

BIC e4libraries project

A Guide to RFID in Libraries

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February 2023: Please be aware that since this report was written, the e4libraries website (www.e4libraries.org) has been incorporated into the main BIC website.

When referring to the list of RFID Suppliers, please bear in mind that organisations may have merged, been taken over or closed since the information was compiled.

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Authors' Note

The authors would like to thank all the librarians, RFID and LMS suppliers who have helped with the compilation of this guide. It has not been possible to consult with everybody who may have an interest in this topic. It is therefore the intention to enable interested parties to submit feedback and for the e4libraries website to hold an up to date copy of the report, available as a .pdf for download. In particular the authors would like to thank Stephen Mossop now of Exeter University Libraries and Lucy Price of Glamorgan University libraries for their contributions.

Introduction

Book Industry Communication is the standards body for the book industry. In 2008 BIC launched the e4libraries project to encourage the use of beneficial technology in the library sector. One of the key areas for this project is RFID. The project seeks to promote the use of RFID within a common standards environment which will prevent costly duplication. This guide is an essential part of this project and will provide libraries with a reliable, neutral and supportive document to help them invest in RFID and importantly gain all the available benefits. This guide is primarily for librarians but it is also for RFID and LMS suppliers because the best way to have a successful roll out of RFID technology across the library sector is for all the main parties to communicate with each other and to understand all the issues. This report has been launched at the CILIP RFID in Libraries conference in London on 13 November 2008.

Section 1: About RFID

1. RFID: What is it?

The concept of RFID (**R**adio **F**requency **I**Dentification) technology was developed in 1948 but it has had to wait fifty years before it has been able to deliver on its original promise.

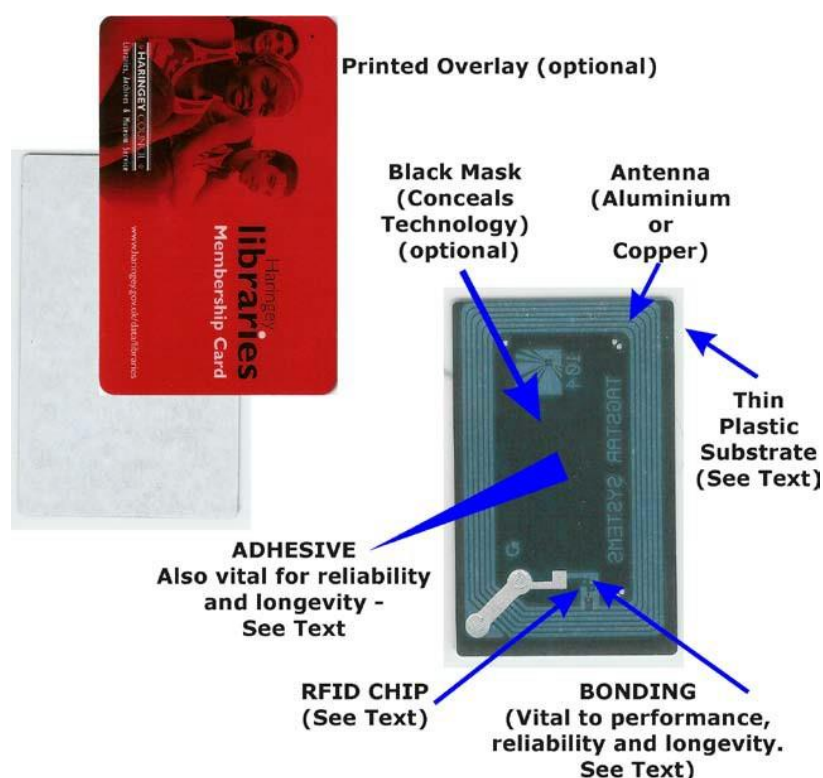
The advent of tiny integrated circuits ("chips") allowed solution designers to add intelligence to the movement of goods through the supply chain and when a chip and an aerial were attached to a sticky label the RFID "Tag" was born.

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).

For some time now they have also been attached to library books. This document seeks to show how and why this has been done up to now, but more importantly how it might be done even more effectively in the future. This is a step by step guide, which will explain what RFID is, how it is used and the benefits which can accrue. It will also provide a realistic view of the issues around RFID, it will look at how it is best deployed and warn of any pitfalls so that libraries can access the necessary information to have meaningful conversations with suppliers. Libraries will then be able to invest in RFID technology appropriately to suit their needs and to maximise the available benefits.

2. What does an RFID solution consist of?

An RFID tag typically comprises a micro-chip and an antenna. The whole device (including the chip) is packaged as a paper-thin adhesive label which may come in a variety of shapes and sizes appropriate to the labelling of books, videos, DVDs and CDs etc. This RFID tag can be applied to library resources in various ways to improve both stock management and security.



RFID machinery (staff workstations, self-service units, security gates, stock management devices - see glossary for explanations of these items) interrogate the tags by radio – in a similar way (but at a different frequency) to the way in which PC wireless networks operate. This equipment may simply read the tag to identify the item, or it may add or change data on the tag attached to the item. This equipment can also read the security element which may be in the tag and this can be used to trigger an alarm when the item is moved near to a sensor such as security gates in a library.

3. RFID performance

This section explains the components of an RFID tag consists of so that we can explore issues around technical efficiency, wireless detection range and tag longevity.

ITEM	DESCRIPTION
CHIP	Typically Philips ICODE SLI (AFI, 13.56MHz) or 100% compatible
AN ANTENNA	Antenna design is critical. Aluminium is becoming cheaper and more common as copper becomes increasingly rare. Different designs are required for: <ul style="list-style-type: none"> • Books • CD/DVDs • Audio Cassette / VHS Video
SUBSTRATE	The nature of the material upon which the antenna is deposited
BONDING	The connection between the CHIP and the ANTENNA. The “Q” of the tag (its effectiveness) is a function of the resistivity of the tuned circuit. A large part of the resistivity element is invested in the bond between antenna and chip. Tags may be equivalent in all respects but this Q variation affects reading distance, reading speed, multi-reading capability, security and overall performance. Tags with low Q can perform very poorly in a closed book i.e. the tag may not be read successfully.
SURFACE ELEMENTS	A “dark field” optionally supplied in some tags can hide the tag and produces a cleaner result when overprinted. Simple white overlays are cheaper but lose some of the effectiveness of the dark field. Other information may also be overprinted on the tags, e.g. the NAG matrix.
OVERLAY	A thin plastic overlay material is often incorporated. But it can adversely affect the Q and the reading performance of the tag.
GLUE	Glue can be silicone or water based and in any event may contain some water. Any water content is critical as it will be the main source of corrosion on the bond and the antenna. This will affect life expectancy. Specialist tags for old or valuable books that can safely be detached have recently appeared on the market.

When talking to tag suppliers or RFID technology suppliers, libraries can focus on the above elements. The key points are:

- the tag's "Q". (Tag suppliers should be able to provide evidence of the tag's effective range and reading performance in various conditions. Note that conditions change depending on the tag's immediate environment; for example, performance may dip near metal shelving.)
- Placement – i.e. where the tag is positioned in the book and how this position relates to the position of neighbouring tags in books on the same shelf.
- The size and material used in the manufacture of the antenna
- The frequency etc.

3.1 Longevity

In the retail supply chain RFID tags are attached to commercial products which are delivered, stocked, purchased and consumed. This type of product has a very short lifespan and its tag only needs to operate while it is in the supply chain and only up to the point at which it is sold to the end customer. A library book, however, which may be issued many times and may live on a shelf for several years, needs to have a tag which will be reliable over a much longer span and suppliers need to be aware of how the tag is going to be used and over what period.

Apart from the issues affecting longevity mentioned above there is another significant element that needs to be considered. The "chip" will normally have a projected life expectancy: usually measured in "cycles" this will indicate how many read/write operations can be expected to be completed successfully before failure. Libraries should ask suppliers about chip life expectancy to ensure that their solution provides adequate cycles.

4. Differences between RFID and a simple barcode system

Many libraries have already installed barcode systems where a barcode is placed in each book and the LMS (Library Management System) uniquely identifies the book by reading the barcode, using a barcode scanner. This technology has enabled self service and self return to operate successfully for many years, functions which have since come to be synonymous with RFID technology. The main differences between using barcodes or RFID tags are the latter's ability to issue multiple items simultaneously and to allow items to be read without having to open them to find the barcodes.

Libraries should consider the volumes of items which will need to be processed either for self-service and self-return and aim for an RFID/sortation solution which can cope. A larger library with big volumes could justify a sortation solution perhaps using a system of conveyors and sorting units etc. A smaller library probably could not justify this investment.

RFID tags and workstations can also identify multi-part sets to detect whether these are complete on return or issue. This is a useful function of RFID assuming the LMS knows to look for all the parts which make up a complete item.

Another significant difference between barcode and RFID systems is that barcodes use standards that can be read by most scanners. While RFID transmission protocols are well established tags are, at present, not governed by similar standards, meaning that some tags may only be read by a specific reader.

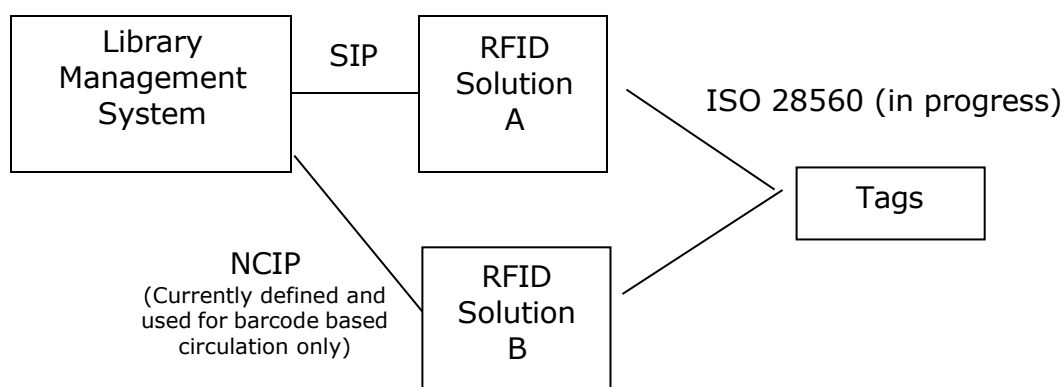
Another important difference between barcodes and RFID is that barcode data is uni-directional (i.e. you can only read it, not write it). RFID not only reads from, but can also write information to, the tag. RFID therefore requires an exchange of data, and that raises some new issues. What data? How is it stored? Where does it come from, where is it stored (e.g. on the tag or on the library management system)? Who is responsible for managing the data (the library system, the RFID supplier – another agency)? This issue should not really be a concern for libraries but should be of great concern to both RFID and LMS suppliers. Libraries should simply be aware that RFID and LMS suppliers need to co-operate and provide libraries with solutions which work.

Early library systems were entirely proprietary (some still are). This may sometimes have been acceptable for internal systems, but as information management moves ever further into cyberspace, modern systems have had to adopt a more “Open Systems” approach. The traditional LMS market is undergoing considerable change, particularly in North America, and future RFID solutions will have to work with new systems and new models of operation. Defining standards and common data models now will make that transition much simpler in the future.

5. Standards

With many RFID suppliers now in the market, new opportunities to use RFID technology, and the need to ensure that libraries don't invest in a proprietary solution which will eventually need to be thrown away, RFID is an area in which standards are becoming increasingly important. Add to this the opportunity to share stock and operate more efficient interlibrary loans and libraries will need RFID systems which can successfully interoperate with each other. In addition it is vital to be aware that libraries are underpinned by their Library Management Systems and these need to be able to communicate with RFID solutions as they develop.

This section deals with the available standards and points out the gaps:



As the above diagram shows, there are several standards in place or in progress and these control different areas of the total solution. These standards have been developed over a long time and newer developments may not be accommodated in the older standards. For example a new RFID solution may programme some data into a tag according to ISO 28560 but if SIP does not handle this data then the data will not be able to move from the LMS to the tag via the RFID solution. This is a complex area and the key point to note is that BIC and CILIP and other

organisations are working to resolve these standards issues and to give guidance to suppliers and libraries on the best way to implement solutions. It is very important that libraries talk to their LMS and RFID suppliers to ensure that their system solutions will interoperate fully. This conversation may need to be very detailed and it is vital that libraries clearly specify the functionality they wish to use so that the suppliers have the opportunity to fully understand the requirements and to ensure that their systems interoperate to deliver these.

- **SIP/SIP2**

SIP (**S**tandard **I**nterchange **P**rotocol) was originally developed by 3M® to enable communication between their original Self-Service units and an LMS. It operates in a similar way to z39.50, by providing a single means of communication that is now supported by almost all self-service systems and LMS suppliers alike. SIP2 is an updated version of SIP.

- **NCIP**

Whereas SIP operates within a single library, a new standard, **NCIP** (**N**ISO **C**irculation **I**nterchange **P**rotocol), offers the ability to extend circulation to library consortia and will also support inter-library loans.

- **ISO 28560**

RFID tags are, at present, not governed by international standards although work is being done to address this and an appropriate standard is expected to be published around second quarter 2009. Whilst this standard is still being ratified it is important that libraries investing in RFID technology are aware that their proposed solution may not be interoperable with other solutions. In the event that they wish to change suppliers in the future or share stock with other libraries, for example through an inter-library loan arrangement, it will be vital to discuss this question with suppliers and satisfy themselves that there is a solution to this problem. This could be a development path working closely with their RFID supplier e.g. tags could be re-programmed on a rolling basis or a one-off exercise or, as some believe, a universal reader could be installed which could cope with all the different ways in which a tag can be implemented. The performance impact of such a solution should be carefully considered (see below).

The type of tag used can be different but other differences between solutions may also include the amount of data stored on the tag, the positioning of the data on the tag, the data structure used and so on. Perhaps the easiest way to think of this is to consider the differences between a Mac and a PC.

In the absence of a ratified ISO 28560, **all** RFID solutions are therefore, at the present time, proprietary by nature. Some RFID suppliers are now claiming to be able to read any tag format – which at first glance may seem like an excellent solution similar to that used by barcode systems. There are, however, some points to be considered carefully before opting for this approach.

- How many different data models – each with its own definitions for content and format – can be accommodated by an LMS before systems performance becomes unacceptably slow, and management so complex that the system is overwhelmed by processing requirements?
- How easy will it be to switch LMS or RFID provider in the future if the new provider does not support the solution being used?

- With no interoperability between RFID/RFID or RFID/LMS systems the risks of buying many thousands of tags using a unique proprietary format are great and the cost of making the wrong decision could be very high

Self-service has been very successfully implemented in a number of libraries now. The reason for this is very simple – the process requires nothing more than a barcode number in order to operate. The way in which self-service operates has been largely unchanged for over 25 years – long before RFID appeared. So RFID has effectively improved on an existing well established barcode-based model and self-service has therefore been fairly easy to implement successfully.

But RFID changes the way in which a library's stock works – permanently. As libraries seek to deploy other solutions, for stock management for example, they will need to be very aware of HOW those operations will work – and how their RFID supplier will use the tags to create solutions for these new functions. The key point is that the LMS drives how things work in libraries and RFID solutions must work appropriately with the LMS.

As the technology moves forward standards which govern how RFID suppliers will deliver and use tags and how RFID and LMS systems will interoperate will be crucial if the benefits are to be fully realised.

Many libraries appear to have invested in RFID in the belief that it was their only means of deploying self-service, only to discover later that they need not have done so. Indeed, at the present time, the benefits that NCIP might eventually bring to interlending are denied to RFID users as a direct consequence of the current lack of standards.

That said it remains pretty much true that if libraries want self-service then they must also have SIP. That means talking to the LMS supplier. Sadly it will almost certainly involve an additional cost.

6. LMS-RFID Integration

This is very important for everyone involved in RFID in libraries. This includes LMS suppliers, RFID suppliers and of course libraries.

When an RFID tag only contains a unique number (barcode or accession number) which identifies that copy of the book, that is the only piece of data which **can** be communicated between the RFID system and the LMS system. Interoperation is therefore quite easy. Any other required data held on the LMS can be accessed using this key identifier.

However, when an RFID solution utilises a tag to hold lots of information about the book, e.g. bibliographic information, the shelf that the book is held on, its previous lending history, supplier information etc., this information will have had to be obtained from somewhere and loaded onto the tag. This data would normally come from the LMS, i.e. the interface between the two sets of hardware (RFID and LMS) would have to be able to exchange all this information. As RFID suppliers are now developing applications which utilise this sort of data they need to be working closely with LMS suppliers. And of course LMS suppliers need to be aware that there is a possibility that the RFID solution is holding data which is not controlled by the LMS. If the two systems interoperate and exchange data then there is no problem but the risk is that libraries end up with two rival systems each with different data and then the problem is to know which database is correct.

This is essentially a standards issue but the new standards are flexible as they have to cater for international and other requirements. It is important that RFID and LMS suppliers get together with Book Industry Communication and other interested bodies to co-operate on more specific UK guidelines which will interpret the standard and enable interoperation.

Section 2: RFID in libraries

7. How is RFID used in libraries at present?

7.1 Self-Issue

Right now by far the most popular use of RFID is in providing or enhancing self-service operations.

There are two main reasons for this. Firstly self-service is seen as the "quickest win" available and offers significant cost savings on circulating stock.

Secondly, the methodology employed by RFID self-service is identical to that used for barcoded stock for over 25 years. It is consequently very stable and well-understood. The only information required to make it work are the barcode numbers of the borrowers and the items.

Self-issue stations come in a wide variety of shapes and sizes. Operation is straightforward, typically:

- Borrowers present their identification to the unit. (This might be another RFID enabled card, a barcode or some other technology)
- Depending on library policy they may be required to enter a PIN code or password.
- Items are placed on the reading table
- Items are read and passed for checking to the LMS (using SIP)
- The LMS returns its decision to the Self Service Unit (or SSU) (again via SIP)
- Any items that may not be loaned will be advised on screen
- Security data is written to the tags to allow or deny them to pass the security gates.
- A receipt may optionally be printed

Instructions and help are usually displayed on a touch screen which may be configured to suit individual library - or even site specific - requirements (supplier offerings vary). Some systems will allow the printing of advertisements or other messages on the receipt.

Libraries should remember the complex decisions that may be involved in issuing a library book. For example, is the book eligible for loan, is the customer "on stop", is the customer the right age to borrow that book or resource? The sophistication of the LMS in answering all of these questions is a good reason why this logic needs to be resident with LMS and not "outsourced" to the RFID solution.

If the LMS is in charge the question may be asked what happens when the LMS goes down? Clearly this **does** happen but nowadays, with much improved reliability of computer technology, it happens quite rarely and perhaps not frequently enough to warrant expensive parallel systems to "understudy" the LMS. It may make more sense for libraries to revert to manual methods for the

one or two days a year when the system goes down and to pay for a robust support contract to keep the LMS running reliably than to invest in understudy systems.

Following the successful issue of an item the next logical step is of course:

7.2 Self-Return

Items may be returned in a similar way to self-issue but in most cases a borrower card is not required for a return. The operation is even simpler than issue:

- Borrowers place items on the reading table
- Items are checked by the exchange of SIP messages with the LMS
- Borrowers place returned items in bins or on shelves as instructed by the unit
- A receipt may optionally be printed

The system indicates that the item's tag has been read and recognised. This can be done by using a beep, a light or a message on the display.

When the system is first deployed there is a learning curve for both staff and customers. When there is a problem for example a book's tag doesn't read correctly, customers must be able to call on staff to sort out the problem.

7.3 Combined Issue/Return

In many instances Issue and Return functions may operate on the same unit. Most suppliers will offer the flexibility to operate units selectively as "Issue only", "Return only", or "Issue and Return".

7.4 Fine/charge payment

Another function that SIP and self-service may be required to provide is fine and charge payment. Fines will be generated and managed by the LMS, either at the point of issue or on return. Clients may be prevented from borrowing items because they have exceeded maximum charge limits. RFID suppliers have a number of solutions available to facilitate financial operations ranging from separate payment stations to integrated units supporting payment technologies as varied as smart card and mobile phones through chip and pin to cash machines – with and without change facilities.

Self-service issue and return are the most common reasons for deploying RFID in the library. Many libraries however have found that the next application delivers even more significant economic returns:

7.5 Automatic Sorting

Depending on the level to which SIP has been implemented by an LMS supplier, returned items may be sorted into many different categories or indeed transported to different locations in the library, from a simple requirement to separate reserved items from the rest, through to complex sort and delivery operations for immediate shelving, or by just about any other required criteria. Self-return sorters are modular devices capable of extension to suit any library.

Typically,

- The borrower activates the return function via a touch screen
- Items are passed through a slot (resembling a letter box)

- RFID tags are read and checked to ensure:
- it is an item belonging to the library
- if it is a set, that it is complete
- SIP messages are exchanged with the LMS to determine the delivery location.
- Optionally a receipt is printed.

The system sorts the books using conveyors and bins. Staff may have to be on hand to monitor the system and to cope with any problems but the system should be expected to have the capacity to process all returned items without queues forming. Libraries should do some analysis of their peak volumes and ensure that their RFID solution can cope with these volumes.

7.6 Security

Item security has long been a concern for librarians. Many methods have been developed over the last thirty years or so of which by far the most popular is the "tattle-tape" solution originally created by 3M.

"Tattle-tape" uses a magnetic field to sensitise or desensitise a thin strip of tape usually concealed in the spine of a book or otherwise secreted in an item. At the point of issue (or return) a magnetic field (different for issue and discharge) is applied to the strip via a surface mounted device attached to a self-service unit. The security gates detect the magnetic status of the strip(s) and the alarm reacts accordingly.

Items have to be processed one at a time since the strips contain no intelligence and cannot identify themselves individually to the SSU. Typically not ALL the stock is "taped" to reduce effort and costs but a high enough proportion is taped to provide the deterrent effect. As the tape is hidden in the book and is very small it is quite hard to find so there is less opportunity for customers to remove the tape and then steal the book.

RFID security is very simple to implement and uses the (currently) only standards-controlled data on the tag to determine whether an item may be removed from the library. There are two ways in which it does this – using either EAS (Electronic Article Surveillance) or AFI (Application Family Identifier).

- *Electronic Article Surveillance (EAS)*: EAS encodes the status of an item on the tag in a similar way to AFI. EAS-based security is, however, entirely proprietary in its nature – each supplier implements EAS security in its own way. EAS is also unable to determine whether an item is a library item or not. In other words the alarm may be set off by an item which is not from the library, e.g. a customer's shopping which has not had its tag de-sensitised.
- *Application Family Identifier (AFI)*¹: The ISO (International Standards body) issues AFI codes for RFID tags to be used in a specific application (such as pharmaceutical brand protection or libraries). This is what stops a library book from setting off the security alarm in a supermarket.

¹ More details of the AFIs available to the library sector can be accessed at <http://www.bic.org.uk/files/pdfs/RFID-for-Libraries-Stds-Advice.pdf>

When a library security system uses AFI, the security gate will request a response from any "checked in" library item. When an item is checked out, the AFI code is modified so that the tag does not respond to this request. Because only tags with an unmodified AFI code respond to the security reader, response rates are fast and reliable. Tags may also use multiple AFI codes to manage collections within collections e.g. to allow items to leave a short-loan collection but not to leave the library.

RFID security requires designated exit routes which are monitored by suitably equipped antenna panels (in a variety of designs). These panels detect the security data encoded in each tag and trigger an alarm whenever an illegal operation is detected. Antennae may also be concealed in existing furniture.

Gates may be installed either to detect that an un-issued item is passing the gates and so sound the alarm or additionally to report the item directly to the LMS. This enables some systems to report which item is in the process of leaving the library and this can be useful when a customer or student is taking out a number of items.

The range at which gates detect items is determined by a number of factors. The size of the aerial, local environmental conditions (such as the presence of large amounts of metal) and the quality of tags and readers will all have an impact on performance. Typically gates will generate a signal all around the gate up to 0.6 metres giving a central aisle of 1.2 metres. This is obviously an important consideration when positioning the gates in the library. Some older libraries are constrained by local factors such as the architecture and fittings of the library and in these cases RFID may offer a degraded solution. It is important to discuss gate positioning and tag detection rates with suppliers to ensure that the security element of the solution functions to an acceptable level.

7.7 Stock management

We are now leaving the world of the well-established and largely standards-controlled aspects of RFID systems. From here on there are **no** rules and **no** established principles of operation. It is an area of operation that offers both the potential for greatest innovation and greatest disappointment.

A popular, but all too frequently disappointing aspect of RFID use in libraries is the way in which it has been deployed for stock control and management.

Essentially the solution comprises a scanning device attached to a data store. Typically the data store will be a PC, laptop or PDA.

Scanning devices come in a variety of shapes and sizes. Those with smaller aeriels will create smaller fields and may perform better on more precise operations, Larger aeriels can read a larger area at once and may speed activities such as stocktaking. Some devices are claimed to be able to perform well for both types of operation.

The operations that may be carried out by such devices include (but are not limited to):

- Taking Inventory
- Identifying Lost or Missing Items
- Checking Shelf Order
- Finding Reservations

Some of these operations may be carried out simultaneously – with the device indicating the nature of any alert on a screen, or as a single operation.

The stock management unit may have an integrated aerial or be connected to a separate device. It may be a PDA, a laptop on a trolley, or a fixed PC –depending on the operations being carried out and the offering of the RFID supplier.

There are many different methodologies available to the librarian. Among the most popular are:

- **Data is stored on the tags themselves**

In this model software on the portable device processes data on the tags to determine what action to take, e.g. tags may carry a record of use enabling the device to calculate which are underused and may be weeded.

- **Data is downloaded from the LMS and used to drive the stock management device.**

In this model the tags carry the minimum of data and the supplementary information (e.g. title, classmark) is supplied by the LMS to the stock management unit.

There are problems with both approaches. The first requires careful data management if the accuracy and integrity of the library catalogue is to be maintained. Different RFID suppliers may recommend different data be stored – This is important to remember if the need arises to switch suppliers in the future. The second requires that the necessary data can be readily supplied by the LMS.

In both cases it is likely that data will need to be uploaded to the LMS after collection. Libraries should always ensure that their LMS provider is able to interoperate fully and efficiently with their chosen RFID solution.

7.8 Accessioning

With library servicing companies offering RFID “shelf-ready” stock the potential for automated accessioning has already arrived but to date has not been widely implemented.

An RFID “tunnel” may be used to accession stock. Tagged items may be identified inside the box and all information passed directly to the LMS database.

7.9 Other

Smart shelves, CD dispensers, intelligent displays...

Many of these solutions are currently in development and are at the new and exciting cutting edge of RFID. The key here is to ensure that the solution delivers what the library expects and that ideally the solution is already proven elsewhere. If a library wants to be the first to implement a solution then they need to be compensated for the risks involved with a good price and a strong commitment from the supplier.

Smart shelves appear to offer the potential to provide an accurate picture of the stock in real time. Some of the key areas to explore with an RFID provider will be:

- How scalable is the solution offered for the library (i.e. can the communications cope with the number of items)?

- Is the solution offered able to deal with the dynamic aspect of stock storage – i.e. items in libraries do not tend to have “fixed” locations as items are added and removed on a regular basis.
- (How) will the shelves interact with the catalogue? If an item is removed for browsing or loan will it disappear from the catalogue altogether?

Section 3: Benefits of RFID

8. Benefits of RFID

8.1 Self-service/Self-issue/Self-return

- Self-service/Self-issue/Self-return is by far the most popular application among adopters of RFID technology. Analysis of circulation figures from a growing number of RFID-enabled libraries suggests that some are now achieving up to 70-90% of their transactions being processed via self-service
- Levels of use appear to be more heavily influenced by the library's commitment to self-service rather than by the actual devices used.
- Automated returns sorters can identify items by collection, status or other SIP-defined categories and deliver them to a trolley, bin or shelf location as required.
- In addition, self-service may be deployed to provide out of hours service, or to facilitate lending at unstaffed locations.

8.2 Stock management

Stock management can be improved by using an RFID scanning device. These benefits are quite hard to quantify but they will enable a library to provide a better service and to be managed more efficiently. Some of the functions it may offer include:

- Taking inventory. In many libraries the annual stock-take has all too frequently been abandoned but with RFID technology libraries have found that stock taking becomes a task that may be carried out far more frequently. As RFID technology improves in accuracy and reading range, stock-taking may become a simple walk through the shelves.
- Finding lost and missing items and identifying mis-shelved stock. Some RFID solutions can help with these problems although libraries will want to see this function at work in an existing library to prove its effectiveness.
- Identifying particular items e.g. for display or relocation.

8.3 Staff savings

Staff displaced by the transfer of circulation to the user population via self service may be redeployed to more pro-active activities, such as reader advisor, delivering both an improved service for the clients and greater job satisfaction for staff.

As more operations are automated the number of staff required to manage them may also be reduced - although staff are still needed to cope when these normally reliable systems go wrong.

It is very important for libraries to plan how they will go about implementing these changes especially ensuring that staff are comfortable with them. This will require planning, excellent communications and full staff involvement

8.4 Catalyst for change in how the library works

As the technology develops, and the issues of interoperability are overcome, RFID will begin to transform the way in which library services are delivered. In particular RFID, in combination with other technologies offers opportunities to take the library service out into the community for example:

RFID enabled book dispensers are currently being trialled in Singapore. Library users use their membership cards to identify themselves to a unit that can dispense the book of their choice and report the loan transaction to their LMS.

By using the potential of RFID to store information on the items' and borrowers' tags a national network of library "stations" in public places – railway and bus stations in the town, community centres in the country – could allow library members to borrow a book in London and return it in Borrowdale – a truly national library service!

Improved ambience e.g. attractive hardware

With the ability to provide self issue and self return, combined with more attractive security gates, there will come the opportunity to reduce the size of the service desk or get rid of it altogether and to redesign the library to use the space more effectively, some libraries have done this already. Staff can now be located at help points or as roving resources helping library users. This has a positive effect on the perception of both staff and users and helps to make the library a nice place to visit and work in. RFID is often implemented as part of a major refurbishment of libraries. Libraries should be aware that RFID is a significant IT project as well as part of a project involving servicing, workflow and refurbishment.

8.5 Customers picking books from shelves using PDA readers

Some libraries may wish to offer customers the use of hand held RFID-capable PDAs to help find books and other items. Some RFID solutions are used to enable blind or partially sighted users to locate items and to navigate around the library. As the technology develops applications of this type will probably become more prevalent although there are issues with reliability, security etc.

8.6 Servicing Savings

There is some debate amongst librarians as to whether RFID will offer the opportunity to reduce the amount of servicing on library books. If books are to be issued on a self service basis and identified and shelved using hand-held PDAs then can books do without some of the cards, stickers and numbers which make up most servicing formulae?

For most companies which provide book-servicing for libraries, the advent of RFID has seen a major new negative impact on their margins resulting, presumably, in higher charges. As each library using RFID may have a different RFID provider using a different data model and possibly different data requirements within that model, the servicing company may find itself with an ever-increasing workload as a result. This often requires additional hardware and software and more space needed to programme the tags to all the different customer specifications.

To try and reduce costs libraries have considered whether they wish to continue using barcodes as well as tags. This needs careful thought. If the library authority offers a multi-site service within which stock circulates freely and some sites are not using RFID there will be no choice but to continue to use barcodes.

In a single site library where all the stock is tagged barcodes may not be required. However libraries would need to be very confident that the information stored on the tags can be accessed or transferred should they change RFID suppliers in the future. Many libraries have opted to keep barcodes as a safety net for dealing with this possibility.

A more complex set of problems arises when libraries form consortia for purchasing and loans. The barcode will need to remain until all consortia members adopt a common standard.

The consensus at present seems to be that while there could be a potential saving in the future once fully standardised RFID solutions are universal, in the meantime there are no savings because libraries need to continue to have their traditional servicing and library suppliers (and servicing companies have to continue to cope with differing specifications.)

Section 4: RFID Suppliers and Purchasing

9. Who supplies RFID?

The following is not an exhaustive list of RFID suppliers and this guide does not endorse any individual suppliers but it may be useful for libraries to have a list of RFID suppliers to contact and with whom to discuss their specific requirements.

Name of Company	Location	Contact	Telephone	Email
2CQR	Long Bennington, Lincolnshire www.2cqr.com	Chris Robb	08458822778	Chrisr@2cqr.com
3M	Bracknell, Berkshire www.mmm.com	Paul Woolvine	0800 3896686	Pwoolvine1@mmm.com
D-Tech	Woodbridge, Suffolk		01394 420077	Info@d-techdirect.com
DSi-TAG	Dorset/Nottingham www.ds.co.uk	Steve Roberts	07813 026028	Steven.Roberts@ds.co.uk
Envisionware	Duluth, USA www.envisionware.com		020 7101 9619	
Intellident	Stockport www.intellident.co.uk	Paul Dalton	07825 437629	p.dalton@intellident.co.uk
Intrepid	Hounslow, Middx www.intrepidsecurity.com	Neil Jackson	0208 893 9922	
Moorgate	Warrington		01925 765432	
Nedap	Aldermaston, Berkshire www.nedaplibrary.com	Jeroen Struycken	0118 9821038	Jeroen.struycken@nedap.com
Plescon	Ipswich www.orfid.co.uk	Nick Hunt	01473 745375	info@plescon.co.uk
Telepen (SB Electronic Systems Ltd)	Harpenden, Herts www.telepen-barcode.co.uk	Paul Burchett	01582 769991	sales@telepen.co.uk

These contact details will be kept up to date on the e4libraries website at www.e4libraries.org. Please note that BIC and e4libraries does not endorse any specific RFID supplier and libraries are advised to research the topic thoroughly and talk to existing users of RFID products.

10. Purchasing RFID

This section looks at how libraries have set about purchasing RFID solutions. Obviously each library's requirements may be different but hopefully this section will be useful in describing a possible purchase process and highlighting some pitfalls to avoid.

Like all major IT projects libraries will probably go through a tendering process but first it is important to understand:

- the subject,
- the required solution
- a range of possible suppliers
- what others libraries have done

There are some key points which libraries should note:

- The RFID solution should interoperate fully with the library LMS

Whilst this will be very simple for self-service – as all RFID and LMS providers essentially do it the same way – the degree of interoperability with other library operations will certainly be very different and possibly very limited.

10.1 Tendering

This section is to help those implementing RFID solutions to ask all the necessary questions for a successful outcome. There are two key points and some general advice.

- Be clear about the library's expectations

RFID will help deliver faster and more efficient self-service but it may limit options for future co-operation, change or development. This problem can be minimised by ensuring that the RFID solution and the library LMS interoperate fully and that the RFID supplier understands the issue around standards and has a cost-effective solution in mind for example to re-program all existing tags with an automated process in the event of the need to change.

- Ask about standards

The publication of ISO 28560 is a first step toward creating a stable environment for RFID deployment. Will all RFID suppliers support it? Will they help customers migrate from their existing systems? What plans do LMS suppliers have for exploiting the potential of RFID?

- Other Issues

Types and frequencies - likely future developments

Tag manufacturing changes all the time. At least one library has already had to remove all tags from their books and replace them with a newer product when the manufacturer decided to discontinue the tags they had used.

Advances in UHF frequency tags may make them a more attractive option at some future date. How should libraries plan to cope with such a change?

This report does not suggest that libraries play a waiting game and see what happens in the area of RFID. This will put off any RFID implementation and its resulting benefits. The key is to communicate with colleagues and suppliers and ensure that the investment made is in line with the likely benefits available. If investment in RFID today delivers huge cost savings and service improvement over the next five years and then the technology changes and the library has to make a new investment then that is fine as long as the payback period in the initial investment is short enough and the benefits large enough to justify the investment.

- Interoperability

At the present time interoperability with LMS is limited to the use of SIP for self-service – which only reads the barcode. As we move ahead with ISO 28560 the potential for using more data will change the way library functionality is delivered. Some RFID suppliers have anticipated this potential by developing their own (proprietary) means of utilising tag intelligence. By doing so they are creating solutions (and stock) that will only function with their RFID equipment. Moving to ISO 28560 would overcome this problem but how LMS systems interoperate with expanded tag data is a discussion that has yet to begin. Ask the

chosen RFID supplier and existing LMS provider how they plan to manage tag data in the future.

- Future direction

New services and new functionality will no doubt emerge once a common data model makes development simpler and solutions transportable. The use of hybrid UHF/VHF tags may make stock-taking simpler and faster. Will suppliers take advantage of such changes in technology and how will they take libraries with them?

- Conversion of RFID systems

If the new standard is widely adopted there will be a number of libraries facing the prospect of converting their tags to the new format. There are many ways of achieving this from "big bang" to "on-the-fly". It may even be possible to use two different models in the same stock for a period of time. Libraries should ask whether their supplier intends to make the switch to the new standard and if so, what is the methodology to be used and what are the costs of doing so.

- Which data model? Will the chosen RFID supplier use standards or not? If they plan to adopt ISO 28560, which version will they use?
- Which data should be on the tag? Remember that the standard does not allow for ANY data to be stored (although three local fields are available). Think carefully before being too prescriptive. How will the library manage the extra data? (e.g. local data) Will this extra data mean that the library's solution is non-standard leading to future problems? Remember that the database should still contain all of the data on each item linked by the ID so that libraries can change course later.
- What are the benefits of more data? Generally the more data added the greater the processing load so remember this fact when drawing up a list of requirements. Also consider the points made in the previous paragraph.

Some of these issues are technical and should be addressed by the RFID suppliers working closely with both the LMS suppliers and standards bodies such as BIC.

Section 5: Conclusion

11. Data privacy and other stories

In the UK there is almost no problem with data privacy as the data protection laws are well understood and most RFID tags only contain information about the book. However libraries should be aware that it would be technically possible to develop an RFID solution which stored information about borrowers on a tag. This should be avoided in order to steer clear of data privacy issues. Alternatively it is sometimes suggested that RFID tags on library books could constitute an invasion of privacy in that they could theoretically enable the State or others to monitor the kind of books read by library customers. This issue has been of concern in the US although it has not seemed of interest in the UK.

Similarly the press occasionally seize upon stories about the dangers of radiation from radio transmitters. RFID tags as commonly used in UK libraries are passive i.e. they don't themselves radiate energy but wait to be read by a reader, and these readers do not transmit with sufficient power to cause such problems but libraries may want to double check this area with their RFID suppliers in the light of health and safety legislation.

12. Conclusion

RFID is still a relatively new technology. So far, several hundred libraries in the UK 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. Broadly BIC/e4libraries believes that RFID is a beneficial technology and encourages libraries to make the commitment to RFID. The key is to take care in the purchase process to follow the advice contained in this guide and to focus on maximising the availability benefits.

Appendices: Case studies and other resources

A. Case studies

Many early adopters have already implemented RFID. There is not sufficient space in this guide to feature these case studies but it is planned to make these available to download from the e4libraries website at www.e4libraries.org.

B. BIC/CILIP RFID Checklist

In 2005 BIC and CILIP put together an RFID checklist (compiled by Martin Palmer of Essex County Libraries). This takes libraries through a series of questions which answer should be considered when evaluating RFID systems. It also forms the basis for drawing up a specification but stops short of suggesting which answers to look for. It remains a very valuable document and should be read in conjunction with the following resources which seek to add more detail to the areas covered.

C. Useful Resources

This section contains some helpful information on the analysis which libraries should undertake as part of the research and preparation for their RFID project.

C1. This is a chart which libraries should fill in to show the volumetric which the RFID solution will be expected to handle. This information can then be provided to the RFID suppliers and it will enable them to provide a more accurate quote eventually to deliver an appropriate solution.

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Annual Issues/Renewals						
Annual Stock Additions						
Current stock						
Books						
CDs						
DVDs						
Other						

Opening Hours						
Main						
Exceptions						
Sat						
Sun						

C2 Tender Response Guidelines

When tendering for a major RFID project, libraries will probably have their own methodology. The following table suggests one approach that might be helpful:

The list is not exhaustive and libraries may wish to undertake further research and take expert advice before proceeding. The table may simply be used as an

aide-memoire or checklist or as a indication of areas where a more detailed technical specification will be required.

The table has three main columns. The first is the list of requirements that will need to be expanded to take account of a library’s particular requirements. For example under Hardware Requirements, libraries may wish to specify such elements as the design and size of a self-service unit. The second (IMPORTANCE) is a column into which the library can put its indication of the priority for each requirement. Thus a simple 1, 2, 3 system could be applied where 1 is desirable, 2, is Highly desirable and 3 is mandatory. Note that Priority 3 (Mandatory) should be applied sparingly and only where a requirement is considered absolutely vital.

The third column (COMPLIANCE) is for the RFID supplier to indicate the extent to which their solution provides for each requirement. A simple A, B, C, D system could be applied here where D is not supported, C is planned for a future release (dates should also be supplied) B is partially supported and on general release (which means in use in some other libraries) and A is fully supported and in use in all libraries.

There is an extra column on the left which can be used for Codes (or paragraph numbers) so that these requirements can be referred to in supporting documentation from the library or the RFID supplier.

Consider that often the tendering process may start with the librarian but it may then be taken on by the IT department and the following table may help to ensure that the library's requirements are maintained throughout the on-going tendering process.

We strongly advise that libraries also allow bidders the freedom to elaborate on their responses rather than relying on a simple score based on compliance. There are many ways to solve a problem and libraries may inadvertently rule out an innovative and effective solution by being too prescriptive. A dialogue with suppliers will always be more productive than a checklist approach.

Code	Requirements	Importance	Compliance
	Hardware Requirements		
	Staff workstations		
	Self Service		
	Self Return		
	Payment requirements		
	Security		
	Stock Management		
	Tags – types and numbers		
	Tendering Company Credentials		
	Supplied solutions before?		
	Relationship with LMS supplier		
	Power, IT & Network		
	Network and server security		
	Wireless interference		
	Any server requirements		
	Hardware life expectancy		
	Network traffic requirements		

	Power requirements		
	Design		
	Flexibility of hardware design		
	Flexibility of software design		
	Software / Hardware Specifications		
	Level of specification for Staff Workstations		
	Software requirements for Staff Workstations		
	Self-service Stations – General Functional Requirements		
	Run unattended		
	Reading requirements/capabilities		
	Limitations range/dimensions/material		
	User-interface configuration design/languages		
	User-friendliness		
	Multipart item management		
	Multiple item loans		
	Secure session methodology PIN etc.		
	Financial management Receipts/Audit		
	Receipt text configuration		
	Interference with other devices		
	Automatic running capabilities		
	LMS connectivity – real time?		
	Book Return Handling		
	Automated/manual sorting requirements		
	Automated/manual sorting capabilities		
	Automated sorter limitations dimensions/material		
	Dealing with unrecognised items		
	Bin overfills		
	Automated check in, simultaneous with sorting		
	RFID Tags		
	Specification Size/Type/Longevity/Anti-collision etc.		
	ISO Compliance		
	Data model		
	Chip spec		
	Longevity		
	Any special requirements eg antiquarian material		
	Self-service Stations		
	Touch screen?		
	DDA compliance and capabilities for disabled/partially sighted users.		
	Secure identification process		
	Functions required – issue/return/renew/account list/fine payment etc.		
	Information displayed during transaction – running total of items/bibliographic data etc		
	Borrower status display capabilities (items on loan/overdue/reserved)		
	Reconfiguration capabilities – e.g. switch to return only		
	Transaction completed process		
	Receipt printer design and ease of use		
	Remote management for low paper alerts?		
	Secure access for system administrator?		
	Self Payment		
	Payment capabilities – onboard/separate unit/change given/recycled?		
	Payment options - Electronic purse/Smartcard/Chip and Pin		
	Receipt information provided?		
	Audit information available		
	Staff Workstations		
	Configuration and capabilities		
	Barcode and RFID?		
	Item Tagging		
	Tagging operation description		

	Security		
	Reporting/non-reporting/triggers?		
	CD/DVD security process?		
	Interference?..		
	Hardware security – PCs and Self-service		
	Power requirements		
	Collection Management (Hand Held Stock Management Devices)		
	Device capabilities and methodologies		
	Resilience & Backup		
	24/7 operation?		
	System failure shall not compromise data integrity		
	Offline capabilities/methodology		
	Usage Statistics & Reports		
	Reporting capabilities		
	Any Legal Requirements		
	Installation, Maintenance & Technical Support		
	Connection to LMS who/how?		
	Training staff/administrator/other?		
	Documentation		
	Upgrade policy/documentation		
	No damage to LMS by RFID system		
	Configuration of stations – manual/remote/other?		
	Service Level Agreement/ Hours of support?		
	Future Development		
	Policy on emerging standards		
	Policy on UHF tagging		
	Interoperability with other RFID/LMS		
	Interoperability of tags		
	Future integration with LMS for enhancing other library functions – eg improved stock control		

Glossary of terms used in this report

Accessioning

The process of receiving ordered items and registering them on the LMS as being "in-stock"

Aerial

(Antenna) the means by which signals are sent to, and received from an RFID tag.

AFI (Application Family Identifier).

A code that identifies the area of operation in which a tag has meaning – e.g. libraries. This differentiates tags used in libraries from by those used in supermarkets etc. and this prevents the false alarms which would otherwise occur where supermarket produce is read by library systems and conversely library book tags are read by supermarket systems.

Automatic Sorting

The process of delivering an item to its correct location by means of identifying its destination by reading the tag and querying the LMS

Barcode

A simple black and white representation of a number that can be read by a scanning device. There are many symbologies in use for encoding numbers in this way – libraries use a small subset of all that are available and can usually set their scanners to recognise more than one without impacting processing time.

BIC/CILIP RFID Checklist

A list of questions produced by Martin Palmer in 2005 to help libraries identify key areas of concern when buying RFID systems. Still current.

CD dispensers

Devices for issuing CDs and DVDs by reading borrower identification and item selection at a display before carrying out an issue or return transaction via SIP with the LMS. Obviates RFID security.

Conveyor

A device for moving stock e.g. on a belt, and part of a sortation unit for sorting stock.

Dark Field

An optional layer that may be incorporated in tags to conceal the presence of an aerial/antenna

Data privacy

Of concern only to those who decide to store sensitive data on their tags

e4libraries project

Book Industry Communication's project to assist libraries in the better exploitation of current technologies, standards and procedures.

EAS (Electronic Article Surveillance)

A simple method of providing security on RFID tags. The EAS functions as a simple "on/off" switch

Fine and charge payment

Overdue library books often incur a fine and some RFID technology can automate this requirement so the customer can input cash etc. into a system and the fine can be discharged.

Intelligent displays

A unit incorporating RFID antennae in shelves (or other display medium) that can interrogate the tags in any items placed upon it. Typically it is the REMOVAL of items from the display that will trigger a response from a PC-based application. The display "knows" which item has been removed and responds accordingly

Interoperate

The ability to exchange meaningful and reliable data between two systems of different design and method of operation.

ISO

International Standards Organisation

ISO 28560

A new standard, due for publication in 2009 that regulates the format and content of RFID tags.

LMS (Library Management System) These are computer systems installed in libraries which are used to run library processes such as ordering, receiving and issuing stock etc. These systems manage the library and hold the stock and customer databases.

MARC

MACHine Readable Catalogue. A standard devised for the description of bibliographic data on computer tape. Now evolved into a standard for describing bibliographic data in LMS.

NCIP

NISO Circulation Interchange Protocol – breaks the rules of acronyms by using an acronym within an acronym. The protocol that defines rules for exchanging in inter-library loans, and other consortia running arrangements.

On stop

Not allowed to borrow

Open Systems

Systems that can be accessed and understood by everyone without referral to, or use of, proprietary (i.e. protected) formats or applications

PDA

Portable Data Assistant - a hand-held computerised device which can be used to hold data from Library Management systems and read tags on library books.

Proprietary

The opposite of "open". Use of a model, format or application that cannot be ascertained or exploited without the owner's consent. Proprietary systems are usually developed to provide the best solution for a particular application or hardware device. They have the disadvantage of preventing the use of tags, equipment or applications so designed with any other device.

Range

The distance at which a signal may be read

RFID

Radio Frequency Identification

Security gates

Physical barriers set up to cover an exit point from a controlled area e.g. a library. These barriers have tag detection technology fitted and this can be used to read tags passing through or past these barriers. This enables RFID technology to provide a security function

Self return

The process of returning items by a library user

Self service

Library user operated service

Self Service Unit

A device for use by library users to borrow or return items

Shelf-ready

Library stock that has been pre-processed by a servicing company and the data added to the LMS database in readiness for its accession.

SIP

Standard Interface Protocol. Developed as an "interpreter" for data exchange between LMS and self-service units.

Smart shelves

Library shelving that contains an RFID aerial and connected to a reader capable of reporting the presence of items placed upon it in real time.

Stock-management

A general term for all stock operations other than circulation.

Tattle-tape

A magnetised strip placed in an item that can be switched on or off to allow items to be monitored as they pass security gates. This is a separate device from RFID security. Some libraries have RFID but still prefer to use tattle-tape because the strip is usually well hidden in the spine of the book and the system is reliable.

Tunnel

An RFID device for reading items passing through it. This can be used to read multiple items at a time and to ensure that only items presented in the tunnel are read. This prevents nearby books from being read in error.

UHF/VHF

Frequencies used in RFID

Uni-directional

Data passing in one direction only. Barcodes are uni-directional as they can only be "read" not "written".

Volumetric

Statistics

z39.50

A protocol developed by libraries and LMS suppliers to allow the translation of data processes on one system by another to facilitate global searching for example on bibliographic databases.