

New RFID technologies & standards – What does it all mean for your library?

Alan Butters
Principal Consultant, Sybis
alan@sybis.com.au
www.sybis.com.au

Abstract

This paper explores practical issues of interest to libraries in two specific areas affecting RFID technology implementation: the development of ISO standardisation and the debate over future technology platforms. Australian libraries are interested in knowing how they may plan for the emerging standardisation of the RFID tag data model and what this standardisation might mean for existing RFID systems. There is also growing debate about the relative merits of Ultra High Frequency (UHF) RFID systems, and whether this technology might form a future basis for library RFID systems.

A standardised data model for library RFID tags

Introduction

The first section of this two-part paper deals with issues involved in a potential migration to a new data model for library RFID (Radio Frequency Identification) tags. Many people by now will be aware that an international project is under way to develop a common data model for use in library RFID systems and that the author of this paper is Standards Australia's representative to this project. The international standard resulting from the project will be known as ISO 28560. The purpose of ISO 28560 is to describe a globally standardised way in which information may be stored in the memory of RFID tags used to identify and manage library material. The current situation is that the data contained in library RFID tags follows a number of proprietary data formats determined by the individual suppliers of the RFID systems, or, in other cases, individual national schemes such as those employed in Denmark, Finland and The Netherlands. These proprietary or national data formats severely reduce interoperability between library RFID systems, even where ISO (the International Organisation for Standardization) standardised tags and reader hardware are utilised.

While applauding the aims of the ISO working group, many libraries have expressed a level of concern about the process of migration to the new standard, following its publication and adoption by suppliers. Libraries that have already embraced RFID are faced with transitioning to the new data model, while libraries considering the purchase of RFID are interested to know whether their purchase should be delayed until after the new standard is implemented. In both cases, the impact of the new standard on borrower privacy is of concern, as is the ability of the standard to be compatible with existing business processes etc. This section of the paper attempts to address these and other issues of concern to Australian libraries.

Migration to a new data model

Timing

A question often asked about the developing standard is "when will it be finished and when will it subsequently be adopted by RFID library suppliers?" Obviously, this is a question more easily asked than answered. An update on the ISO working group's progress will be given at the VALA2008 conference during the presentation that will accompany this paper, but a few points may be made in advance.

Firstly, it is fair to say that as at September 2007 a consensus view regarding the structure of the new data model does not yet exist within the ISO working group. This is particularly the case where backwards compatibility with existing national schemes is concerned. In 2006 a working group within Standards Australia released a proposal for a data model based around two existing ISO standards (this proposal and other documents from the countries involved may be downloaded from the ISO project's official website at <http://www.bs.dk/standards/rfid/>). This proposal suggests that *functional* compatibility with existing library RFID systems may be achieved by the new data model, whereas *tag-level* compatibility may not. This is to say that the

operational models of libraries will be supported but the existing tag data will need to be reformatted into the new structure. The crux of the current debate within the ISO group is whether compatibility at the tag level should be engineered into the new standard to comply with existing national schemes.

Obviously, from a migration perspective, a tag-level compatible solution requires little if anything in terms of effort from the libraries involved. Unfortunately, this level of compatibility comes at the expense of complexity. Additionally, given the fact that the largest communities of users within the library RFID space are those with supplier-proprietary data models, an argument could be mounted that the greatest good would come from a solution backwardly compatible with these. Clearly, compatibility with all of the models on the market is unrealistic and unnecessarily complex.

The next observation that might be made is that within the ISO working group, strong support is being expressed for a data model broadly similar in concept to that proposed in Standards Australia's document. While it would be inappropriate to predict an outcome, it would appear that momentum for a self-declaring data model employing selectable data elements encoded according to ISO 15962 is growing. The statements made in the rest of this paper are therefore based on the growing probability (not certainty) that such a model will form the basis of ISO 28560.

It may be possible at the VALA2008 conference to make a comment about timing for the release of the standard, but it is possible at this time to comment on the attitude of the major library RFID suppliers towards the implementation process. Since the formation of the ISO project, many suppliers have been asked as part of formal tender processes to commit themselves to implementing the standard within twelve months of its release. None of these suppliers has declined to make that commitment. It should also be noted that supplier representatives are present within the Standards Australia working group, the ISO working group itself and the North American NISO (National Information Standards Organization) group – all contributing their expertise to the new standard.

Migration process

The answer to the question of whether a library currently contemplating a move to RFID should wait until after the standard is implemented before purchasing is to a large extent influenced by the degree of difficulty involved in switching data models at a later date. If the migration to the new standardised model represents an equivalent effort to that of the original retrospective RFID conversion, libraries may be persuaded to wait. Fortunately, it does not appear that the process needs to be quite so difficult.

Discussions with several suppliers about migration strategies have revealed that, in many cases, it may be feasible to actually accomplish the migration as part of standard circulation activities. At the point of material checkin, for example, the RFID system could read the data from each tag, reformat it into the new model and then write it back to the tag as a set of standardised data elements. This process could be expected to add a little extra time to the processing of returns, but is significantly more efficient than handling all of the library's collections separately. Using this method, migration to a new model could occur seamlessly over a period of time. Of course, manual conversion could also be possible for those libraries wishing to

accomplish the project faster. Naturally, not all library RFID systems on the market have the same structure or architecture and libraries should check with prospective suppliers regarding their own migration plans. A relatively seamless transition for libraries is obviously the desired outcome.

Item security

ISO 28560 is expected to introduce a standardised method of accomplishing item security by means of the RFID tag attached to each item. This will probably be accomplished by means of a unique identifier that, when set, universally identifies an RFID-tagged object as a circulating library item. This method has two advantages. Firstly, it provides a standardised tag-based security option, and secondly, it identifies the item to other non-library RFID systems as belonging to the application of circulating library materials. For this second reason, the identifier in question is known within the standards world as the Application Family Identifier (AFI). A unique AFI has been assigned to identify library material circulating outside of the library.

Currently, item security within an RFID library system may be handled in several different ways. Some systems use various bits of data within the RFID chip's memory as security flags, others use proprietary EAS (Electronic Article Surveillance) hardware on the tag, while still others use off-tag security methods that are not dependent on the tag memory at all. Clearly, it would be advantageous to have a common system for item security for those libraries that wish to enter into cooperative arrangements with their collections.

With this in mind, some libraries have asked whether or not this means that, under the new standard, their security systems would need to be replaced or upgraded. Fortunately, the answer is no. The standard will not mandate the use of a particular security methodology, and so item security may continue to be accomplished in various ways, even making use of separate electromagnetic security strips if so desired. It is likely, however, that the standard will make some recommendations regarding how the AFI should be handled in alternative security schemes, so as to preserve its integrity, should it be required by another library. Of course, continuing to use security systems that do not use the ISO standard security scheme will limit the interoperability possible between libraries where item security is concerned, but to an extent this situation is true of existing security technologies today.

Precisely what security interoperability will exist between different sorts of systems is beyond the scope of this paper, but it is proposed that the standard will address this issue in some detail by means of an informative annex.

User Data

Individual libraries demonstrate significant variation with regard to the data they wish to place on the RFID tag. This variation is seen at institutional, sector and geographic levels. Where libraries have made (or have had the option to make) conscious decisions about the data set they have employed, these decisions are based on a particular operational model or a set of specific interoperability or process outcomes. Given that considerable thought usually accompanies the selection of data elements, some existing RFID libraries are interested in the impact on their existing processes from implementation of the new standard.

One of the significant advantages conferred by the kind of data model described previously is flexibility. Unlike many existing proprietary and national models, the new ISO standard should allow libraries to select the data elements to be placed on their tags based on the process outcome they desire. For example, consider two neighbouring libraries. The first library may wish to place a call number on the RFID tags to facilitate rapid automated sorting by means of tag based data. This may have no relevance whatsoever to the neighbouring library and the second library may decide that the call number on the tag is unnecessary in their case. Neither adding nor excluding the call number data element threatens the interoperability between the two institutions. Data in common may be used by both and the rest ignored. Naturally, where specific interoperability is envisaged (beyond that provided by the standard item identifier) a common set of data elements will be required. As the data elements to be used are selectable by the library, where privacy concerns exist it will still be possible to place only the item identifier on the RFID tag. This is in contrast to many national and proprietary models, which essentially mandate a much larger data set for every tag.

The point is that whatever data elements are utilised currently by a library service or by a national initiative, the same elements will be selectable from a list within the standard for use as part of the new data model. Over time, the list of available elements may be increased, based on libraries' changing needs and collections.

RFID readers

There has been some misinformation spread within the library community which suggests that, under the sort of data model described previously, there would be a requirement to replace or upgrade all existing RFID readers employed within current RFID library systems. This is not the case and is based on a lack of familiarity regarding the way current data models are usually implemented. The most likely scenario for a supplier implementing the new ISO standard would be to do so as part of the application or "edgeware" software inside RFID devices, such as self-service units, staff stations and security portals. There should be no requirement to replace RFID hardware components or to upgrade firmware in RFID readers.

"Future proofing" current systems

The following sections suggest some practical steps libraries can take in an attempt to protect their investment in RFID technology as the new ISO standard unfolds.

Selection of an RFID supplier

It should come as no surprise that RFID suppliers demonstrate a range of attitudes toward the process of standardisation within their solutions. These attitudes range from genuine support through to indifference and, occasionally, resistance. It would be prudent for libraries considering the purchase of an RFID system to probe prospective suppliers in this context. Suppliers who genuinely support a standardised approach will be able to demonstrate this support by their individual involvement in the standards process or through their backing of standards initiatives.

Tag selection

Naturally, ISO standardised tags form the basis for the new data model. It would be unusual these days for a library to select a system not utilising ISO standard tags (most commonly ISO 18000-3 M1 and its smartcard predecessor, ISO 15693), but obviously to do so could potentially preclude the use of the new data model as well as posing additional interoperability difficulties.

Data locking

One of the features of the ISO standardised tags in common use within the library application is data locking. This represents the ability to permanently fix some or all of the data in the memory of an RFID tag. There might exist valid reasons for locking data, such as an increased immunity to digital vandalism or tampering. Some have suggested that if institutional identification data is placed on the tag such as the ISIL (International Standard Identifier for Libraries and related organizations) code, this should be locked to facilitate more robust ILL processes etc.

In the context of an emerging data model standard to which a library may want to migrate in the future, data locking is a two-edged sword. Notwithstanding the valid reasons behind the original decision to do so, locked data cannot be unlocked. As RFID tag memory is often a precious commodity, a prudent approach may be to ensure that no data is locked on the tag thus leaving open the option to replace all the data when the new model is implemented. Libraries will need to discuss this with their existing or potential supplier to ensure that their needs are met.

Conclusion

A standardised data model is in the long-term best interests of the global library community, including the suppliers delivering the RFID solutions to it. With some care and planning, the migration to the new model does not have to be onerous or financially burdensome. It behoves libraries to begin discussing these issues of migration with current or potential RFID suppliers, to ensure that solutions appropriate to the needs of libraries are developed. For suppliers, a seamless migration path may be a point of differentiation in the market and will accelerate the adoption of the new model when released.

Ultra High Frequency (UHF) technology for libraries?

Introduction

Traditionally, library RFID systems have been based on High Frequency (HF) systems operating internationally at 13.56 MHz and that are either proprietary or that conform to two ISO High Frequency standards. The decision to select the HF technology platform was made by library RFID suppliers as long ago as the mid to late 1990s. In more recent times, Ultra High Frequency (UHF) systems, licensed to operate in Australia at 918 to 926 MHz, are beginning to dominate in sections of the commercial RFID space. This is particularly the case in commercial supply chains, where use of UHF technology is being increasingly mandated by massive organisations such as Wal-Mart and the United States Department of Defense.

Some libraries are asking whether or not this same UHF technology might be suitable for the library application of RFID, and whether cost savings brought about by increased production volume of UHF RFID tags might be available to the library sector. The second part of this paper will explore some of the issues within the debate that are important to libraries and will also briefly touch on the status of the market, including where UHF systems are being deployed within the global library community.

Why UHF in libraries?

Price

A popular line of thinking is that if UHF RFID tags come to dominate the RFID space, production volumes will rise and tag prices will fall. Roberti (2006, p. 25) reported, in a case study of a large US based manufacturer of kitchenware, that the organisation started out paying US\$0.53 each for their UHF tags in 2005, US\$0.16 in 2006, and expected to pay US\$0.10 for their next order. These sorts of stories are by no means unusual in the RFID trade press. The same reasoning is often extended to RFID hardware and equipment which is also expected by many to reduce in price, through increasing production volume and advances in technology. As an example, in March 2007, Chip manufacturer Intel (Intel, 2007) released a fully integrated Gen2 RFID reader chip which is expected by many to significantly reduce the cost of manufacturing RFID readers. Obviously, falling prices for tags and hardware benefit all sectors using the technology.

Performance

One of the characteristics of UHF systems is that they can be configured to have significantly greater reading range than the 70cm maximum typically seen in HF implementations. This enables wider corridor widths for security systems, and potentially improved functionality in some areas of hand-held reader operation, such as searching for items.

Systems based on UHF also appear to offer greater immunity to the problem of tag masking, which is an important issue for libraries. Tag masking occurs when two RFID tags are placed in close proximity to the extent that they overlap one another with little physical separation between them. This can occur when RFID-tagged

library books are presented to a reader as a stack with their spines in alignment, particularly if the books are thin, as is the case with children's books for example. In this scenario, overlapping tags within the books may mask each other to the extent that one or both tags are unreadable. Preliminary indications are that UHF tags and readers are significantly less prone to this particular phenomenon.

Integration with publishers & supply chain

There are continuing discussions within the library community about compatibility with the supply chain of the publishing industry. One school of thought suggests that publishers or distributors may choose to employ UHF RFID tags at the point of manufacture, in order to better track their shipments and also to provide stock management and item level security at retail outlets. Collins (2006, p. 2) reports on one such example from Holland, where Centraal Boekhuis, the sole distributor for most books sold, is supplying UHF-tagged stock to BGN, Holland's largest bookseller. If publishers more broadly should choose to employ UHF systems in common with other supply chain systems, libraries may be advantaged if they are able to use the same RFID tag that is provided with each item.

Questions

With these obviously desirable advantages touted, some libraries are asking whether the future of RFID actually lies in UHF technology rather than the HF currently employed. Questions most commonly asked by libraries include:

1. In selecting HF, have libraries chosen the wrong technology?
2. Are there any good reasons why libraries couldn't use UHF systems?
3. I can see that we may gain in some areas but do libraries lose any of the benefits we currently have if we migrate to UHF?
4. Can we use both HF and UHF in the same library system?
5. Should we wait until this issue is decided before purchasing a system?

These are legitimate questions to which it is not always possible to provide definitive answers. However, a relatively small amount of information does exist regarding UHF in the library application and, on this basis, some preliminary comments may be made. Each of the five questions is dealt with separately in the following sections.

1. In selecting HF, has the library sector chosen the wrong technology?

The first thing that should be said in defence of the library RFID suppliers that were actually responsible for this decision is that the UHF technology we see today didn't exist in the mid to late 1990's when library RFID systems were being designed. This very fact has led some to speculate that if the first library RFID systems were being designed now instead of a decade ago, UHF technology would have been the obvious choice. Needless to say, not everyone agrees with this position.

The answer to this question may ultimately be determined by which RFID technology platform (if any) becomes dominant in the commercial world. Debate continues regarding which technology is more suitable and cost effective for item-level tagging in the retail sector. Obviously if a decision is made for one particular technology, the resultant tag volumes may drive down prices significantly – indirectly benefiting other sectors such as libraries as well. However, for technical reasons the retail sector

may be divided in its preferences, based on the physical nature of the products being tagged. As Das points out (2007, p. 1) different technical challenges exist in tagging frozen foods, for example, compared to a box of facial tissues, and these challenges may drive technology selection. So while it is claimed that the market share for UHF technology is growing when compared with other RFID platforms, (VDC, 2007) future dominance at the item level is by no means guaranteed.

Libraries must be careful to keep their focus on the benefits that RFID brings to their organisations. The technology is (or at least should be) secondary to delivering the desired business result. If one particular technology confers an advantage that is critical in supporting a business case for an individual library service, this might be a reason to look at it carefully. More important to libraries than the question of technology per se are issues concerning process, staffing levels, materials handling by staff, customer service etc.

2. Are there any good reasons why libraries couldn't use UHF RFID systems?

Some of the current library RFID suppliers actually investigated UHF systems when they began to appear in the supply chain and decided that the answer to this question was yes. The early UHF systems did not have the performance seen currently in the newer Gen2 products, and this caused some suppliers to dismiss the technology as unsuitable for the library application. However, it is fair to say that in many cases the emergence of UHF Gen2 products has turned this perception around and has enabled the penetration of UHF technology into many new application areas, including library systems (Banks et al, 2007; Brown 2007, Schuster et al 2007). The fact of the matter is that there are several library systems operating with UHF technology in Australia. By all accounts, therefore, it is certainly technically feasible to build a library RFID system on a UHF platform.

3. I can see that we may gain in some areas but do libraries lose any of the benefits we currently have if we migrate to UHF?

This is perhaps the most difficult question to answer at this time. One of the reasons for this difficulty is that the UHF systems on the market have not yet had the depth of development that their HF counterparts have had. It can be premature to judge a technology based on its early implementations, as these could be expected to evolve over time. There are, however, a few important questions that hang over UHF implementations and that are likely to require time and effort to resolve. These questions relate to issues such as OH&S (Occupational Health and Safety) considerations with UHF systems in the library context (Magellan 2006), the longevity in library materials of tags originally designed to be used in the supply chain, compatibility with emerging data model standards, national frequency allocations, etc. It would be advantageous for the library community to find ways to support research into some of these issues (particularly OH&S) so that libraries can make informed choices.

It is also true that radio waves in the UHF spectrum area behave differently to those operating at HF, the differences often discussed in the context of liquids that absorb radiated energy and metals that mostly reflect it. To some extent, the differing behavioural characteristics of UHF may prove to be a mixed blessing for libraries. While libraries may like to be able to perform faster inventories and have the option of broader security corridors, there is still a need to carefully control the RFID fields.

Library users in close proximity at self-service facilities for instance should not be able to accidentally borrow the library material belonging to each other. There also exists a need for controlled fields in both security and collection management contexts. Controlling UHF fields typically presents a greater challenge to developers than is the case when designing with HF, and work still needs to be done in this context.

4. Can we use both HF and UHF in the same library system?

At this point in time, the answer is no. The differences between UHF systems and HF systems extend well beyond the RFID tag. There are issues of antenna design for RFID readers, differing frequencies of operation, different air interface standards, etc. For these same reasons, there is fundamentally no interoperability between a HF RFID library and a UHF one. Considering the fact that at the present time the majority of libraries operating with RFID are using HF-based systems, libraries considering UHF will need to consider their interoperability requirements before proceeding.

5. Should we wait until this issue is decided before purchasing a system?

One could probably argue that almost any technology will be cheaper, faster, smaller and more standardised if purchase is delayed for a year or two. Certainly personal computers could be used as an example in support of this argument. An analogy could also be drawn with library management systems. When these systems first started emerging in Australia during the late 1970s and early 1980s, by comparison with current systems they were stratospherically expensive, physically large, painfully slow and offered limited functionality. There were essentially no database or information standards in existence, no public search facilities available, and some systems did not even have CRT screens.

These limitations, and the general realisation that future systems would be superior, did not stop some libraries from purchasing them, however, and herein lies the point of the analogy. At the stage that a particular institution could demonstrate a positive service and management advantage commensurate with cost, many proceeded to implement a system and reaped the benefits. The reality was that not all libraries reached this point during the same time period, and many years passed before small libraries could justify the purchase. At any point in time between the installation of the first library management system and today, it could have been argued (and often was) that delaying purchase would equate to increased value for money in the future. However the business of running a library could not be postponed, and so institutions embraced the technology for the advantage conferred at the time of purchase.

In the case of RFID, a similar situation is unfolding, albeit somewhat accelerated. UHF technology may well be a part of this. The real question is whether or not a library is able to develop a defensible and robust business case for employing RFID today. If so, benefits are to be gained immediately. These benefits exist independently from questions regarding which technology platform will dominate in five or ten years from now.

Library UHF systems globally

There is a growing interest within the global library and library vendor communities regarding the possibilities of using UHF technology. Anecdotally, much interest in the use of UHF for library systems is seen in countries such as China and Japan. The following section contains links to organisations that are currently active in this area. As UHF technology is relatively new in the library application, there are doubtless other projects in existence which have not yet been made public. Please note that the author of this paper neither endorses nor has commercial relationships with the organisations mentioned, they are named only for informative purposes.

<http://www.civicapl.com/AUS/Sectors/Library/>

Civica is a well-established provider of library management software solutions. In Australia, several libraries also use Civica's UHF RFID system, including Blacktown Library in New South Wales, the first Australian library to employ UHF RFID technology.

<http://www.adilamtech.com.au/>

Adilam Technologies is a Melbourne, Victoria based solutions provider and implementation partner with specialist knowledge of UHF RFID within the library sector.

http://www.inveno.cn/english/index_p.asp

Inveno is a Chinese RFID supplier testing UHF RFID products in cooperation with Shantou University Library, China. Also testing covert UHF RFID tags.

Conclusion

It is very early for predictions regarding the ultimate success of UHF systems within the RFID library application. The use of existing UHF systems would suggest that there is no technical reason that the technology could not find a home within libraries, even though the systems themselves are still evolving. There are some issues yet to be resolved and the outcome of these may have a bearing on the eventual level of acceptance of the technology in some countries. Research into the use of this technology within the library application should be encouraged.

References

Banks, J & Hanny, D & Pachano, M & Thompson. L 2007, *RFID Applied*, Wiley, p. 127.

Brown, D 2007, *RFID Implementation*, McGraw Hill, pp. 50-53

Collins, J 2006, 'Reading books reduces out-of-stocks', *RFID Journal*, retrieved 12 September, 2007, from <http://www.rfidjournal.com/article/articleview/2696>

Das, R 2007, 'RFID progress in retail to mid 2007' *IDTechEx*, retrieved 12 September, 2007, from <http://www.idtechex.com/products/en/articles/00000583.asp>

Intel, 2007, *Intel® UHF RFID Transceiver R1000*, viewed 12 September, 2007, at <http://www.intel.com/products/embedded/rfid/r1000.htm>

Magellan, 2006, *Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields*, retrieved 13 September, 2007, from <http://www.magtech.com.au/downloads/White%20Paper%20on%20RF%20Compliance%2020%20April%202006.pdf>

Roberti, M 2006, 'How World Kitchen got it right', *RFID Journal*, July/August 2006, pp. 18-25.

Schuster, E & Allen S, & Brock, D 2007, *Global RFID – The value of the EPCglobal network for supply chain management*, Springer, p. 26.

VDC, 2007, *Global RFID market overview*, viewed 12 September, 2007, at http://www.integratedsolutionsmag.com/index.php?option=com_docman&task=docview&qid=73