

## RFID in Libraries: An Overview

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A library is a growing organism. As it grows in size the problems associated with the maintenance and security of the documents also grows. The researchers have always helped the librarian in solving their problems. To solve the problems of arranging documents in order they have given classification schemes. To solve the problems of searching documents they have given cataloging guidelines. To solve the problems of space and time they have taught librarians to digitize the documents and share over network. To automate the counter activities they gave us bar-codes. Bar-codes have served the librarians and libraries for a long time, and now it is slowly getting replaced by RFID. This paper given the overview of RFID in Libraries and discussed the methodologies, advantages and disadvantages of RFID in Library

### 1.Introduction

What is RFID:

The concept of RFID (*Radio Frequency Identification*) technology was developed in 1948 but it has had to wait fifty years before it has been able to deliver on its original promise . The advent of tiny integrated circuits ("chips") allowed solution designers to add intelligence to the movement of goods through the supply chain and when a chip and an aerial were attached to a sticky label the RFID "Tag" was born. RFID was then conceived, as the name suggests, as a means of enabling tags to identify themselves to a radio receiver. The tags now come in all shapes and sizes and are attached to a staggering range of items with a wide range of applications from cars (electronic tolls) to earrings (brand protection). RFID is also called *dedicated short range communication (DSRC)*.

#### Some definitions of RFID

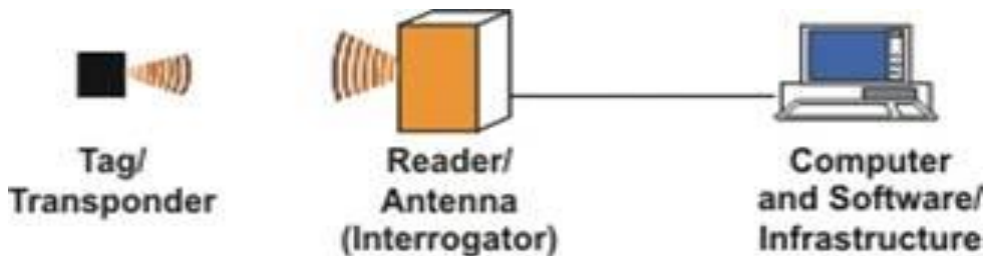
Radio Frequency Identification: A data collection technology that uses electronic tags for storing data. The tag, also known as an "electronic label," "transponder" or "code plate," is made up of an RFID chip attached to an antenna. Transmitting in the kilohertz, megahertz and gigahertz ranges, tags may be battery-powered or derive their power from the RF waves coming from the reader. [1]

RFID (radio frequency identification) is a technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency (RF) portion of the electromagnetic spectrum to uniquely identify an object, animal, or person.[3]

## COMPONENTS of RFID

A basic RFID system consists of three components:

- An antenna or coil
- A transceiver (with decoder)
- A transponder (RF tag) electronically programmed with unique information



The antenna emits radio signals to activate the tag and to read and write data to it.

The reader emits radio waves in ranges of anywhere from one inch to 100 feet or more, depending upon its power output and the radio frequency used. When an RFID tag passes through the electromagnetic zone, it detects the reader's activation signal.

The reader decodes the data encoded in the tag's integrated circuit (silicon chip) and the data is passed to the host computer for processing.

The purpose of an RFID system is to enable data to be transmitted by a portable device, called a tag, which is read by an RFID reader and processed according to the needs of a particular application. The data transmitted by the tag may provide identification or location information, or specifics about the product tagged, such as price, color, date of purchase, etc. RFID technology has been used by thousands of companies for a decade or more. . RFID quickly gained attention because of its ability to track moving objects. As the technology is refined, more pervasive - and invasive - uses for RFID tags are in the works. A typical RFID tag consists of a microchip attached to a radio antenna mounted on a substrate. *The chip can store as much as 2 kilobytes of data.* To retrieve the data stored on an RFID tag, you need a reader. A typical reader is a device that has one or more antennas that emit radio waves and receive signals back from the tag. The reader then passes the information in digital form to a computer system.

## 2. RFID Technology in Libraries

The concept of RFID can be simplified to that of an electronic barcode and can be used to identify, track, sort or detect library holdings at the circulation desk and in the daily stock maintenance. This system, consist of smart RFID labels, hardware and software, provides libraries with more effective way of managing their collections while providing greater customer service to their patrons. The technology works through flexible, paper-thin smart labels, approximately 2"X2" in size, which allows it to be placed inconspicuously on the inside cover of each book in a library's collection. The tag consists of an etched antenna and a tiny chip which stores vital bibliographic data including a unique Accession number to

identify each item. This contrasts with a barcode label, which does not store any information, but merely points to a database. These smart labels are applied directly on library books and can be read with an RFID interrogator/scanner. Line of sight is not essential for reading the tags with the scanner, therefore, the books require much less human handling to be read and processed. A middleware or Savant software integrates the reader hardware with the existing Library Automation Software for seamless functioning of circulation. The information contained on microchips in the tags affixed to library materials is read using radio frequency technology regardless of item orientation or alignment. It provides a contact less data link, without need for line of sight, for example, the documents in the shelves or cardboard boxes can be checked without removing or opening. RFID has no concerns about harsh environments that restrict other auto ID technologies such as bar codes. Tags have a discrete memory capacity that varies from 96 bits to 2kbytes. In addition to tags, an RFID system requires a means for reading or "interrogating" the tags to obtain the stored data and then some means of communicating this tag data to library information system. RFID-based systems have been implemented for efficient document tracking purpose throughout the libraries that combine, easier and faster charging and discharging of documents, security of materials, inventorying, stock verification and shelf handling. RFID tag's transponder listens for a radio query from the reader and respond by transmitting their unique ID code. Most RFID tags have no batteries; they use the power from the initial radio signal to transmit their response.



Libraries have several activities that can benefit from RFID. These include:

- Circulation: checking out books and other items, and checking them back in again
- Inventory management: ensuring items are properly located in the collection
- Book processing: adding items to the library's collection

By making books and other library items "smart," RFID offers the following improvements to library services:

1. Reduction in workplace injuries. Workplace injuries caused by the repetitive motions related to flipping books and angling books under barcode readers cost libraries millions of dollars every year, and lead to pain, limited physical range, and other problems familiar to a feminized workforce.
2. Facilitating self-check. Self-check, or checking out your own books, is much easier with RFID technology because the book does not have to be positioned or angled under a barcode scanner, but can be simply moved within range of an RFID reader. Self-check saves money directly, by reducing labor costs for circulation (check-out) activities, and indirectly, by reducing opportunities for repetitive stress injuries. Furthermore, self-check is inherently more private than requiring another human to handle and inspect the items you wish to check out of the library.
3. Streamlined inventory management. Libraries spend a lot of money ensuring books are where they need to be. Books with barcodes require humans to physically remove and handle every item to ensure it is in the correct location. RFID offers the ability to analyze and correct library inventories without handling the items.
4. Streamlined in-processing. Acquisitions—the library activity associated with purchasing books and adding them to the collection—can be streamlined with RFID. [2]

### **3. How RFID Works**

#### 3.1 RFID systems:

In typical system tags are attached to objects. Each tag has a certain amount of internal memory (EEPROM) in which it stores information about the object, such as its unique ID, or in some cases more details of bibliographic data and product composition. When these tags pass through a Radio Field generated by a reader, the transponder in the tag transmits the stored information back to the reader, thereby identifying the object.

#### 3.2 How Tags Communicate

The communication process between the reader and the tag is by wireless. The major differences between the different types of waves are the distances covered by one cycle of the wave and the number of waves that pass a certain point during a set time period. The wavelength is the distance covered by one cycle of a wave. The frequency is the number of waves passing a given point in one second. For any electromagnetic wave, the wavelength multiplied by the frequency equals the speed of light. The frequency of an RF signal is usually expressed in units called hertz (Hz). One Hz equals one wave per second. Basically what happens is that when the reader is switched on it starts emitting a signal at the selected frequency band (in library HF is used with 13.56 MHz). Any corresponding tag in the vicinity of the reader will detect the signal and use the energy from it, to wake up and supply operating power to its internal circuits. Once the tag has decoded the signal as valid, it replies to the reader and indicates its presence by modulating (affecting) the reader field

3.3 Anti-collision If many tags are present (in a row of books) then they will all reply at the same time, which at the reader end is seen as a signal collision and an indication of multiple tags. The reader manages this problem by using an anti-collision algorithm designed to allow tags to be sorted and individually selected. The number of tags that can be identified depends on the frequency and protocol used, and typically range from 50 tags/s for HF and up to 200 tags/s for UHF. Once a tag is selected the reader is able to perform a number of operations such as read the tags identifier number, or in the case of a read/write tag write information to it. After finishing dialoging with the tag the reader can then either remove it from the list, or put it on the stand by until a later time. This process continues under the control of anti-collision algorithm until all tags have been selected. In fact very real challenges for the ICs' exist such as achieving very low power consumption, managing noisy RF signals and keeping within strict emission regulations. Other important function of the circuit is to allow the chip to transfer power from the reader signal field, and convert it via a rectifier into supply voltage. The chip clock is also normally extracted from the reader signal. Most RFID tags contain a certain amount of NVM (non-volatile memory) like EEPROM in order to store data. The amount of data stored depends on the chip specification, and can range from just simple identifier numbers of around 96 bits to more information about the product with up to 32Kbits. In 1999 the AUTO-ID centre (now EPC Global) based at the MITUSA, together with the number leading companies developed the idea of an unique electronic identifier code called the EPC(Electronic Product Code). The EPC is similar in concept to the UPC used in barcodes today. Having just a simple code of up to 256 bits would lead to smaller chip size, and hence lower tag cost, which is recognized as the key factor for wide spread adoption of RFID. Like a barcode, the EPC is a 96 bit unique number which is divided into numbers that identify the manufacturer, product, version and serial number.

3.4 Tag IC's A single-chip design led to the RFID tag, a small device composed of a chip, an antenna, and an optional power source, that carries a unique identifier. The 1990s witnessed the use of such tags for card-keys, fuel-station payment systems, and automated toll payment. Such tags were typically specialized for a certain class of 274 applications and cost a few dollars each. The tags typically stored application-specific data and were capable of modest processing on-tag [2].

3.5 Tag Classes: one of the main ways of categorizing RFID tags is by the capability to read and write data. This leads to the following four classes and EPC global has also defined five classes which are similar to the one below:

3.5.1 Class 0: Read only – factory programmed. These are simplest type of tags, where the data, which is usually a simple id number is written only once into the tags during manufacture. The memory is then disabled from any further updates. Class 0 is also used to define a category of tags called EAS or anti-theft devices which have no id, and only announce their presence when passing through an antenna field.

3.5.2 Class 1: Write Once Read Many(WORM) - Factory or user programmed. In this case tag is manufactured with no data written in to the memory. Data can then either be written by manufacturer

or by the user – one time. Following this no further writes are allowed and the tag can only be read. Tags of this type usually act as simple identifiers.

3.5.3 Class 2: Read-Write – This most flexible type of tag, where user have access to read and write data into the tags memory. They typically used as data loggers, and therefore contain more memory space than what is needed for just a simple id number.

3.5.4 Class 3: Read-Write (with on board sensors) – These tags contain on board sensors for recording parameters like temperature, pressure and motion, which can be recorded by writing into the tags memory. As sensor readings must be taken in the absence of a reader, the tags are either semi -passive or active.

3.5.5 Class 4: Read-Write (with Integrated Transmitters) – These are like miniature radio devices which can communicate with other tags and devices without the presence of the reader. This means that they are completely active with their own battery power source.

3.6 Active and Passive tags:

First basic choice when considering a tag is either passive or semi -passive or active. Passive tags can be read at a distance of up to 4 – 5 m using UHF frequency band, whilst the other types of tags (semi -passive and active) can achieve much greater distance of up to 100m for semi -passive, and several KM for active. This large difference in communication performance can be explained by the following;

- passive tags use the reader field as a source of energy for the chip and for the communication from and to the reader. The available power from the reader field, not only reduce very rapidly with distance but is also controlled by the strict regulations, resulting in a limited communication distance of 4 -5 M when using UHF frequency band (860 MHz – 930 MHz) .
- Semi-passive (battery assisted back scatter) tags have build in batteries and therefore do not require energy from the reader field to power the chip. This allows them to function with much lower signal power levels, resulting in greater distance of up to 100meters. Distance is limited mainly due to the fact that tag does not have an integrated transmitter, and is still obliged to use the reader field to communicate back to the reader.
- Active tags are battery powered devices that have an active transmitter onboard. Unlike passive tags, active tags generate RF energy and apply to the antenna. This autonomy from the reader means that they can communicate at the distance of over several KMs.

#### **4. Difference between Barcode and RFID**

- Information can be read from RFID tags much faster than from barcodes
- Several items in a stack/counter can be read at the same time using RFID
- Items do not have to be handled one-by-one nor removed from the shelves

- Inventory-taking is no longer a tedious operation
- RFID can stand more than 10,000 read/write
- RFID can have theft bit which can be in two states "ON/OFF"
- Shelf verification/rectification can be done on daily basis
- More information can be written in the RFID tag on incremental basis
- Need not open/remove books to capture information
- Items are identified on upper and lower shelves more comfortably

**5. Advantages of RFID Systems:** The advantage of RFID is that it does not require direct contact or line-of-sight scanning.

- *Rapid charging/discharging:* The use of RFID reduces the amount of time required to perform circulation operations. The most significant time savings are attributable to the facts that information can be read from RFID tags much faster than from barcodes and that several items in a stack can be read at the same time. While initially unreliable, the anti-collision algorithm that allows an entire stack to be charged or discharged now appears to be working well.
- *Simplified patron self-charging/discharging:* For patrons using self-charging, there is a marked improvement because they do not have to carefully place materials within a designated template and they can charge several items at the same time. Patron self-discharging shifts that work from staff to patrons. Staff is relieved further when readers are installed in bookdrops.
- *High reliability:* The readers are highly reliable. Some RFID systems have an interface between the exit sensors and the circulation system to identify the items moving out of the library. Were a patron to run out of the library and not be intercepted, the library would at least know what had been stolen. If the patron card also has an RFID tag, the library will also be able to determine who removed the items without properly charging them. This is done by designating a bit as the "theft" bit and turning it off at time of charge and on at time of discharge.
- *High-speed inventorying:* unique advantage of RFID systems is their ability to scan books on the shelves without tipping them out or removing them. A hand-held inventory reader can be moved rapidly across a shelf of books to read all of the unique identification information. Using wireless technology, it is possible not only to update the inventory, but also to identify items which are out of proper order.
- *Automated materials handling:* Another application of RFID technology is automated materials handling. This includes conveyor and sorting systems that can move library materials and sort them by category into separate bins or onto separate carts. This significantly reduces the amount of staff time required to ready materials for reshelving. Given the high cost of the equipment, this application has not been widely used.

- *Long tag life:* Finally, RFID tags last longer than barcodes because nothing comes into contact with them. Most RFID vendors claim a minimum of 100,000 transactions before a tag may need to be replaced.
- *Fast Track Circulation Operation* The use of RFID reduces the amount of time required to perform circulation operations. The most significant time savings are attributable to the facts that information can be read from RFID tags much faster than from barcodes and that several items in a stack can be read at the same time. While initially unreliable, the anti-collision algorithm that allows an entire stack to be charged or discharged now appears to be working well.

## 6. Disadvantages of RFID Systems:

- *High cost:* The major disadvantage of RFID technology is its cost.
- *Vulnerability to compromise:* It is possible to compromise an RFID system by wrapping the household foil to block the radio signal. It is also possible to compromise an RFID system by placing two items against one another so that one tag overlays another. That may cancel out the signals. This requires knowledge of the technology and careful alignment.
- *Removal of exposed tags:* The RFID Tags can not be concealed in either spine or gutter of the books and are exposed for removal. If a library wishes, it can insert the RFID tags in the spines of all except thin books, however, not all RFID tags are flexible enough. A library can also imprint the RFID tags with its logo and make them appear to be bookplates, or it can put a printed cover label over each tag.
- *Exit gate sensor (Reader) problems:* While the short-range readers used for circulation charge and discharge and inventorying appear to read the tags 100 percent of the time (Boss 2004), the performance of the exit gate sensors is more problematic. They always don't read tags at up to twice the distance of the other readers. There is no library that has done a before and after inventory to determine the loss rate when RFID is used for security.
- *Lack of Standard:* The tags used by library RFID vendors are not compatible even when they conform to the same standards because the current standards only seek electronic compatibility between tags and readers.

## 7. Conclusion

RFID is still a relatively new technology. So far, several hundred libraries in the world have implemented RFID, mostly for self-service and the vast majority of these libraries are positive about their RFID

investment and its benefits. However, it is not been completely straightforward to research, purchase, implement and exploit RFID technology. There are some important concerns which libraries should be aware of. This guide has spelt out all these known issues so that libraries starting to invest in RFID can go into the process with their eyes open, having learned about the main pitfalls from the experiences of others. It is also important to educate library staff and library users about RFID technology before implementing a program.

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