RFID TECHNOLOGY FOR IDENTIFICATION, SECURITY AND DOCUMENT HANDLING IN LIBRARY

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ABSTRACT

Radio Frequency Identification (RFID) is a wireless non-contact system that uses radio-frequency waves to transfer data from a tag attached to an object, for the automatic identification and tracking. It is a technology that uses the radio waves for transferring data from an electronic tag called as RFID tag. Library RFID systems are composed of tags, readers and middleware software. The systems rely heavily on the Integrated Library Management System (ILMS). Tags are placed inside library documents. The readers are placed at staff workstations and self-check machines and built into security gates. The readers read the information on the tag and pass the information to the ILMS. RFID is a powerful technology that can change how libraries deal with physical as well as digital technologies to offer new services.

Keywords: *RFID, Library, RFID Frequency, RFID Tags*

RFID - INTRODUCTION

A Radio Frequency Identification tag, or RFID tag, is a small tag placed on objects like shipping pallets or product packages. RFID tag contains a unique serial number, as opposed to a generic product identifier. In other words, it doesn't just identify that a pallet contains some Model123 computers. It identifies the pallet as being a specific, unique set of Model123 computers.

When an RFID reader sends out a signal, the RFID tag responds by sending information back. It's possible to have many tags respond to one query if they are all with range of the reader. This makes accounting of lots of items easy. Even when items are stacked on top of one another or behind a wall, as long as signals can penetrate, it will be possible to get a response. RFID tags remove the need to manually or inventory each item and allow a census to be taken much more rapidly.

Most RFID tags used outside of very high value applications are known as passive. This means that the tags do not have an embedded battery. The radio waves from a reader create a magnetic field that is used to provide just enough power to allow a tag to send out the information embedded within it.

While RFID technology has been around for a long time, costs were unaffordable for most applications. Today a passive tag costs just a few rupees and prices continue to drop.

HISTORY OF RFID

RFID technology came into fame when the first *Auto-ID lab* at *MIT* (Massachusetts Institute of Technology) was started. The Auto-ID lab, was started by a consortium of businesses (including large retailers, packaged consumers good manufacturers and others), the US DoD (Department of Defense) and academics, who wanted to solve a very global and big problem – how to track shipment in the global supply chain. At that time, problems of pilferage, counterfeiting and lost shipments were in the range of billions of dollars (as they are even today). The Auto-ID centre was to find a solution, using automatic identification technology, to minimize these losses.

Later on, the Auto-ID centre at MIT expanded to include a global chain of six labs at universities, including Cambridge (UK) and the University of Adelaide (Australia) among others. The technology, which MIT had developed upon that point, was licensed to an organization known as **EPCglobal**, who is then carrying it forward to develop standards, protocols and allot *Electronic Product Codes (EPCs).* The ultimate vision is to network all physical objects (including consumer items, containers etc.) into a globally pervasive "*Internet of Things*"[2].

BASIC PRINCIPLES OF RFID

 The three key or the main components of an RFID system are tag, middleware and reader**.**

- **RFID tags:** also known as transponders or labels which are attached to the objects. Tags could be of active, passive or semi-passive. There are tags with memory that are available to store information in the form of bits.

- **Reader:** also known as transceiver (transmitter/receiver) made up of a Radio Frequency Interface (RFI) module and control unit. The readers are classified based on the frequency (LF,HF,UHF, etc.,) and also in terms of portability (Fixed & Handheld).Their main function is to activate the tags, structure the communication sequence with the tag and transfer data between the application software and tags Middleware.

- **RFID middleware:** It is a computer program that controls one or more RFID Interrogators and allows the data captured by those devices to be routed to another system. RFID middleware solutions provide messaging, routing, and connectivity features required to integrate RFID data into existing library management system[4]. The library management system connects data coming in from tags on library items such as Middleware provides a coherent and stable interface between RFID hardware operations and flow of data elements such as membership number, catalogue number, etc. into the library database[3].

RFID TAGS

RFID tags are the objects containing the Radio Frequency circuits which are affixed to the items which need to be identified. We can think them as "*Smart labels*" or "*Smart bar codes*". Each RFID tag consists of a data storage device (like an electronic chip) and an antenna to communicate.

To read RFID tags, one need RFID reader, just like one need to have a bar code reader to read bar codes. RFID tags and RFID readers communicate with each other using radio waves. The RFID tag may also have other components, based on its type. RFID tags

can store enormous amounts of data, compared to bar codes.

RFID WORKING SYSTEM

A basic RFID system, at its minimum, requires and RFID tag and an RFID reader. If the tag is passive, then the radio waves coming from the RFID reader to the tag also supply it with power. The reader is said to 'interrogate' the tag. The tag replies and gives out the data stored in it. This data also travels through the air in the form of radio waves and is 'read' by the RFID reader. The RFID reader is then connected to a standalone PC or a network, which collects the data from the reader and transmits it to a higher level system. Many such tags communicate with one or more readers and many such readers are connected to a central computing system (e.g. EPR system or a Warehouse Management System or a similar database).

In libraries, *passive tags* are used, these tags remain inactive. The readers will be always propagating radio waves. When a tag comes in the range (radio wave area) the tags harvests power get activated.

TYPES OF RFID TAGS

There are several types of RFID tags and they can be classified in many ways. One of the ways is by classifying them on the basis of their *power source*.

- **Active tags** – RFID tags that have their own onboard power supply, like a battery.

- **Passive tags** – Those RFID tags that do not have their own power supply. These tags derive their power from the RFID reader, when it communicates with them.

- **Semi-passive tags** – These RFID tags have a smaller onboard battery, which is enough to retain only its onboard data. It cannot use this data for communication.

Another way to classify RFID tag is by specifying whether the RFID tag is Read-Only tag or a Read/Write tag.

- **Read-Only RFID tags** – Those tags that have the data fields written to it when it is manufactured and cannot be changed afterwards. These tags are also called *Write once read many*.

- **Read/Write RFID tags** – Those tags that have the data fields written to it many times over, by the users. Users can use RFID readers to write the data apart from reading. So, in this case the RFID reader is called *RFID reader cum writer*. These tags are also called *Write many and read many.*

Tags are divided on the size of the tag - Tag memory with 1K, Tag with memory 2K. In libraries passive tags with 1 K or 2 K memory and frequency 13.56 MHz. are used.

RFID FREQUENCIES

RFID tags can be conceptually similar to small radio transmitters, which beam out information about themselves to RFID readers. Just like our domestic radios, RFID tags and readers operate at different frequencies in different bands, depending on the application. The RFID tags used in smart cards for toll passes operate at different frequency, than for tags that are used to track shipping containers in a truck yard. The typical frequency bands for RFID tags are divided into –

- **Low Frequency (LF)** around 125 KHz.
- **High Frequency (HF)** around 13.56 MHz
- **Ultra High Frequency (UHF)** around 902-928 MHz
- **Microwave** around 2.45 GHz

So, different types of RFID tags used different frequency bands, for different types of applications. Thus, RFID tags used in smart labels on books in a library are used in a different frequency band than the RFID tag used to track containers in shipping yards.

In fact, though both use radio communication, their method of communication with their readers are also different. *For example*: some types of tags use a method known as "***load modulation***", while others use "***backscatter***" and so on.

RFID Tags	Low Frequency (LF)	High Frequency (HF)	Ultra High Frequency (UHF)
Frequency	125kHz	13.56 MHz	100 MHz to 1 GHz
Operating Distance	30 cm to 1 m	10 cm to 1 m	Passive: up to 25 m Active: up to 100 m
Characteristics	Short read range. Read range is easier to control. Handle metal and water better than UHF. Can be affected by industrial noise. Slower data transfer rate. Cannot always communicate with multiple tags.	Short read range (especially NFC tags). Read range easier to control than UHF. Not as effective as LF in presence of metal and water, but better than UHF. Unaffected by industrial noise. Can communicate with multiple tags simultaneously	Long read range. Fast reading of multiple tags. Less tag memory than HF. Poor performance around liquids and metals. Operate in a crowded frequency.
Applications		Library materials management and security, access control, banking cards, contactless payment systems, goods control, security.	Asset tracking, supply chain, logistics, toll booths, real-time locating systems, container security, library material management and security (limited)

Fig. 1- Types of RFID tags (Source: Library Technology Report, Vol. 48, No.5, July 2012)

BENEFITS OF LIBRARY RFID SYSTEM

The benefits of adopting RFID technology in library are –

- Reduction of staff manual processes, error and repetitive motion.
- Enhanced customer experience through fact and private self check-outs.
- Reduction of staff and patron time spent on finding items.
- Integrated security functionality.

RFID STANDARDS

Standards are established and agreed protocols that enable people, as well as devices to work and communicate. *For example*: English language.

Similarly, there are established standards for RFID tags and the communication protocols used. These standards specify the frequency of communication, form of the data that is being transferred and many other aspects, which make it easier for tags and readers, often made by different vendors to communicate clearly and work harmoniously together. Many of these standards have been set by International organizations like ISO and are widely accepted. *For instance* ISO: 15693 & ISO: 18000 Part 2 Mode 3 etc.

Standards act as a warranty on library's investment in RFID. Without standards, RFID is more risky investment for libraries. Standards eliminate vendor lock-in and allow for interoperability across different vendors' solutions. With vendors' interoperability, libraries can buy their RFID components from any

vendor with the expectation that everything will work together.

Standards lead to library and ILMS interoperability as well. With library interoperability, libraries can read each other's RFID tags, making resource sharing and inter library loan (ILL) transactions more secure and simple. Integrated Library Management Solution (ILMS) interoperability will allow libraries to switch from one ILMS to another without having to worry that their RFID components will stop working[4].

RFID TAGS AS AN ANTI-THEFT SOLUTION

In Libraries, one bit chip in-built in the RFID tag, gets de-activated at the time of issuing and activated at the time of returning. If a book issued properly is moving through the walk through antenna (as the one bit chip is inactive) will not produce any beep sound. But when a book not properly issued and is moving through the walkthrough antenna, it will produce a beep sound thus alerts the counter Assistant. Similarly, it can be used in departmental stores.

CONCLUSION

RFID tags have been used in libraries since 1999, when the National Library of Singapore installed the first system. RFID tags, like barcodes, are used to uniquely identify library documents. It can be used for weeding, stock verification, ILL, materials handling, and possible even for providing enhanced content to patrons using RFID enabled Smartphone. But in order to develop these new library applications, Librarians need to be able to interface in more ways with the ILMS. It is also time to think creatively about what else libraries can do with RFID tags. This will require new protocols for communicating with the ILMS and development of new functions.

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