database(s).

- Library users must be given notice of the purposes for which tags and readers are used.

- There must be auditable security and integrity in transmission, databases, and system access, including the use of encryption.

- The library must inform its users who they can contact for questions and complaints.

- If a library selects an RFID-based system, it is likely to retain that system for a long time, primarily because of its high cost as well as the time-consuming structural changes that the library must engage in to successfully use the new system.

- A performance criterion should be formulated.

5.3 Implementation road map

1. Prepare building for installation of Self-Return Book Drop.

2. Installation of Self-Return Book Drop.

3. Installation of Security Gates.

4. Installation of RFID antennas at circulation desk(s).

5. Setup of technical services area for implementation of RFID.

6. Acquire smart labels and affix them to books.

7. Program tags at technical services area.

8. Installation of Self-Checkout workstation. Ensure your automation system is SIP or SIP 2 compliant.

9. Train library staff.

5.4 Major vendors of RFID in libraries

There are many different RFID vendors with different areas of expertise. However three major competitors are VTLS, 3M, with their Digital Identification System and Checkpoint's Intelligent Library System. Here is an overview of their respective product offerings.

	VTLS	**3M**	**Checkpoint**
Tag Manufacturer	TAGSYS	Texas Instruments1	Microchip
Software developer	VTLS	3M	Checkpoint
Inventory technology	RFID	RFID	RFID
Security technology	RFID	EM	RFID
Integrated security bit	Yes	N.A.	No
Query ALS to determine security status	No	No	Yes
Table 1. RFID OPERATIONAL OVERVIEW			

	VTLS	3M	Checkpoint
Tag type	Passive	Passive	Passive
Read/ write or WORM	Read/ write	Read/ write	Write once, read many (WORM)
Memory Size	74-bits	256-bits	96-bits
Typical bid price	$1.00	$1.00	$1.00
Table 2. TAG RELATED FETURES			

	VTLS	3M	Checkpoint
Read sped (in books per second)	20	2	20
Time to inventory 250K collection	3.5 hours	35 hours	3.5 hours
Time to find 100 books in 10K collection	8 minutes	83 minutes	N.A.
Accepts downloads for weeding and similar activities	Yes	Yes	No
Table 3. PORTABLE READER FEATURES			

6. Major Concerns

There are some serious concerns from concerned citizens that RFID can be used to "secretly identify you and the things that you are carrying," to quote the CASPIAN website. CASPIAN is consumers against Supermarket Privacy Invasion and Numbering, and they have put

together a website called stop RFID (www.stopRFID.com) that talks about some of the concerns about RFID.

I think the real threat of RFID is how inexpensive and pervasive it can make surveillance in our increasingly online, interconnected world.

Possibility of remotely tracking people and their RFID tags is one of the major concerns of privacy organizations such as the electronic Frontier Foundation (EFF).

7. Conclusion

Patron satisfaction has become crucial for librarians. Today, many libraries are turning to RFID technology for it has proven to bring convenience and efficiency in item management through the automation of workflow processes. It has also proven to significantly improve customer service.

The RFID tags in libraries offer the possibility of great increases in productivity and hold a promise of better service for the patrons. The tags are "powerless", have a very small read range, store a minimum amount of data (normally a barcode) and carry no patron data on the tags. All these factors make privacy concerns almost non-existent at this time. It is therefore important to work with a vendor that understands patron privacy concerns and builds systems that will minimize the risk for the patrons.

RFID in libraries, just part of RFID in a larger scheme. Library community should conduct a comprehensive technology assessment of RFID as soon as possible to enable librarians to make the best possible decisions involving the implementation of this technology. The library community is a leader in protecting intellectual freedom and user privacy. Libraries have an opportunity to be societal leaders and a "model industry" in the way in which they adopt RFID-based circulation and ILS systems. What we need to do is to be responsive and strong about saying we want to use this technology, so make it possible for us to do that.

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