Standards for RFID systems in Australian Libraries – What does it all mean and why should you care?

The topic of Radio Frequency Identification (RFID) standards is not well understood within the Australian library community. It is often not clear to library professionals with which standard a particular vendor's offering complies or even whether it complies. While the desirability of standards within the library RFID space is recognised, there exists significant misunderstanding regarding what benefit current standards actually confer. Unfortunately, this misunderstanding leads many library managers to believe that the current standards enable interoperability between systems which is actually not the case.

During 2005 a working group (chaired by the author) was established under the auspices of Standards Australia to determine what would constitute an appropriate standard for an RFID data model for Australian libraries. The working group is composed of senior library professionals from Victoria, NSW, & Queensland, together with representatives from the publishing and RFID vendor communities.

At the outset, the working group identified that one of its key functions would be to act as a resource within Australian libraries, where an acknowledged lack of understanding exists with regard to the critical issues involved. This paper will provide an update on the activities of the working group and convey the current status of standards within the RFID space. The emphasis will be on imparting an understanding of the gap between the actual and the perceived benefits. The paper aims to raise the awareness of the library community to the work of the standards group and, in so doing, provide a contact point for further discussion and support.

1. Introduction

Radio Frequency Identification (RFID) systems have the potential to offer many benefits to Australian libraries. Perhaps foremost among these benefits are potential productivity gains and improved collection management (Ayre, 2005; Holt, et al 2002; Mackenzie and Aulich, 2002). By enabling non-line-of-sight identification, tracking and processing of library materials, many current processes may be improved and new processes enabled. Non reliance on barcode technology permits processing of multiple items simultaneously and greatly improves the utility of process-automation technology such as self-serve loans and returns systems. RFID may also be seen as an enabling technology with products such as smart-shelving and smart dump-bins considered by many to be technically feasible.

Given the relative ubiquity of existing barcode technology, many libraries are concerned, not about what might be gained, but about what might be lost in switching to a new method of identifying library materials. This concern is particularly centred on the issue of interoperability and how a migration to

RFID technology might impact upon it. This paper seeks to address this issue and to provide information aimed at raising awareness of the issues involved. Firstly an overview of standards employed by current systems will be presented. Secondly an analysis of where standards might usefully be incorporated into library RFID systems will be given and thirdly, the implications of the possible approaches will be compared.

2. Standards and current library RFID systems

While RFID is not a fundamentally new technology (Thornton et al, 2006) its use in the library application is relatively recent. Although penetration remains low, during this decade we have seen an increase in the interest shown by individual libraries as well as library RFID vendors in the possible benefits that the technology offers.

While there are no international standards in existence that have been specifically developed for the library application of RFID, many standards exist in the commercial RFID technology space and this is where library RFID vendors first turned when considering a standards-based approach (Ayre, 2005). It should also be noted that not all library RFID system vendors base their solutions on standards at all. Some are proprietary and therefore closed systems. The library community has long recognised the value of standardised and open systems, particularly in the area of Information and Communications Technologies (ICTs) and so this continues to be a topic of focus within discussions of RFID solutions.

Relatively early in the development of RFID systems, vendors realised that a particular ISO standard aimed primarily at smart-card applications could quite easily be re-purposed to suit a *smart-label* application (Paret 2005). The standard in question was ISO/IEC 15693, first published in the year 2000. This multi-part standard defines three things specifically:

1. The physical characteristics of the RFID tag
2. The “air interface” characteristics of the RFID tag
3. The command set for communication with the RFID tag and the anticollision sequence to be adopted

While the details of this standard are outside the scope of this paper, some useful general comments can be made. The standard, as originally intended, was meant to describe a “vicinity” smart-card implementation (Finkenzeller, 2004). This kind of smart-card system is one that is characterised by its operation at a distance from the RFID interrogator technology. Whereas many smart-card systems require the card to be brought within a couple of centimetres to ensure correct operation, ISO/IEC 15693 systems could operate in environments where the smart-card would be read while perhaps as much as seventy centimetres away from the reader. Manufacturers of library RFID systems realised that this sort of read range would be appropriate for systems employing smart-labels within library items and so this standard was selected by some on which to base their product offerings. While part one of the standard required the RFID tag to be the size of a

standard access card, the RFID manufacturers deviated from this to produce the array of tag sizes we see in current systems while maintaining compatibility with parts two and three of the standard which actually specified how the tag would communicate etc. So, as a general statement, when a vendor professes “ISO compatibility” with reference to their system, they are indicating that the tags employed in their library solution comply with parts two and three of ISO/IEC 15693.

This standard is not without its limitations when used within the library application and, particularly in the area of data security and privacy, leaves much to be desired (Molnar and Wagner, 2004). Nevertheless, it is almost universally the standard prevailing in current library RFID systems.

During 2004, another multi-part standard was published which superseded ISO/IEC 15693. This standard was ISO/IEC 18000. Each part of this standard refers to communication with an RFID tag at a different range of frequencies. The part that refers to the tags generally (but not exclusively) used within the library application of RFID is ISO/IEC 18000-3. This section has two modes of operation, referred to as Mode 1 and Mode 2. ISO/IEC 15693 is a perfect subset of Mode 1. So, for the sake of completeness, we can say as a general statement, when a vendor professes “ISO compatibility” with reference to their system, they are indicating that the tags employed in their library solution comply with parts two and three of ISO/IEC 15693, and/or that their tags comply with ISO/IEC 18000-3 Mode 1.

2.1 Implications of this standards compliance

If an open-systems “Utopia” exists with reference to RFID systems for libraries, it would likely be a situation where an individual library could select any components from any vendor’s system and combine these components taken from different vendors to build a customised solution which would then work with RFID tags purchased from a range of suppliers. Any two of such systems would have full interoperability both at the tag level as well as the equipment level.

Unsurprisingly perhaps, this situation does not exist today. But the question remains; How closely does compliance with the standards previously mentioned move libraries toward the Utopia of RFID systems interoperability? The short answer, unfortunately again, is not as close as many libraries might believe.

Specifically, a tag compatible with either ISO/IEC 15693 or ISO/IEC 18000-3 Mode 1 can be formatted to operate with any vendor’s RFID system that incorporates these standards at the appropriate levels within the system architecture. Once formatted, however, there exists no interoperability between individual vendor systems at the tag level. In other words, the formatted RFID ISO standardised tag can be read by only the system for which it was formatted. If presented to a different vendor’s solution, the tag might be read but the data would be meaningless.

The reason for this is that the formatting of the data on the RFID tag is not specified by the standards under discussion and so is proprietary to each vendor. So while the ISO compatible tag is read by each vendor using the same set of commands, the format of the actual data, that is to say the arrangement by which it is set out in the RFID tag's memory is different for every vendor. An analogy to this might be the use of floppy disks in Macintosh and IBM-compatible personal computers. Floppy disk manufacturers sold differently labelled boxes of what were essentially the same physical disk but with pre-formatting for the particular brand of PC owned by the customer. A disk formatted for use in the Mac could not be used in an IBM compatible PC. While the disk was the same in both cases, the layout of the data on the disk was not.

Clearly, this represents only limited value to the library community. Without a common way of formatting the RFID tag, there is no interoperability at the tag level. If neighbouring library organisations wanted to enter into a cooperative arrangement with some of their collections but had different RFID vendors, they would not be able to read each other's ISO standard RFID-tagged library material. It could, in fact, be argued that this situation offers a reduced level of interoperability than existed with the lower-tech barcode solutions from which the two libraries migrated. At least in the barcode scenario, while the individual items might not exist on the database of the neighbour library, it is likely that the barcodes could be read by either library, permitting temporary records to be established if desired.

Fig. 1 summarises the current state:

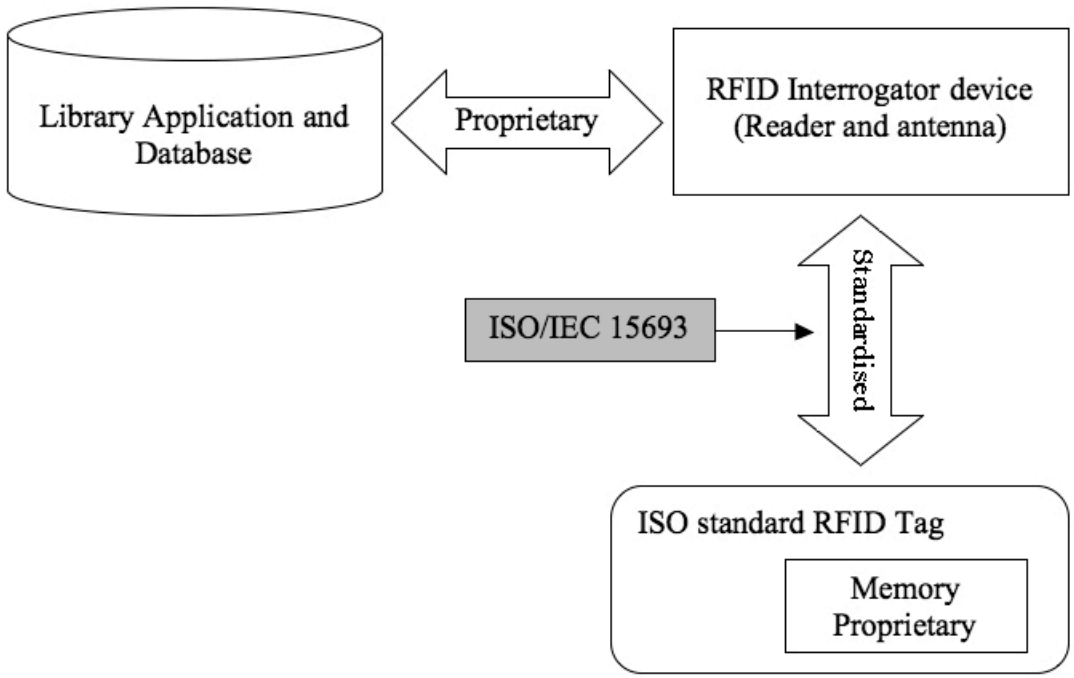

Figure 1. Standards - current state

Fig. 1 indicates that the data exchange between the library's application system and database and the RFID equipment such as hand-held readers or

security gates is proprietary. The connection for this data exchange would normally be a wired one. The diagram also shows that across the “air interface” between the RFID equipment and the RFID tag, the data exchange is standardised according to ISO/IEC 15693 or ISO/IEC 18000-3 Mode 1 as discussed earlier. However, the data in the RFID tag’s memory is formatted by each vendor in a proprietary fashion.

3. The Standards Australia IT-19-01-02 Working group

The situation outlined above is of concern to libraries (and to some library vendors) around the world. Independently, several groups have formed to consider what sort of standardised data format could be developed for RFID tags used within library materials. Some of these groups (NBLC, 2004) aimed to develop a national standard while others set their sights more broadly (RFID 2005). At the time of writing, a proposal from Denmark has been accepted as a national standard and the intention is to offer it as a foundation for an international standard. All of the groups sought to address the same issue; How can interoperability be achieved at the tag level between cooperating institutions?

During 2005, an Australian working group consisting of library and publishing professionals as well as vendor experts was established under the auspices of Standards Australia to examine this same question. To ensure that the group was adequately resourced, 3M Australia generously offered to sponsor the time of Alan Butters (the author), an independent technology consultant and the chairperson of the working group. The first meeting of the working group was held in September 2005, the members of the group being:

- Alan Butters – Principal Consultant – Sybis (Chair)
- Brian Dunne – Senior Technical Specialist – 3M Australia Pty Ltd
- Jan Wild – Sales Manager ANZ – DA Library Technologies (Bibliotheca)
- Craig Anderson – Director, University Library – RMIT University
- Peter Dart – Information Services Director – Pearson Australia Group
- Christine Mackenzie – Chief Executive Officer – Yarra Plenty Regional Library
- Lynn Regan – Manager, Library Services – Baulkham Hills Shire Council
- Leona Jennings – Coordinator, Library Services Management Projects – Gold Coast City Council
- Janifer Gatenby – New Busines Development Manager – OCLC PICA (corresponding member)

Between them the members of the working group have a great deal of experience within the library and publishing sectors, spanning both the vendor and library professional communities. Within the group there exists RFID technical expertise, standards development expertise, project management expertise, library senior management experience, product development experience etc. Members also have strong links into library professional organisations such as ALIA and VALA.

The group has met several times and at the time of writing is in the process of compiling its conclusions into a formal document to be published on the Standards Australia website. Details to be announced at the conference.

To understand the conclusions drawn by the working group and the resulting proposal developed, it is necessary to provide an overview of the possible approaches to the task.

3.1 Possible tag data-models

The proposal for a standard method to store library information on an RFID tag is referred to as a tag data-model proposal. The proposal must specify things such as:

- What data will be stored on each RFID tag
- What data will be mandatory and what will be optional
- The nature of the data fields – ie fixed or variable etc
- How the data will laid out in the RFID tag's memory
- How the data might be encoded
- How tag-based security will be accomplished

While a variety of proposals are possible, as a general statement tag data-models fall into two categories; Prescriptive and Non prescriptive.

A prescriptive model could be characterised as one mandating (with very limited options) which data elements are to be used on the RFID tag. Typically these models include a mandatory set of data elements that must be present on every tag and then optional blocks of further elements which might be included at the discretion of the individual institution. The data elements must be accepted as "packages" of elements with no ability to vary the contents of each package. The Danish data-model proposal (RFID, 2005) is one such example and contains a mandatory block with eight data elements, an optional block with a further seven data elements and an optional unstructured block for local use. The NBLC proposal from The Netherlands (NBLC, 2004) is also a prescriptive data model.

Experience would suggest that one of the failures of a prescriptive architecture is the difficulty in gaining agreement from the total population of users as to exactly which data elements should be included. While such consensus might be possible within a single country, the task becomes extremely difficult when applying the prescriptive model on a global basis across all library sectors. As an example of this difficulty, the Finnish data-model proposal is identical to the Danish model but with the addition of one field and a prohibition on using certain fields in the optional block. So, prescription begets more prescription with each new "version" of the standard undermining the very reason that brought the standard into being originally.

Also, with the current level of concern regarding privacy issues and RFID, particularly in the United States of America, some commentators are calling for the absolute minimum of data to be stored on the RFID tag (Ayre, 2005).

Obviously, a prescriptive model with a large mandatory block containing eight data elements would not be suitable in this context.

Fig. 2 summarises the situation with a prescriptive model in place:

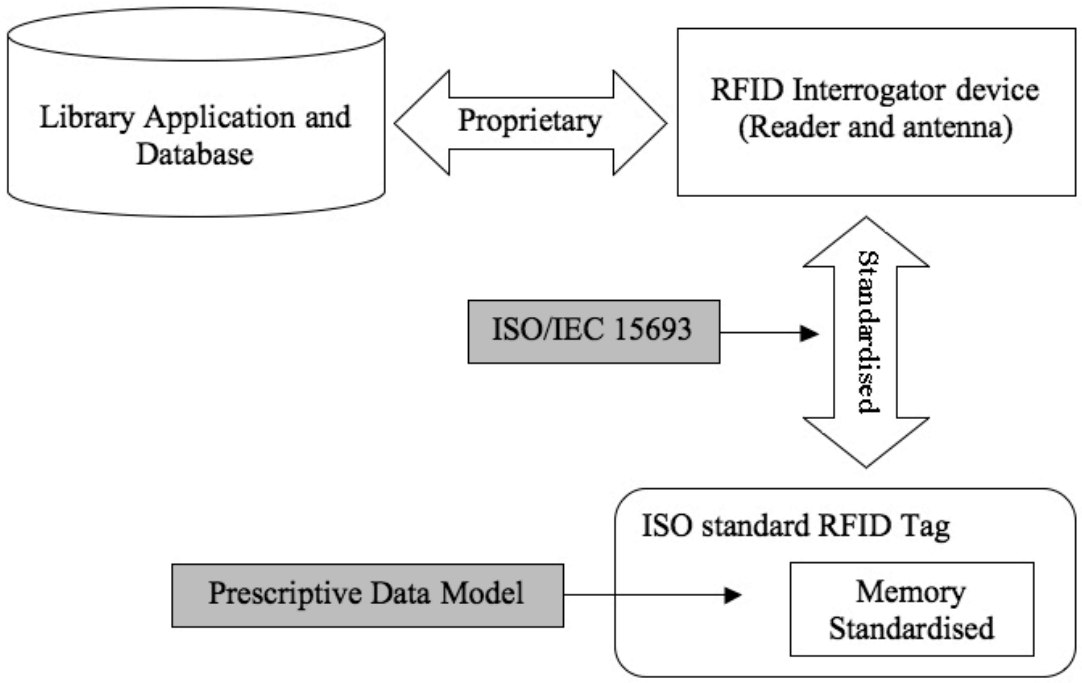

Figure 2. Standards – prescriptive model state

A solution to the problems associated with prescriptive models is available in the form of a non-prescriptive model. Such a model has only one mandatory data element (the primary item identifier) with every other element being optional. Thus individual institutions may choose the data elements to include based on their needs and the level of interoperability required. For example, all institutions wanting to engage in Inter-Library Loans (ILL) would choose to include the appropriate data elements and these would be standardised and readable at any other RFID equipped ILL library. Essentially, each library (or library sector) is able to construct a set of data elements that suit their own purposes. Once chosen, the elements are stored within the RFID tag in a standardised way, enabling all other systems to be aware of what elements exist on the tag and to read them correctly.

In addition to achieving this non-prescriptive flexibility, the working group also examined the possibility of achieving this end by means of standards which, in the long term, might move the library community toward the Utopia of complete interoperability at all levels. In this context, a paper by Paul Chartier, a consultant from Praxis Consultants and associated with the British standards body proved to be extremely helpful (Chartier, 2006).

4. The proposal of the Working Group

Broadly, the working group proposes a data model generated by the use of two additional standards implemented at a higher level in the RFID systems architecture. These standards are already existing and used in other RFID application areas. The standards are:

- ISO/IEC 15961
- ISO/IEC 15962

While a detailed description of these standards is outside the scope of this paper, essentially they are employed together to create an object oriented data structure on the tag which is standards based, flexible, and space-efficient. Individual libraries or library sectors would be free to adopt data objects from a detailed list to incorporate within their RFID tags based on their requirements and the memory available in their selected tags. When fully implemented, this proposal would have the additional value of introducing standards at higher layers within the RFID communications architecture which will serve to provide true interoperability at the RFID component level as well as the tag level.

Many libraries have demonstrated a desire to use the RFID tag attached to the library material as a security device in addition to the duty it serves as an item identifier. The working group considered several ways that this might be accomplished while still permitting libraries who wished to combine ElectroMagnetic (EM) security strips for item security to do so. A detailed description may be found in the proposal of the working group but essentially the solution selected involves the use of the Application Family Identifier (AFI) contained within the system part of the RFID tag. This method has the additional benefit of ensuring that library items identified with RFID tags are recognised as such in other non-library RFID application areas employing the same standards.

Fig. 3 summarises the ultimate state:

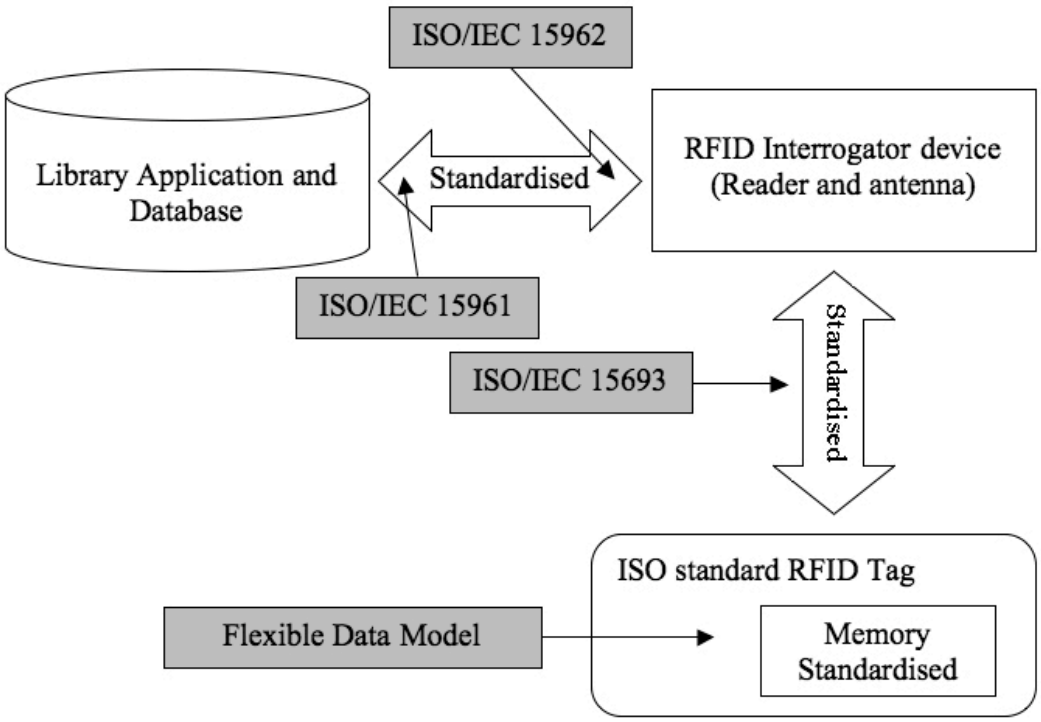

Figure 3. Standards – ultimate state

Fig. 3 indicates that the data exchange between the library's application system and database and the RFID equipment such as hand-held readers or security gates is now standardised according to ISO/IEC 15961 and ISO/IEC 15962. The connection for this data exchange would normally be a wired one. The diagram also shows that across the "air interface" between the RFID equipment and the RFID tag, the data exchange is standardised according to ISO/IEC 15693 or ISO/IEC 18000-3 Mode 1 as discussed earlier. The data in the RFID tag's memory (the selected data objects) are formatted according to rules specified by ISO/IEC 15961 and ISO/IEC 15962. This is an outcome that brings libraries much closer to the RFID Utopia mentioned at the outset.

The proposal generated by the working group suggests appropriate data objects and their format for use in the data-model as well as a suitable method of employing tag-based security for libraries who wish to do so. If the concept behind the proposal is accepted as a sound basis on which to proceed, the actual list of data objects and their structure can be refined by a broadly consultative process.

4.1 Implementation phases of the working group's proposal

In its deliberations, the working group was also sensitive to the commercial needs of library RFID vendors. Not all vendors may be ready to embrace the complete interoperability conferred by a total implementation of the two new

standards referred to. Accordingly, the working group will propose a two-stage implementation plan:

Stage one would be an implementation sufficient that the tag data structure fully conforms to the standards but without requiring the vendor to implement the standards at the application layer ie, between the RFID interrogator equipment and the library application and database.

Stage two would be a complete implementation at all levels and is shown diagrammatically in Fig 3. At this time the full benefit of the standards would be realised leaving competition in the RFID market to occur along the lines of features and benefits.

4.2 Next steps

At the time of writing (June 2006) No decision had yet been made regarding an appropriate RFID tag data-model to form the basis for an international standard. The Danish data-model proposal has been submitted as a suitable model for internationalisation. While acknowledging the work done by the Danish working group, The Standards Australia IT-019-01-02 working group does not consider the Danish data-model to be an appropriate architecture for an international standard for libraries, for reasons outlined earlier.

A committee under ISO TC-46 will consider the proposal of the Australian working group as well as other international input before making a decision. At the time of writing no timeframe for this decision has been set. Much will depend on the level of debate surrounding proposed models.

5. Conclusion

This paper has demonstrated that, while standardising the RFID tag data-model is important to the Australian (and indeed, global) library community, there exists a way to accomplish this goal while at the same time avoiding the pitfalls associated with prescriptive models and at the same time laying a standards based foundation for an open-architecture future.

The paper has shown that the commercial sensitivities of library RFID vendors do not have to be compromised in order to realise immediate benefits in the form of a standardised tag data-model. The timing of the complete adoption of the standards referred to in the text can be the subject for further discussion between individual library organisations, library professional bodies and vendor organisations.

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