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RFID TECHNOLOGY IN LIBRARY SYSTEM: A NEW APPROACH TO CIRCULATION, TRACKING, AND SECURITY OF LIBRARY MATERIALS

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ABSTRACT

This paper introduces topic that are essential for exploring the library material of security, implementation methodologies, advantages and disadvantages of RFID systems. Library management plays a key role in patron satisfaction. RFID technology can effectively improve the self-service and the collection management, which correspondingly leads to improving the patrons' satisfaction with using the library. Library consist intellectual capital it might be scholarly journals, books, reports, theses etc. For security purpose, the goal of the security system should be to provide a safe and secure facility for library employees, library resources and equipment and library patrons. At the same time due to application of security system, that promise to increase efficiency, productivity and enhance user satisfaction.

KEYWORDS: RFID in Indian Academic Libraries, Implementation of RFID in Library, Components of RFID, RFID Technology and Operating Principle, Benefits of RFID at Library

INTRODUCTION

Radio Frequency Identification, abbreviated "RFID" basically provides a means to identify objects having RFID tag attached. Fundamentally, RFID tags provide the same functionality as barcodes but usually have a globally unique identifier. Using RFID, the identification is performed electromagnetically. RFID is a communication technology to exchange data between RFID readers and reader an electronic RFID tag using radio waves. This technology is in use since the 1970s. patented in 1973, first used in harsh industrial environment in 1980s', and standards presented in 2001, is the latest addition of technology to be used in the libraries for a combination of automation and security activities in the well maintenance of documents either inside the library or goes out-of library.

RFID systems have more components than the already mentioned RFID tags, just like barcode system consist of more than just the printed barcodes. A distinction of the following three components is common

- **RFID Tag or Transponder**: Where is located on the object to be identified and is the data currier in the RFID system.
- **RFID Readers or Transceiver**: Which may be able to both read data from and write data to a transponder.
- **Data Processing Sub system**: Which utilizes the data obtained from transceiver in same useful manner.

RFID FOR LIBRARIES

RFID is a combination of radio-frequency-based technology and microchip technology. The information contained on microchips in the tags affixed to library materials is read using radio frequency technology regardless of item

orientation or alignment (i.e., the technology does not require line-of-sight or a fixed plane to read tags as do traditional theft detection systems) and distance from the item is not a critical factor except in the case of extra-wide exit gates. The corridors at the building exit(s) can be as wide as four feet because the tags can be read at a distance of up to two feet by each of two parallel exit sensors.

RFID IN INDIAN LIBRARIES

Library automation in India is started before 12-15 years. When considering current state of our 380 Universities, Indian libraries are geared up for Automation today with support from Government, NKC &organizations like INFLIBNET, DELNET etc. we had more than 20%-30% of Indian Libraries are using ILS (Integrated Library Systems) efficiently today and hardly 50% of this is using library automation technology. Now automation is must for library activities. RFID is really useful for university library to share the information among them (IIL) through integrated library system. Many large university libraries have gone for RFID as this will allow efficient circulation of library items to large number of patrons visiting these libraries. Libraries should be promoted as an environment for serious learning (Information centers, facilities, ambience etc.) A mechanism to rank the libraries on basis of collection, services, use of technology Library Automation will also help in building a National Union Catalog similar to Library of Congress.

COMPONEMENTS OF RFID SYSTEM

A basic RFID system consists of three modules: Tags, Readers and Antennas. An RFID Tag is made up of a coupling element and a chip; each tag has a unique electronic code, attached to the object used to identify the target. RFID readers are devices that are used to retrieve and write the information on RFID tags. There are handheld readers and fixed readers. Handheld readers designed that act like handheld bar code scanners and fixed readers are mounted to read tags automatically as items pass nearby them. The antenna emits radio signals to activate the tag and to read and write data to it.

Tags as Transponders

As mentioned RFID tags are small IC with coupling elements. They have enough capability to store large amounts of data. They are divided into major group: passive tags which have no power supply: and active tag which have their own power supply.

Passive RFID Tags

Passive RFID tags have an embedded IC and antenna, but have no internal power supply. The incoming RF signals provide enough power to booth up the IC in the tag and transmit a response. Due to the lack of an embedded power supply or battery, passive RFID tags are quite small. In terms of size, they can vary between the sizes of a postage stamp to that of a post card. The Passive RFID tags are useful only for a limited set of application because they have no internal power source and can be read only at short distance. The passive tag remains readable for a very long time; even after the commercial product containing passive RFID tag has been sold. These tags are very cheap to manufacture.

Active RFID Tags

Active RFID tags also have an IC and An anteena. However, unlike passive RFID tag, active tags have their own embedded power source. This is used to power the IC within the tag to generate an outgoing signal. Active RFID tags have the ability to conduct a session with an RFID reader. They can transmit at higher power levels and are more reliable than passive tags. These tags can be also effective in RF challenged environments such as in water, in shipping containers and

in vehicles over long distances.

Table 1: Comparison of Active and Passive Tags

Parameters	Active Tags	Passive Tags
Power source	Embedded power source	Power from RF field
Battery	Yes	No
Signal Strength to tag	Very low	Very high
Operating Range	Low range	Up to a few meters
Data storage capacity	High	Low
Manufacturing cost	Expensive	Cheap

Readers

An RFID reader is a device that is used to interrogate an RFID tag. As mentioned earlier, it contains a transceiver, a control unit, and an antenna. The antenna emits radio waves and the reader captures the data transmitted by the tag, and delivers it to the infrastructure for the further processing, for example, retrieving content connected to the identification number on the tag. Readers are either capable of reading single frequencies whereas multi-protocol readers can read the spectrum of most available bands.

The power supply of the reader is also used for powering passive tags via the electromagnetic field created by the reader.

There are two different categories of readers:

- **Stationary Readers**

- **Mobile Readers**

Stationary readers have a fixed location and a permanent network connection can be presumed. In contrast, mobile readers can be moved around and application scenarios may exist in which no network collection is available. For instance, stationary readers could be located at goods receiving, whereas mobile one s could be used for querying prices of goods in a supermarket or for machine maintenance. Of course, different models of readers exeunt: For examples, "gates" can be used at doors and or "tunnel readers "at belt conveyors.

One of the most important characteristics of RFID systems in contrast to barcode systems is that the communication with the reader does not need a line-of-sight. There is also no wiring required . Instead, the communication between RFID tags and RFID readers is performed by electromagnetic means. This has advantages but also has inherent problems.

RFID Readers Used in Library Following Ways:

- Conversion station: where library data is written to the tag

- Staff workstation at circulation: used to charge and discharge library materials

- Self check-out station: used to check out library materials without staff assistance

- Self check-in station: used to check in library materials without staff assistance

- Exit sensors: to verify that all material leaving the library has been checked out

- Book-drop reader: used to automatically discharge library materials and reactivate security

- Sorter and conveyor: automated system for returning material to proper area of library

- Hand-held reader: used for inventorying and verifying that material is shelved correctly.

Antenna

The antenna emits radio signals to activate the tag and read and write data to it. Antennas are the conduits between the tag and the transceiver, which controls the system's data acquisition and communication. Antenna produced the electromagnetic field that can be constantly present when multiple tags are expected continually. If constant interrogation is not required, the field can be activated by a sensor device.

Server

The server is the heart of some comprehensive RFID systems. It is the communications gateway among the various components. It receives the information from one or more of the readers and exchanges information with the circulation database.

OPERATING PRINCIPLES OF RFID TECHNOLOGY

The most important operating principles of RFID technology are inductive coupling and backscatter coupling:

Inductive Coupling

In accordance with an inductively coupled transponder comprises of an electronic data carrying device, usually a single microchip and a large area coil that function as an antenna. Inductively coupled transponders or tag are generally passive tags which have no internal power sources .Thus they can be only used in near field cases. This means that all the energy for the embedded microchip within the tag has to be provided by the RFID reader in order for the microchip to operate.

The RFID reader's antenna generates a high frequency electromagnetic field. This field penetrates the cross section of the antenna coil area and the area around the coil. The wavelength of the frequency range is several times greater than distance between the RFID reader's antenna and the passive RFID tag. This electromagnetic field can be also identified as a simple magnetic alternating field.

Backscatter Coupling

The electromagnetic field of RADAR technology, the electromagnetic waves hit objects, and the object reflects them. These objects have a large reflection cross section feature which is a measure of efficiency in an object reflecting waves.

In a typical RFID system, an electromagnetic field propagates outwards from the RFID reader's antenna. a small proportion of that fields is reduced for free space reasons. The rest of the field reaches the transponders or RFID tag antenna. The antenna supplies the high frequency voltage. After rectification by diodes, this power can be used to turn on the voltage for the deactivation   or activation of the power saving mode.

In the case of backscatter coupling, some of the incoming RF energy is reflected by the transponder antenna. The reflection cross section of the transponders antenna can be influenced by altering the load connected to be antenna. In order

to transmit data from the RFID tag to the RFID reader, a load resistor connected in parallel with the tag`s antenna is switched on and off in time with the transmitted data. Thus the strength of the signal reflected from the transponder can be modulated. This is called backscatter modulation.

The signal from the transponder is radiated into free space. Some of this signal is received by the RFID readers antenna. So, the reflected signal goes in a backwards direction to the RFID reader's antenna. It can be decoupled with the help of a directional couple.

RFID SECURITY GATES AND PRIVACY GOALS

Security gates are used to detect RFID tags to ensure that all items leaving the library are checked out. Each library item is embedded in a RFID tag and the AFI (Application Family Identifier) status in the tag is activated until the item is checked out. The RFID tag triggers the alarm system if the AFI status is not deactivated. However, RFID readers may not be able to detect items if there are metals surrounded or tags embedded in items are been squeezing when passing by the security gate.

Maintaining Data Security

The goal of maintaining data security is almost reached .The only data that is left in the tags is the unique tag identifier and additional data that is used for protocol operation. e.g. state information or keys. The mentioned keys should not be shared among several tags. The reason is that shared keys provide a higher incentive for an attacker for performing attacks than keys that are only relevant to single tags. IF the incentive was high enough, even sophisticated physical attacks would be worth the effort.

Coping with Denial of Service

In this principle no solution to the denial-of-service problem. For example, Shielding using devices acting like a faraday case disrupts services. Instead, one needs the ability to detect denial-of-service and discover from it appropriately. Coping with the possibilities of denial-of-service needs to be per formed. For our considerations here it is important that no additional means for denial-of-service attacks get introduced .e.g. bringing tags and backend out-of-sync in case state full protocol are used .

Prevention of Counterfeiting

Another goal that has been stated is the prevention of counterfeiting. This means that one needs to be able to effectively prevent tag cloning and the use of mimicking devices.

COMMON RFID APPLICATION THROUGH THE WORLD

RFID Application Has Been Implemented Through the World Including

Casino Chip Tracking

Some casinos are placing RDID tags on their high value chips to track and detect counterfeit chip, to follow the betting habits of individual players, to speed up chip tallies and to determine counting mistakes of dealers.

Animal Identification

Using RDID tags for animals is one of the oldest RFID applications. RFID provides animal identification management for large ranches and rough terrain. An implantable verity of RFID tag is also used for animal identification.

Inventory System

RFID technology enables fast and easy management of an inventory for companies. It also enable to track reduction in out of stock , increase in product selling as well as reduction in labor cost, simplification of business processes and reduction in inventory inaccuracies.

Hospital Operating Room

Using as RFID reader and RFID tagged disposable gauze and towels is designed to improve patient safety and operational efficiency in hospitals.

Ski Resorts

Many ski resorts have adopted RFID tags to Provide Skiers hands free access to ski lifts. It enables collecting information such as vertical feet skied and number of runs taken, which can also made available to the user online.

Human Implants

Implantable RFID chips designed for animal tagging are also being used in humans.

ADVANTAGES OF RFID SYSTEM

- Rapid charging-discharging

- Simplified patron self-charging-discharging:

- High reliability

- High-speed inventorying

- Automated materials handling

- Long tag life

- Fast Track Circulation Operation

- Improved tracking of high-value items.

- Reduce shrinkage errors.

- Improved production planning and smart recalls.

- Technology standards to drive down cost.

- Automated Issue/Return

- Stock Verification and control

- Automated Sorting Of Books on Return

- Tested and Proven solution available now

- No lines or greatly reduced lines at the checkout counter.

- Less repetitive work for personnel and increase the security functions in library.

- Reduce materials cost and handling.

- A regular inventory control and update of the databases is possible.

- Automation of sorting and conveying functions and easy search for misplaced books.

DISADVANTAGES OF RFID SYSTEM

- Costly technology

- Reader collision

- Tag collision

- Lack of standard

- Acquire special skills to set up and maintain the RFID system.

- Require special Training

- User has to accept the media.

- Antenna signal problem in accessing multimedia resources.

- Initial HW/SW cost

- Library staffs are wary of the new recent technology.

RFID DOCUMENT MANAGEMENT

Books and other materials are identified with smart labels that carry a unique, tamperproof ID code. Librarians at the circulations desk and patrons read the tags with RFID reader's ti check items in and out. The process is faster and more accurate than with traditional optical barcode labels. Some economic facts that help justify installing this system are as follows:

- A lost book typically costs a library around $45.

- An average library can have as many as 22 million items circulating each year.

- With RFID smart labels on items, check in and checkout saves at least 1.5 minutes per transaction.

Besides the unique identification number, these labels can be programmed with additional information, such as type of media and storage location. In the retail RFID space, the EpC global suite of RFID specification mandates that tags support an irrevocable kill command. In the library setting, however, tags must be reused to check in loaned items.

RFID DATA MANAGEMENT

Arbitrary data can be associated to each object tagged with an RFID tag. This could for instance be the date of manufacturing minimum durability, batch number, etc there are two possibilities where this data can be stored:

- Directly on the tag

- Off the tag (in a database in the backend)

If the data is stored in a database, a tag only a unique identifier that can be used as key within the database so that data can be linked to the tag. Such a database does not need to be a central one but can be partitioned amongst multiple organizations.

Advantage of Storing Data off Tag in a Database:

- Cost savings: storage space on tags is much more expensive;

- Data can be easily chanced without the tag being in range of a reader;

- Data can be queried without the presence of the tags storing it;

- Decoupling of subsystems results in simpler migration paths towards future applications

- Interoperability can be guaranteed more easily since the backend has the capabilities to deliver data in the needed format independently from physical storage;

- More flexible and extensible access control is possible as there is no lack of resources;

- Easily upgradeable (augmenting additional data, new security primitives etc);

- Data security can be ensured more easily (better access control, no data needs to be transmitted over the insecure air interface between tags and readers)

Advantage of Storing Data on the Tag

- Mobile applications are implementable easily;

- Simpler system architecture for simple applications;

- Ability to store data immutably and in a distributed manner.

BENEFIT OF RFID LIBRARIES

The use of RFID reduces the amount of time required to perform circulation operations. The most significant time saving attributable to the fact that information can be read from RFID tags much faster than from barcodes and that several items in the stack can be read at the same time.

- Improve tracking of high –value items.

- Reduce shrinkage errors.

- Inventory visibility, accuracy and efficiency.

- Technology standards to drive down cost.

- Automated issue/return

- Theft Prevention

- Stock verification and control Automated sorting of books on return

- Reduce materials cost and handling.

A regular inventory control and updates of the databases is possible.

Less repetitive work for personnel and increase the security functions in library.

RFID TECHNOLOGY ISSUES

- Technology issues include the following:

- Technology standards and interoperability

- Reliability and maturity of technology;

- Data integration and evolving middleware;

- Environmental issues;

- Spectrum congestion and frequency availability ;

- Security of data on tags and readers;

- Accuracy of tag reading;

- Volume of data produced.

CHALLENGES OF RFID IMPLEMENTATION

It has to be emphasized that the implementation of the technology itself has not been a difficult exercise; however, to gain the full benefits of implementing RFID within an enterprise, a more holistic view needs to be taken. A large volume of data is created when implementing RFID, data that has to be turned into information and intelligence. At the present time, enterprise resource planning technology suppliers are developing extensions to their products to work with RFID system. The following list represents the potential challenges to be considered when implementing an RFID solution.

- No proven return on investment;

- Cost of initial implementation

- Data sharing between supply chain partners

- Intellectual property issues;

- Environmental (disposal) issues;

- Consumer privacy objections;

- Lack of organizational expertise;

- Lack of historic data.

FUTURE OF RFID LIBRARIES

Once the idea of RFID libraries takes a concrete shape, it surely will convert most big and prestigious libraries into RFID libraries. A great shift can now be expected in the library set up in the near future. A large number of RFID schools have already strengthened their perspective in this direction and are likely to obtain a precise solution to their library related problems. According to some reports, approximately 130 libraries in North America are using RFID systems, and hundreds more are moving in the RFID direction

ROLE OF LIBRARIAN

The RFID technology introduces an ethical dilemma for librarians. The technology allows for greatly improved services for patrons especially in the area of self-checkout, it allows for more efficient use of professional staff, and may reduce repetitive stress injuries for library workers. And yet, the technology introduces the threat of hot –listing and tracking library patrons. Librarians have taken extra steps to ensure that laws

CONCLUSIONS

In concluding remarks we can say that RFID technology promises to change our word. It has the capability of making our personal lives and our work lives in the library more convenient. However every new technology comes at a cost. In order to remediate those costs, efforts must be undertaken to guide its development and implementation. RFID system is not new in Indian libraries. RFID is increasing in popularity among libraries. But libraries should not yet implemented RFID system. RFID system in the library speeds up book borrowing and inventories and free staff to do more user-service tasks.

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