

## **RFID Technology: Security System in Modern Libraries**

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### **Abstract**

RFID (Radio Frequency Identification) is now applied in the latest technology to be detection of library theft systems. Unlike EM (Electro-Mechanical) and RF (Radio Frequency) systems that have been incorporated in libraries for decades, RFID-based systems move beyond security to become tracking systems, which combine security system with more efficient tracking of materials throughout the library, including easier and faster charge and discharge, inventorying, and materials handling.

RFID is a combination of radio-frequency-based technology and microchip technology to be utilized. 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 has not been a critical factor except in the case of extra-wide exit gates. The corridors at the library 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.

**Keywords:** RFID Technology, Micro Technology, Security System, Library System.

### **Introduction**

RFID has long been used as an electronic key to control who has access to library buildings or areas within office buildings. The first access control systems used low-frequency RFID tags. Recently, vendors have introduced 13.56 MHz systems that offer longer read range. The advantage of RFID is it is convenient (an employee can hold up a badge to unlock a door, rather than looking for a key or swiping a magnetic

stripe card) and because there is no contact between the card and reader, there is less wear and tear, and therefore less maintenance.[5]

Radio Frequency Identification (RFID) is a subset group of technologies, often referred to as an automatic identification, that are used to help machines and to identify objects that include bar codes and smart cards. RFID refers to the subset of automatic identification that uses radio waves to automatically identify bulk or individual items.[7]

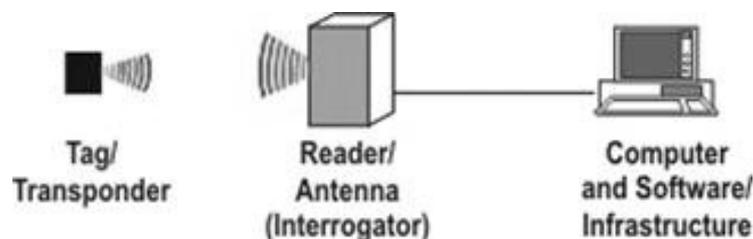
RFID has been around for a long time; one of its original uses being the identification of aircraft during the Second World War. Until recently it was viewed as being too expensive and too limited in functionality for many commercial applications. Advances in technology have both reduced the cost of individual system components and provided increased capabilities, to the point where numerous organizations are either using or considering using RFID technology. While RFID technology offers numerous benefits for manufacturers, for instance, certain characteristics of the technology also raise a number of privacy concerns.[7]

### What is RFID?

An RFID system consists of three components: a tag (or multiple tags), a reader or interrogator and the necessary supporting infrastructure (both hardware and software). An RFID reader, or interrogator, is a device to communicate with the RFID tag. It also broadcasts a radio signal, which is received by the tag. The tag then transmits its information back to the reader. Readers can either be portable handheld terminals or fixed devices that can be positioned in strategic places such as loading bays in shipping and receiving facilities, or the doors in transport trucks. RFID tags, also known as transponders, are usually small pieces of material, typically comprising three components as noted below:[7], [14]

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 [5]



Tags can be either read-only or read-write tags. These terms refer to whether or not the information stored on the tag might be changed or erased. A Read-only Tag is a form of RFID tag that has an identification code (more specifically, an Electronic Product Code) recorded at the time of manufacture or when the tag is allocated to an object. Once programmed, the data on the tag cannot be modified or appended but it

may be read multiple times. A Read-Write Tag is a tag that can have its memory changed, or written to, many times. Because their ID codes can be changed, they offer greater functionality albeit at higher price.

While most commonly seen as a replacement for the Universal Product Code (UPC), or bar code, RFID tags differ from bar codes in several ways. More than one tag can be read at a time. Tags do not require a direct line of sight for reading and may be read through hard material such as book covers or other packaging material. Each tag can uniquely identify the object to which it is attached, even if that object is one of a multitude of identical items. It is these latter characteristics that are the cause of many of the privacy concerns associated with the use of RFID technology. [14]

### **RFID Management System:**

In addition to the tags and readers, an RFID system also includes other software and hardware. The most important component is the RFID-specific software that translates the raw data from the tag into information about the goods and orders that are represented by the tags. This information can then be fed into other databases and applications (e.g., inventory management) for further processing. In the case of read-write tags, software is also required to control whether data can be written to the tag, which tag should contain the data and to initiate the process of adding data to, or changing data in the tag.[13]

Equipment & parts needed:

1. Portable RFID reader
2. Portable Computer - Notebook PC or PDA
3. Inventory & Searching software

### **LibBest Library RFID Management System**



### **Major Components of RFID**

A comprehensive RFID system has three components: (1) **RFID tags** that are electronically programmed with unique information; (2) **readers or sensors** to interrogate the tags; and (3) **a server** or docking station on which the software that interfaces with the automated library system is loaded. It is also possible to distribute the software among the readers and sensors.

## Tags

Each paper-thin tag contains an etched antenna and a microchip with a capacity of at least 64 bits. There are three types: "read only", "WORM," and "read/write." Tags are "read only" if the identification is encoded at the time of manufacture and not re-writable. This type of tag contains nothing more than item identification. It can be used for items acquired after the initial implementation of RFID and by libraries that have collections without barcodes. Such tags need not contain any more than 96 bits.[9]

### WORM (Write-Once-Read-Many)

Tags are programmed by the using organization, but without the ability of rewriting them later. They can be used when a retrospective conversion of a collection that is already bar-coded is undertaken. The main advantage over read only tags is that information in addition to the identification number can be added. However, it must be information that won't need to be changed. That could be an author and/or truncated title if the tag has enough capacity, but not library location or circulation status. **Read/write tags:** which most libraries choose, can have information changed or added. For example, a library might add an identification code for each branch. That information could be changed were the holding location subsequently changed. When a vendor includes a "theft" bit that can be turned on and off, the RFID tag can function much like an EM or RF tag. In library RFID, it is common to have part of the read/write tag secured against rewriting, e.g., the identification number of the item.

All of the tags used in RFID technology for libraries are "passive." The power to read the tags comes from the reader or exit sensor, rather than from a battery within the tag. "Active" tags, which have their own power supply, are substantially larger and more expensive than the tags used in library RFID applications. It is these tags that can be read at distances of up to ten feet.

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. The pattern of encoding information and the software that processes the information differs from vendor to vendor, therefore, a change from one vendor's system to the other would require retagging all items or modifying the software.

A few libraries have placed RFID tags on staff and patron identification cards. Not only does that identify patrons for charging and discharging of library materials, but also for access to restricted areas or services.

A "smart" card, which is an RFID card with additional encryption, is an alternative to merely adding an RFID tag to a patron card. That would make it possible to make it into a "debit" card, with value added upon pre-payment to the library and value subtracted when a patron used a photocopier, printer, or other fee-based device, or wished to pay fines or fees.

Tagging materials--A library planning on doing its own tagging should consider using volunteers in addition to its regular staff. Only limited training is required, typically 15 to 20 minutes. While there is little choice with regard to the placement of tags on CD/DVDs and videotapes, there are many options for tagging books. It is

important to select a consistent location for book tags. The inside of the back cover is the recommended location because it is the fastest for right-handed tag installers to reach. One vendor recommends near the spine approximately three inches above the bottom. That avoids possible interference from metal shelves when inventorying.

There is an argument about uniform placement of the tags. 3M suggests that three locations should be selected to reduce the possibility that the tags of two or more books will alight exactly on top of one another and cancel one another out. Other vendors and several librarians who are using RFID say that they have not encountered problems.

Most libraries are not able to tag their entire collections at one time. They must, therefore, plan a phased implementation. A common approach is to convert materials not already tagged when they are being discharged from circulation. While it might seem desirable to do the conversion at the time of charging, that may create a bottleneck during busy periods. Regardless of whether it is done after discharge or as part of the charging process, it will only be a few months before the large majority of circulating items will have RFID tags. If this approach is used, the equipment at the circulation points will have to read both barcodes and RFID tags.

Pre-programmed tags, which are used for new acquisitions in libraries that want only identification numbers on the tags, take even less time because they do not involve scanning existing barcodes.

Dividing responsibility for removing and replacing library materials, converting the barcodes, and inserting the tags among at least three people can increase the speed of conversion. It is essential that the tasks be rotated so that no one repeats the same motions over an extended period of time.

Almost all libraries tag new acquisitions as part of the cataloging process, however, libraries that have experienced losses of unprocessed library materials from technical services, might consider doing the tagging at the time of receipt in acquisitions. While inadvertent duplicates cannot then be returned, it should significantly reduce losses and facilitate tracking of items in technical services.[2]

## **Readers**

A typical system includes several different kinds of readers, also known as sensors when installed at library exits. These are radio frequency devices designed to detect and read tags to obtain the information stored thereon. The reader powers an antenna to generate an RF field. When a tag passes through the field, the information stored on the chip in the tag is decoded by the reader and sent to the server that, in turn, communicates with the automated library system when the RFID system is interfaced with it. While there is software in each reader to facilitate communication with the server and/or with library staff, most of the software supplied by the RFID system vendor is on the server when one is included in the system. When there is no server, most of the software is on the readers, although some may be on a docking station.

The types of readers include staff workstations for circulation desk charging and discharging, patron self-charging stations, and longer-range walk-through exit sensors to detect and read an RFID tag passage for purposes of determining whether it is a charged (authorized/no alarm) or discharged (non-authorized/alarm) event. The exit

sensors are sometimes called "antennae," but that is not correct because an antenna is only one component of an exit sensor. It is also possible to install a reader in a book drop to discharge materials as they pass the reader. Finally, there is a portable device that consists of a scanning gun attachment to read a group of items on the shelves for purposes of locating missing and misplaced items.

Patron self-charging stations are similar to those, which have been available for years. A number of models can support not only conventional barcode library cards, but also magnetic strip cards and smart cards. Some models can also be used for patron self-discharging.

RFID exit sensors at exits look much like those installed in libraries for the last several decades, however, the insides are very different. One type reads the information on the tag(s) going by and communicates that information to a server. The server, after checking against the circulation database, activates an alarm if the material is not properly checked-out. Another type relies on a "theft" byte in the tag that is turned on or off to show that the item has been charged or not. It is then not necessary to communicate with the circulation database.

A book drop reader can automatically discharge library materials and reactivate security. Since they have already been checked-in, they can go directly back onto the shelves. These units can also be used with sorter and conveyor systems. Book drop readers usually are the same as circulation desk readers and cost plus the cost of installation into a desk or wall.

The portable scanner or inventory can be moved along the items on the shelves without touching them. The data goes to a storage unit, which can be downloaded at a docking station or a server later on, or it can go to a unit that will transmit it to the server using wireless technology.

### **Server/Docking Station**

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. Its software includes the APIs (Applications Programming Interface) necessary to interface it with the automated library system. The server typically includes a transaction database so that reports can be produced. A vendor may choose not to use a server by substituting a less expensive docking station and increasing the amount of software in the readers.

### **Charging and Discharging of RFID**

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 book drops.[8]

### **High reliability**

The readers are highly reliable. Several vendors of RFID library systems claim an almost 100 percent detection rate using RFID tags. Anecdotal evidence suggests that

is the case whenever a reader is within 12 to 14 inches of the tags, but there appears to be no statistical data to support the claims. There are fewer false alarms than with older technologies once an RFID system is properly tuned. The libraries contacted that have experience with both EM and RFID security systems; report a 50 to 75 percent reduction. 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. However, the author has not been able to identify a library that has implemented this security feature.

Other RFID systems encode the circulation status on the RFID tag. 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. If the material that has not been properly charged is taken past the exit sensors, an immediate alarm is triggered. Another option is to use both the "theft" bit and the online interface to an automated library system, the first to signal an immediate alarm and the second to identify what has been taken.[4]

### **High-speed inventorying**

A 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.[8]

### **Automated materials handling**

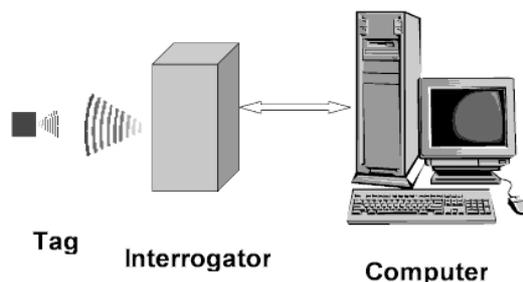
Another application of RFID technology is automated materials handling. This includes conveyor and sorting systems that can move library materials and sort them by category into separate bins or onto separate carts. This significantly reduces the amount of staff time required to ready materials for reshelving. 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.

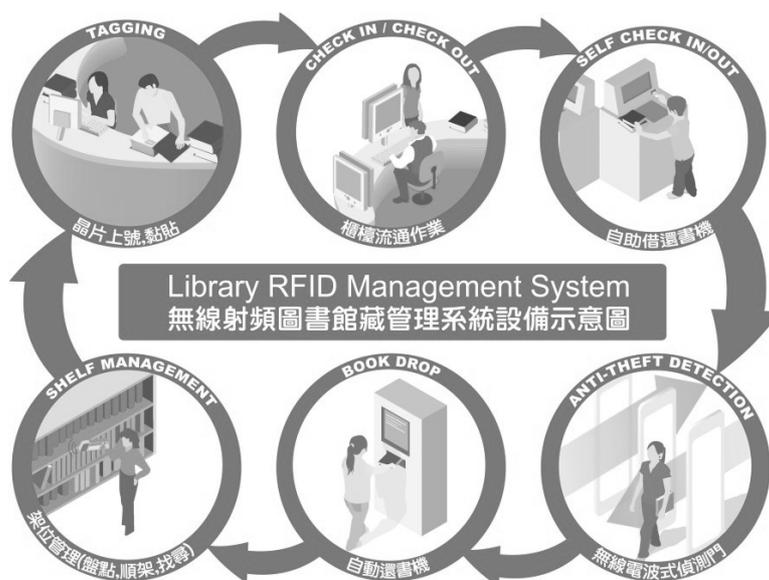
### **How RFID Works?**

A RFID system has several components including chips, tags, readers and antennas. In its simplest form, a small silicon chip is attached to a small flexible antenna to create a tag. The chip is used to record and store information. When a tag is to be read, the reader (which also uses an antenna) sends it a radio signal. The tag absorbs some of the RF energy from the reader signal and reflects it back as a return signal delivering information from the tag's memory.[10],[12]



### RFID Technology for Libraries

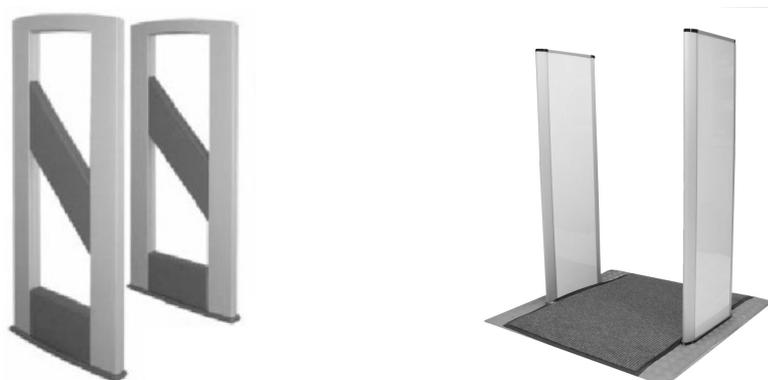
RFID (Radio Frequency Identification) is the latest technology to be used in library theft detection systems. Unlike EM (Electro-Mechanical) and RF (Radio Frequency) systems, which have been used in libraries for decades, RFID-based systems move beyond security to become tracking systems that combine security with more efficient tracking of materials throughout the library, including easier and faster charge and discharge, inventorying, and materials handling.[4],[13]



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The targets used in RFID systems can replace both EM or RF theft detection targets and barcodes.[1],[13]

### **Anti-theft Detection**



RFID EAS Gate is the anti-theft part of the RFID Library Management System using the same RFID tags embedded in the library items. Each lane is able to track items of 1 meter or more and would trigger the alarm system when an un-borrowed item passed through them. The alarm will sound and lights on the gate will flash as patron passes through with the library material.

The EAS Anti-Theft Gate is used to detect RFID tag that is equipped with EAS (Electronic Article Surveillance). It can detect the RFID tags within 1 meter range without interference of magnetic items, Upon detecting of Armed RFID tags, the alarm will sound on the gate. It has option to trigger a Camera to record patrons who trigger the alarm to the Surveillance Station.

Theft detection is an integral feature of the chip within the tag. It is a stand-alone technology, which operates independently of the library database.[13]

Advantages of RFID systems:

Major advantages of RFID system are

### **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.

The other time savings realized by circulation staff are modest unless the RFID tags replace both the EM security strips or RF tags of older theft detection systems and the barcodes of the automated library system - i.e., the system is a comprehensive RFID system that combines RFID security and the tracking of materials throughout the library; or it is a hybrid system that uses EM for security and RFID for tracking, but handles both simultaneously with a single piece of equipment. There can be as much as a 50 percent increase in throughput. The time savings are less for charging than for discharging because the time required for charging usually is extended by social interaction with patrons.[13]

**Simplified patron self-charging/discharging**

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**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.[3],[11].[13]

**Disadvantages of RFID Systems**

The major disadvantage of RFID technology is its cost. While the readers and sensors used to read the information are comparable in cost to the components of a typical EM. It may be some time before the cost of tags comes down to less,[11] which is polling of librarians has determined is the key to their serious consideration of the technology. For example, Gemplus, a European manufacturer of RFID tags, has predicted that it will bring into a market within two years, but there is considerable

skepticism in the industry.[8]

It is possible to compromise an RFID system by wrapping the protected material in two to three layers of ordinary household foil to block the radio signal. Clearly, bringing household foil into a library using RFID would represent premeditated theft, just as bringing a magnet into a library.

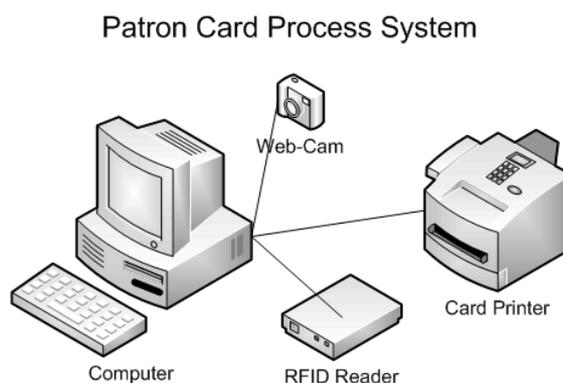
It is also possible to compromise an RFID system by placing two items against one another so that one tag overlays another. That may cancel out the signals. This requires knowledge of the technology and careful alignment.

3M, which recommends EM for security and RFID for tracking, argues that EM strips are concealed in the spines (30 percent of customers) or the gutters (70 percent of customers) of books and are, therefore, difficult to find and remove; while RFID tags are typically affixed to the inside back cover and are exposed for removal. The author found no evidence of removal in the libraries he visited, nor did any of the library administrators contacted by telephone report a problem. That does not mean that there won't be problems when patrons become more familiar with the role of the tags.

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.

While the short-range readers used for circulation charge and discharge and inventorying appear to read the tags 100 percent of the time, the performance of the exit sensors is more problematic. They must read tags at up to twice the distance of the other readers. The author knows of no library that has done a before and after inventory to determine the loss rate when RFID is used for security. Lacking data, one can only conjecture that the performance of exist sensors is better when the antennae on the tags are larger.[6],[8]

## Patron Card Process System



## Perceived Invasion of Patron Privacy

There is a perception among some that RFID is a threat to patron privacy. That perception is based on two misconceptions: (1) that the tags contain patron

information and (2) that they can be read after someone has taken the materials to home or office.

The vast majority of the tags installed in library materials contain only the item ID, usually the same number that previously has been stored on a barcode. The link between borrower and the borrowed material is maintained in the circulation module of the automated library system, and is broken when the material is returned. When additional information is stored on the tag, it consists of information about the item, including holding location, call number, and rarely author/title. The RFID tags can only be read from a distance of two feet or less because the tags reflect a signal that comes from a reader or sensor. It is, therefore, not possible for someone to read tags from the street or an office-building hallway.

Perceptions, even when mistaken, may have real consequences. It is, therefore, important to educate library staff and patrons about the RFID technology used in libraries before implementing a program. The best way to do that is to emphasize that RFID technology is not one technology, but several. E-Z pass is RFID that is meant to be read from a distance. It would be impractical to affix tags of that size and cost to library materials. The same is true of the tags used on pallets in warehouses.

Several states are considering legislation that would pose restrictions on the use of RFID by retailers and libraries. It is, therefore, important to monitor legislative activity and to be prepared to inform legislators about the differences between retail and library applications. Library administrators should be sure to keep their boards informed.[13]

### **RFID in Indian Libraries**

While there are over 500,000 RFID systems installed in warehouses and retail establishments worldwide, RFID systems are still relatively new in libraries. Several libraries have successfully installed the RFID solution. Since traditional security systems have proved to be less effective than libraries desire them to be and RFID is more effective in material management, one can safely say that the RFID solution is here to stay. Automation and self service can help libraries of all size to achieve their operations. RFID is the need to increase efficiency and reduce cost. The products of six manufacturers of library RFID system are available in India through their business associates Bibiliotheca, Checkpoint, ID systems, 3M, Edutech, X-ident technology GmbH represented by Infotek software and systems in India, and TAGSYS represented by Tech Logic, Vemon, Libsys in India and VTLS.

RFID technology has been introduced in a few Indian libraries like NASSDOC (New Delhi), university of Pune (Jayakar Library, Pune), University of Jammu (J&K), Indian Institute of Technology (Madras), Indian Institute of Management (Indore), Bank of Baroda (Mumbai), Indian Institute of Science (Bangalore), Indian Institute of Technology (Kharagpur), Indira Gandhi Centre for Atomic Research (IGCAR, Kalpakkam).

## **Conclusion**

RFID is in use all around us. If you have ever chipped your pet with an ID tag, used through a tollbooth, or paid for gas using Speed Pass, you've used RFID. In addition, RFID is increasingly used with biometric technologies for security. Unlike ubiquitous UPC bar-code technology, RFID technology does not require contact or line of sight for communication. RFID data can be read through the human body, clothing and non-metallic materials. Now-a- days libraries are interested to be introduced this type of technology, which is most usable and easily identifiable one in the library world. Without RFID technology, the library professional will be going to be mesh in their libraries. This technology also use in DMRC (Delhi Metro Rail Corporation), which is the largest transport sources of Delhi and NCR.

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