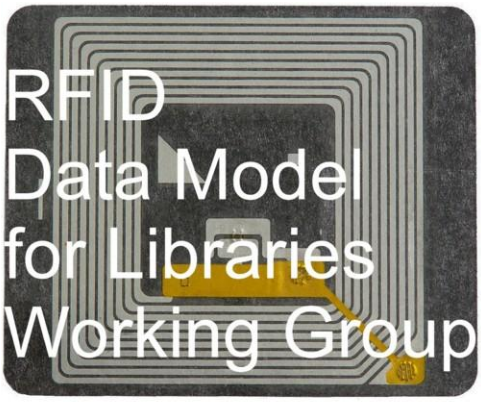
RFID Data Model for Libraries



Finnish Data Model

Finnish Libraries' RFID Working Group

Based on the document prepared by the Danish
RFID Data Model for Libraries Working Group

Final document – November 24 2005
Status: Public

RFID Data model for libraries

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Table of contents

Summary

Please note that in this and subsequent chapters, all Finnish modifications are marked with bold & italics.

This report is an edited version of the text published by the Danish RFID Data model for libraries working group. The Danish working group was established in November 2004 and affiliated to Danish Standard S24/u4 in cooperation with the RFID vendors on the Danish library scene. The purpose was to establish an RFID Data Model for the Danish market with a view to providing the background for international initiatives in standardisation for libraries.

The organisations behind the working group are:
3M Germany.
Axiell Bibliotek AB.
Bibliotheca RFID Library Systems AG.
Dantek A/S.
DBC medier.
Draupnir.
Codeco.
FKI Logistex A/S.
P.V. Supa Oy Ltd.
Tagsys.
TagVision.
Tårnby Kommunebiblioteker.
Hein Information Tools

The data model proposal report consists of three parts plus annexes:

Part 1 contains background information, formalities and progress of the work.

Part 2 outlines the principal demands for a data model and presents the discussion on choices and options to consider and the conclusions. There is the selection of data elements to be included and the construction of mandatory and optional elements. Important conclusions are the standards background in the ISO/IEC 18000 family with the choice of the 13.56 MHz frequency. The rest of the work is based on the ISO/IEC 15961-63 standards. For encoding UTF-8 is specified. The data model does not cover security issues. There is a discussion on usage of AFI. However, this issue is still open.

Part 3 is the detailed data model defining data elements, the structure of data elements, encoding and value range. The complete structure for RFID tags for library usage including encoding and check facilities.

It is detailed almost to the programmer's level. This is done to achieve clarity and to avoid ambiguities.

Summary to the Finnish version of the document

The Finnish Libraries' RFID working group was established in spring 2005. The plan was to evaluate existing standards and recommendations, and use these as the starting point. After the evaluation the group agreed to build the Finnish data model using the brilliant work done in Denmark as the starting point.

Key differences between the Finnish and Danish specification are the following:

1. ***Request to write protect the mandatory data elements in order to improve security.***
2. ***Request to use neither the alternate item ID nor extended owner library since these data elements are not write protected, due to being located in the (non-write protected) structured extension data blocks.***
3. ***Recommendation to limit the utilisation of Type of usage –code.***
4. ***Recommendation to store MARC media type code into unstructured extension data block 101.***

This specification is maintained by the Helsinki University Library – The National Library of Finland. The national library is also the national ISIL agency starting 2006.

Part 1 - Introduction

1.1 Intro

The ever more intense interest in massive introduction of library applications facilitating usage of RFID tags has placed libraries and vendor in a position where the absence of common standards is a serious obstacle. Without common standards both libraries and vendors are running risks of introducing proprietary solutions without perspectives or security for life span or for costs. The purpose of this work is to provide a data model which will be useful in present day libraries, however, the structure shall be open for the future.

1.2 Scope

The scope of *the RFID Data model for libraries working group* is to set up a data model for the content of RFID tags to be used in library applications.

It is envisaged that the data model shall be in 3 parts:

A mandatory part
A structured extension part
A nonstructured extension part

The data model shall also deal with the following issues:

The RFID tag in security systems
The relation between a library data model and other application areas

The data model will appear as a data structure and its encoding format.

The data model shall be applicable in Finnish Libraries. At the same time the approach shall be so broad that international aspects are taken into consideration.

The result of the work will be submitted to Tietohuoltokomitea, SFS committee representing ISO TC 46 developing national information & documentation standards. When approved by the committee it will be published as a common understanding and submitted to relevant parties in Finland, in the ISO system and elsewhere.

1.3 Background

In 2005 Finnish libraries already have some experiences from using RFID technologies. Two largest domestic library system vendors support usage of RFIDs, and three pilot libraries (two public libraries using Origo and Pallas systems, one special library and one polytechnics library using Voyager) have started utilisation of these features. But most libraries have postponed RFID implementation projects for the time being. Therefore December 2005 is a good time to publish a data model; most Finnish libraries can benefit from the specification, and do not need to change their existing systems in order to do this.

Compared with the pioneers Finnish libraries are starting RFID work a bit later. Especially in Denmark there has been active interest towards both standardisation and practical implementation to RFID technology. Another pioneering country is the Netherlands.

Examples of Danish libraries using RFID:

The municipal library in Silkeborg, Denmark started an RFID development several years ago. This was sponsored externally and regarded as a test bed. It is now regarded as a regular daily system. See: http://www.silkeborg.bib.dk/eng/ (English text)

The municipal library in Lyngby, Denmark started an rfid application at the end of 2004. At present it is a composite system as part of the stock is still using barcode. See: http://www.lyngbybib.dk/show.asp?id=222 (English text)

Other Danish libraries were initiating RFID applications in summer 2005.

Several libraries both in Denmark and in Finland have made contracts with vendors on the conditions that the systems installed shall comply with the data model from the working group. With the new interest in RFID in libraries, especially in the Unites States, it has been discussed in ISO if the time had come to consider standardisation in the area.

Bringing home information on this interest Danish Standard S24u4 decided in the spring of 2004 to restart work on the subject. S24u4 established a working group consisting of three of its own members:

- Leif Andresen, Biblioteksstyrelsen/Danish National Library Authority,
- Morten Hein, Hein Information Tools and
- Tommy Schomacker, Dansk BiblioteksCenter.

The working group decided that instead of starting with a data model it would be more appropriate to make scenarios for the utilisation of RFID technology. A report was published in September 2004 in Danish with English abstract. View http://www.ds.dk/2567,1

The Danish National Library Authority set 5 objectives for usage of RFID in Danish libraries:

- For inter library loan safeguarding an RFID tag from one library shall be readable and usable in other libraries
- An RFID application shall have a standardised interface to any library system
- To ensure independence of suppliers RFID tags shall be available from several sources
- To ensure backwards compatibility RFID tags shall use the same identification numbers as used on present barcode systems
- Danish library RFID applications shall comply with existing international standards.

These objectives were relevant to Finland as well, but in addition we wanted to make sure that RFID technology is implemented in a safe way. This led to the following recommendation:

- ***In order to improve safety and reliability of RFID utilisation, critical information on the tag should be write protected.***

1.4 The Danish ***and Finnish*** working group***s***

At a meeting on November 16, 2004 Danish Standard represented by the secretariat and members of S24/u4 had invited all known potential suppliers of RFID solutions for the Danish Library market. Danish Standard presented the document on Scenarios in RFID applications and asked the participants if the way ahead could be a working group representing the suppliers for the purpose of making a proposal for a data model for library RFID applications.

The participants agreed that a working group would be a step forward towards standardisation and were of the opinion that this would be beneficial for libraries and suppliers. It was a common understanding that a document resulting from a successful piece of work should be approved by Danish Standard and subsequently published as a technical report. In Danish Standard terminology this will be a 'DS Inf' publication.

The RFID Data model for libraries working group was established. Due to the international participation in the work it was decided that the working language should be English. Invitations were made to join the working group.

The RFID Data model for libraries working group has the following members:

Wolfgang Friedrichs, 3M Germany.
Anders Bjurnemark, Axiell Bibliotek AB.
Gregor Hotz, Bibliotheca RFID Library Systems AG.
Henrik K. Jensen, Bibliotheca RFID Library Systems AG.
Henrik Dahl, Dantek A/S.
Carsten H. Andersen, DBC medier.
Kaj Frøling, Draupnir.
Jan Didriksen, Codeco.
Ian Koch, Codeco.
Dennis Sørensen, FKI Logistex A/S.
Ivar Thyssen, P.V. Supa Oy Ltd.
Pierre Matignon, Tagsys.
Alastair McArthur, Tagsys.
Ole Sundø, TagVision.
Henrik Wendt, Tårnby Kommunebiblioteker.
Morten Hein, Hein Information Tools (chairman).

In Finland, RFID data model development was launched on request of the two domestic library system vendors which had already implemented RFID. The Finnish working group was co-ordinated by Helsinki University Library and consisted of the following people:

- ***Juha Hakala, Helsinki University Library (chairman)***
- ***Riitta Ikonen, Laurea Polytechnic Library***
- ***Esa Kurki, Helsinki University Library***

- ***Riitta Lehtinen, HelMet Libraries***
- ***Seppo Lindström, TietoEnator Libraries Oy***
- ***Janne Rouhiainen, Akateeminen Tietopalvelu ATP Oy***
- ***Pauli Tossavainen, ToP Tunniste Oy***
- ***Saku Tuominen, AB Axiell Oy***
- ***Juha Veijalainen, BTJ Kirjastopalvelu Oy***

The Finnish working group wishes to express its gratitude for the Danish colleagues who have developed a very useful and high-quality specification, and then made it available for everyone for free. We look forward to further co-operation with the Danish RFID experts in creating future versions of this data model.

1.5 Work method and editorial information

The Danish working group has had 4 meetings: On December 9, 2004 and on February 1, 2005. On March 1, 2005 and on April 13, 2005. All meetings were held at Tårnby Municipal Library. Kastrup, Denmark.

Between meetings and after there has been a comprehensive digital communication between the members of the working group.

The report document is a collective effort of the working group. All members have made drafts and written comments. Henrik K. Jensen, Bibliotheca, has been drafting Part 3.

Morten Hein has been the overall editor.

The Finnish working group met also four times, during the latter half of 2005. All meetings were held in the Helsinki University Library. All the changes to the Danish data model were discussed and approved by all group members. Pauli Tossavainen reviewed the Danish specification from the technical point of view. Juha Hakala was the editor of the Finnish text.

1.6 Basic standards

The data model for library applications is based on or related to the following standards:

International standards:

ISO 3166-1:1997 Information and Documentation. Codes for the representation of names of countries and their subdivisions - Part 1: Country codes
Origin: ISO/TC 46/WG 2

ISO/IEC 10646:2003 Information technology -- Universal Multiple-Octet Coded Character Set (UCS) Amendment 2, 1996: Annex R (normative): UCS Transformation Format 8 (UTF-8)
Origin: JTC 1/SC 2

ISO 15511:2003 Information and documentation -- International Standard Identifier for Libraries and Related Organizations (ISIL)
Origin: ISO/TC 46/SC 4;

ISO/IEC 15961:2004 Information technology -- Radio frequency identification (RFID) for item management -- Data protocol: application interface
Origin: ISO/IEC/JTC 1/SC 31

ISO/IEC 15962:2004 Information technology -- Radio frequency identification (RFID) for item management -- Data protocol: data encoding rules and logical memory functions
Origin: ISO/IEC/JTC 1/SC 31

ISO/IEC 15963:2004 Information technology -- Radio frequency identification for item management -- Unique identification for RFID tags
Origin: ISO/IEC/JTC 1/SC 31;

ISO/IEC 18000 Information Technology AIDC Techniques-RFID for Item Management - Air Interface:
18000-1 Part 1 – Generic Parameters for the Air Interface for Globally Accepted Frequencies
18000-3 Part 3 – Parameters for Air Interface Communications at 13.56 MHz
Origin: ISO/IEC/JTC 1/SC31/WG4/SG3

US standard:

ANSI/NISO Z39.83 - 2002 Circulation Interchange
Part 1: Protocol (NCIP)
Part 2: Protocol Implementation

Proprietary company standard:

3M Standard Interchange Protocol (SIP)

Part 2 - Discussion on the data model

2.1 Different approaches to a data model

It has been recognised that a data model for library usage of RFID tags will have four main headings: Data elements, Values and range, Encoding and Physical mapping. This is necessary due to the complexity of the technology.

A data model can be constructed according to several principles:

At one end of the spectre there is the 'One model for all purposes'. This model shall be simple and open for any type of usage. This broad variety of usage can be difficult to determine in advance.

At the other end of the spectre is 'The open model' that can vary and be differently introduced from one library community to another library community. In this case there would be a need for identifiers for each version and also a need for a registration authority to keep track of different versions so that a vendor can learn what model to apply for what market. This provides flexibility in the one hand but also bureaucracy on the other.

The aim of the working group is to launch a 'One model for all purposes', a data model that can work anywhere without local modifications. The structure of mandatory and optional parts is an example of this principle.

It can be added that even with this objective no model will last for ever. Therefore a version identifier will be in the meta data part.

2.2 Data elements

This is the core part. Which data elements shall be present and for which purpose. Data elements can be identified in two dimensions: Content categories and the categories of mandatory usage or less formalised extensions. This can be expressed in a matrix:

	Mandatory part	Structured extension	Nonstructured extension
Meta data elements			
Item data elements			
Library data elements			

Application data elements			
Supplier data elements			

Apart from the structure the working group has been focusing on data elements in the mandatory part but also in the structured extension. Furthermore encoding values and ranges have been carefully examined.

Mandatory data elements must be write protected. The purpose of this is to prevent malicious or accidental changes to this data.

2.3 Value and range

For each data element the representation for the element has to be defined. Furthermore the range of values shall be determined.

Mandatory data elements

Standard version
Even the best model will be changed or amended after a period of time. The first version of the ISBN lasted more than 30 years. Only very few issues will in future have a version life span of that length. To ensure compatibility between the first and later versions a version number is introduced as a data element.

Type of usage
An RFID tag will either be identifying a media housed in a library or a person using a library.

This data model is only covering the media handling in a library. To ensure interoperability in libraries using RFID tags for person ID part of the capacity in this field is left open for person ID. Those using person ID options should respect the standard version above and identify eventual other changes in person ID systems later in their data model.

Inside the media range examples can be given on specified usage:

- In acquisition: Item has not been entered into the library inventory yet. It can not be circulated.
- Item for circulation:
- Item not for circulation:
- Discarded item. Item is discarded and permanently removed from circulation.

Number of parts in item
'Number of parts in item' is used for media package handling. 'Number of parts in item' does tell the number of Transponders (RFID tags)/parts in a media package.
Ordinal part number
'Ordinal part number' is used for media package handling. 'Ordinal part number' identifies the RFID tag at each item in a media package or the only one tag for a package.

There is a general tendency to produce circulation items containing more than one part. Examples of this include a CD with a booklet, a double CD, a book containing a CD ROM and a piece of plastic as a template for something. This has always been an added complexity in a circulation department. With self service devices this is only handled with a limited security in bar code based application. This issue may be the decisive element for changing to RFID based applications.

For each of these elements one byte is set aside. This gives a possibility to control a media package of 256 elements. This could be observed as an overdoing. However, the more simple solution of half a byte gives only an option of 16 elements. Several vendors are close to that limit already.

Primary item ID
The primary item ID is a unique identification of an item in the library. This will typically be a transfer of the ID that today is on the bar code.

The primary ID is specified to a maximum of 16 characters. The length of 16 characters is based on the experience of the members of the working group. An example of a bar code system using 27 characters has been found. Therefore a method for long IDs can be found in the data model in Part 3.

Cyclic Redundancy Check (CRC)
To ensure safety in reading a data element of selfchecking is introduced. This is specified as a 16 bit CRC for the mandatory starting block. The CRC itself is excluded from this calculation.

The CRC is a very powerful but easily implemented technique to obtain data reliability. The CRC technique is used to protect blocks of data called Frames. Using this technique, the transmitter appends an extra n- bit sequence to every frame called Frame Check Sequence (FCS). The FCS holds redundant information about the frame that helps the transmitter detect errors in the frame. The CRC is one of the most used techniques for error detection in data communications and has the following qualities:

- High error detection capabilities.
- Little overhead.
- Ease of implementation.

See an example of CRC calculations in Annex D: Example of CRC calculations

Country of Owner library
Two-character country code as specified in ISO 3166-1 Alpha-2.

Owner library
A code for owner library as specified in the ISIL code (ISO 15511 International Standard Identifier for Libraries and Related Organizations).

Together *Country of Owner* library and *Owner library* is identical to ISIL. For the purpose of this data model it has been found desirable to split the two elements and to omit the hyphen. The combined data elements can hold any ISIL. Libraries with a short ISIL can cut 2 bytes in the ”Library Identifier” part. This gives an option for using an RFID tag with a maximum user area length of 32 bytes. See details in Part 3. This will give a considerable economic saving and might be an option in a mass conversion at the introduction of RFID applications.

This field can be either 11 or 9 bytes long, depending on the tag.

Despite the advantages of the ISIL standard it can be observed that it is rather recent and at present only adapted by 8 countries. Even if more countries must be expected to adopt the ISIL standard in the near future it will be necessary in the data model to make provisions for libraries without ISIL codes. For this purpose a prefix byte is added to the identifier. This allows 10 or 8 bytes for the identification code.

In Finland, Helsinki University Library will set up the ISIL National Agency during 2006. The library will assist other Finnish libraries and related organisations in ISIL usage.

Structured extension data blocks

Media format
Description of the item type. It should be observed that ‘media format’ is not the media description known from bibliographic formats. The purpose is mainly to assist sorting robots and similar equipment in an off line situation. The object is to secure that light and vulnerable items are not damaged by heavier items or exposed to unsafe conditions.

The range of values reflects this: Undefined. Book. CD/DVD/etc. Magnetic tape (Video or music).Other. Other, careful handling is required. Very small item, special handling may be required with sorting equipment.

Please note that according to the Finnish specification, MARC media type code should be stored at unstructured extension data block 101.

Alternate item ID
An alternate ID code for the item or used as the primary ID code when it is longer than 16 characters.

Since alternate item ID is on non-write protected area, Finnish libraries must not use this data block.

Extended owner library
This field is used for long “owner library” codes.

Since extended owner library code is on non-write protected area, Finnish libraries must not use this data block. Helsinki University Library will not assign any ISILs that exceed the maximum length of the primary item ID; thus there should be no need to use this code.

Supplier ID
Media supplier identification. Decided by the library and the supplier.

Item identification
An item identification, decided by the library and the supplier. This number can be removed before the item goes into circulation to save space in the tag. Maybe this will also be necessary according to demands from data protection agencies.

Order number
An order number for the item. Decided by the library and the supplier.

Invoice number
An invoice number for the item

The optional data elements:

- Supplier ID
- Item identification
- Order number
- Invoice number

are related to assist the process between an item supplier and the library. It can be foreseen that some media suppliers wish to extend their services so that supplied media are ready-made with RFID tags pre-written with data on an agreement with the library. At the same time data from the supplier can assist the acquisition process in the library and also the accounting checking in the library. The supplier can also benefit by using the data in an automated storage and packing facility.

The data elements can later be overwritten to save space and maybe for reasons put forward by data protection agencies. However, the supplier ID could be preserved in case of later complaints.

Unstructured extension data blocks

For obvious reasons nothing is specified about the contents of the unstructured data blocks ***in the Danish data model.*** This can be controlled by either the vendor or the library. ***In the Finnish data model, there may be one or more defined data blocks in this area. The reason for using unstructured extension data blocks is interoperability with the applications based on the Danish data model.***

In this version of the Finnish specification, block 101 is reserved for MARC media type –code. Other blocks may be reserved in the future. Helsinki University Library will control these blocks, and any suggestions for new data elements to be added should be sent to the library's KATVE (http://www.lib.helsinki.fi/katve/) working group.

2.4 Encoding

The encoding of RFID tags is a delicate job. The space available in a tag is still rather limited for the cost-conscious buyer and vendor. The encoding issue may be the most pertinent for a successful data model.

Three factors can be observed as important

- There are no general guidelines in the present set of generic standards on how to introduce encoding
- The limited capacity of RFID tags call for rather compressed solutions
- To facilitate fast operation in the use of RFID tags a set of information shall physically be located at the same place in every tag.

See also Annex B: Empirical test results. Inventory Operation Performances versus Read Memory Size.

General on encoding

Several methods of high sophistication exist in encoding procedures. These methods will often end in a floating designation of data. This will not speed up reading and writing procedures.

The right solution will be a fixed length format with fixed length fields. This will create a certain surplus of space thereby asking for even more compressed coding formats to save space.

If a system is only dealing with one type of RFID tag encoding with a known structure there is no need of indicating where information is located in the tag. The system will know already. There will be the need of a tag identifier and a version number. This should be indication enough for the system. There will be no need for general format information in the tag. However, certain types of format information may be needed, see below.

Encoding format

A simple solution would be to observe everything as a string of characters. Knowing the character set identification it will be easy to read everything as character strings. This could be in character octets. However the space available is not positive for this format. With less than 400 bits available as user area this would give less than 50 characters altogether. It is open to discussion whether there is a need for more compressed formats to deal with the subject.

There are several options:

- Alpha character fields as octets. Numerical fields could be as character strings in half octets making room not only for decimal numbers but also for hexadecimal expressions.
- Alpha character fields as words with less number of bits. Here the choices are 7 bits words, 6 bits words and even 5 bit words.
- Numerical fields can be compressed more than half octets, however, as mentioned before this will usually be floating information that would slow down any system.

There is little indication that complex alphanumeric expressions will be the determining factor.

- Alphanumeric fields could be encoded in words of less than 8 bits.
- Numerical fields could be coded in 4 bit words.
- All fields of fixed lengths.

This could tempt several to introduce very compressed encoding to save space. The working group finds that some saving can be achieved by very compressed encoding but that this must be considered rather short-sighted.

To ensure a longer life span for the coming data model it is the opinion of the working group that coding principles shall follow practice from other application areas.

The conclusion is to use 8 bit encoding. In certain numeric expressions binary coding will be found appropriate.

The working group has had long discussions on whether to choose ISO 8859-1 or UTF-8. The conclusion is that UTF-8 should be the encoding format. This will serve well in countries using the Latin alphabet with a larger number of characters than the range of ISO 8859-1. Thereby the usefulness of the data model will be expanded beyond the basic part of the Latin alphabet.

Format information
Some types of format information will be needed. The data model is separated in different blocks. There will be starting and ending information.

There will also be the need for format check by check calculating algorithms. These shall be identified as well. The data model is open for extensions for several fields for content larger than the specified length. Here a certain format signal will indicate the handling of overflow.

2.5 Physical mapping

The working group has introduced the category 'Physical mapping'. Again the complexity of the RFID tag shows that the physical mapping and variation hereof can influence the efficiency in reading from a particular data model including its encoding.

Through the cooperation of three of the companies participating the working group has had a series of empirical tests made. The results of these tests have formed a solid suggestion for the physical mapping. The findings of these tests can be seen in Annex B: Empirical test results. Inventory Operation Performances versus Read Memory Size.

It can be observed that the technology is perfecting more and more but that areas are still to be improved. Therefore optimisation by the physical mapping of the tag is a method that will speed up operation and raise accuracy and is an issue worth while pursuing. This is reflected in the lay out of the data model.

2.6 Pre-requisites

2.6.1 Background standards

The data model for RFID applications in libraries is based on a number of international standards.

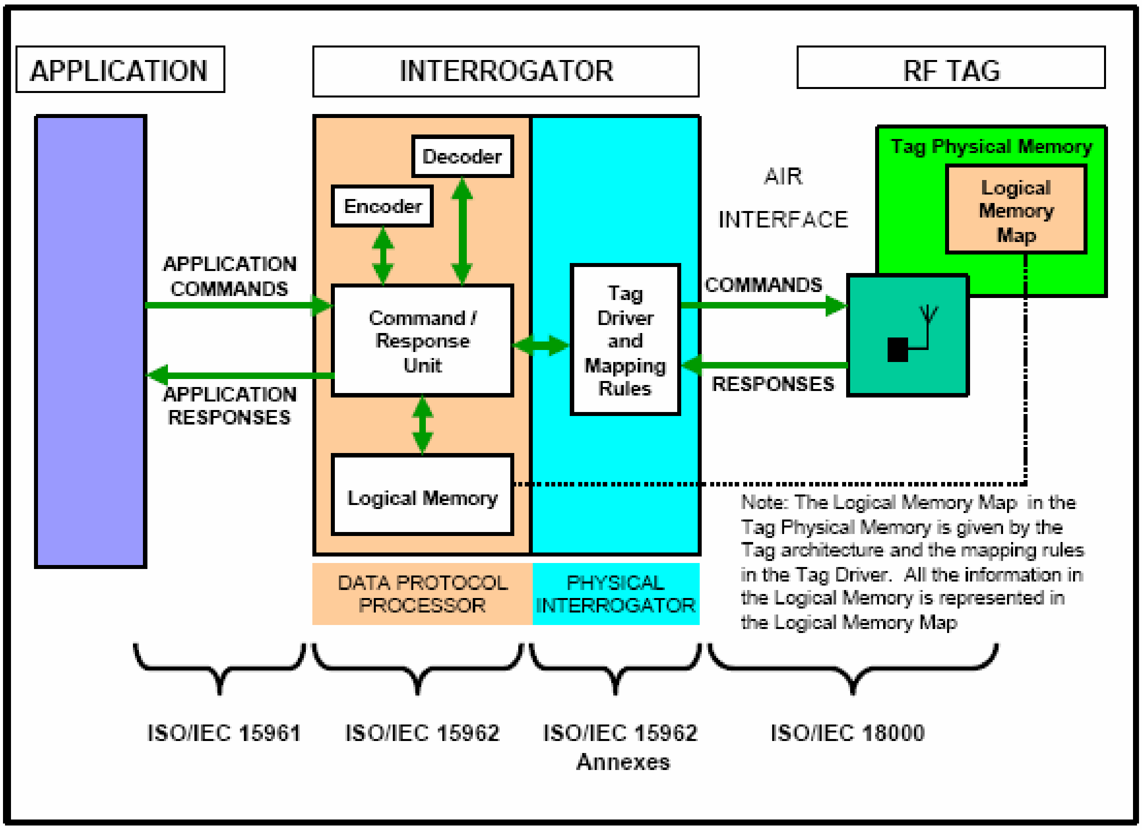
The working group had no doubts that concerning air interface the data model should rely on the ISO/IEC 18000 family of standards. Of this ISO/IEC18000-3 is selected as it specifies the appropriate choice of frequency: 13.56 MHz. See Annex A: Selection of RFID carrier frequency for library applications.

ISO/IEC 15961: Data protocol: application interface, ISO/IEC 15962 Data protocol: data encoding rules and logical memory functions and ISO/IEC 15963 Unique identification for RFID tags shall form the basis for the next step in the RFID library applications.

ISO 15511:2003 International Standard Identifier for Libraries and Related Organizations (ISIL) is selected for identifying libraries using RFID applications according to this data model.

2.6.2 Interface to ILS

In the generic standards a certain general structure is foreseen in RFID applications. It is necessary to see if this structure can be applied to library applications without any special considerations.

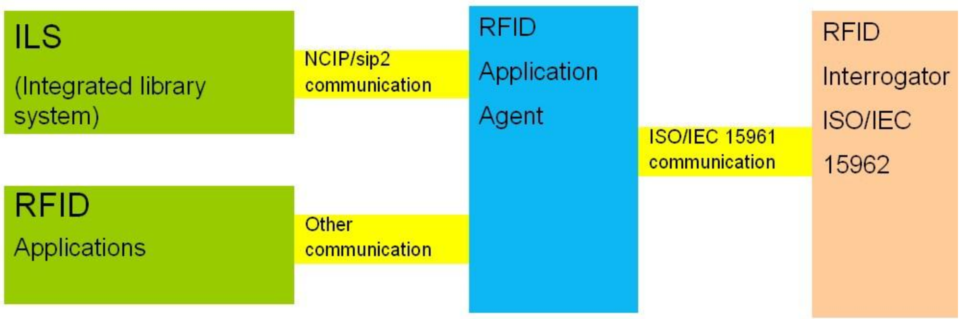


Logical functions and interfaces - as quoted from ISO/IEC 15961

ISO/IEC 15961 is covering the interface issue between the interrogator and the application. This will also be the case in library application. The interface could be detailed by two library application protocols widely used: 3M SIP 2 (Standard Interface Protocol, version 2) and NCIP (ANSI/NISO Z39.83 - 2002 Circulation Interchange). However, integrating RFID tag based applications to ILS (Integrated Library systems) brings a need for new design features as some of the functionality offered by RFID tag based systems and to be included in this data model are not supported by two recognised standards:

One example is the facility of keeping track of several entities in a common unit, e.g. a box set of CD's, an important feature in RFID tag based systems. This is not covered by the standards mentioned. At the same time the data necessary are not part of bibliographical formats or normally stored in databases in ILS systems. Other non-covered features can be observed as well.

Any suggestions for the integration of these features in the mentioned protocols are outside the scope of the data model. Some may wish this to be an unsettled issue as it could be an area of competition among several suppliers. One way of dealing with the issue could be to make an application agent that would communicate with the RFID application and then communicated with the ILS for transactions covered by the mentioned protocols and also communicated with an application controlling the functionality not covered by the protocols and the ILS.



The figure illustrates these considerations

2.6.3 Application Family Identifier - AFI

The ISO 15961-15963 standards specify the introduction of Application Family Identifier (AFI) for the purpose of identifying different application areas. This can be compared to the country code in an ISBN. The application specific AFI is a method also to avoid confusion if a person carries an item with an RFID tag from one application area into another application area. An example could be a library book brought into a supermarket. Under given conditions an RFID tag could be misinterpreted by another application area system.

The AFI is specified in the systems part of a tag according to the generic standards in this field.

Some security methods are also depending on the use of AFI or a pair of AFI's. See section 2.6.4.

The working group can endorse the concept of AFI to identify the library area. The working group has been seeking ways of having a pair of AFI specified for library usage. It has, however, not been possible to find ways to do so. There is not obvious address to go for a pair of AFI's. However, in the final editorial phase new information has been tabled.

The working group is concerned that this area is still unclear and might suggest that the existing standards are not yet sufficiently implemented to secure AFI as specified in the standards for an application area like libraries to have AFI allocated according to needs.

The working group has also made the observation that the space allocated to hold AFI in an RFID tag may be too narrowly specified so that the amount of AFIs possible is not sufficient to give world wide coverage of application areas.

To avoid problems with RFID systems used for other purposes the working group suggests that the AFI values for the library field are allocated.

As there is no mechanism found at present for handling AFI value allocation the working group urge everyone involved in standardisation in the libraries field to seek AFI values as soon as this is possible.

The Danish RFID data model defined two provisional Application Family Identifiers:

AFI value for "Checked out" items	0x9D
AFI value for "Checked in" items	0x9E.

We recommend that Finnish libraries and library system vendors utilise these AFIs until the official values are approved by ISO/IEC JTC1.

For more information, see Annex F. How to get an AFI.

The working group is confident that the result of its work will be the background for an international standard by ISO TC46. The appropriate body within ISO TC46 will seek a permanent solution in cooperation with the appropriate body within ISO/IEC/JTC1.

2.6.4 Security

RFID tags offer several methods for usage in security systems. Some are using the AFI for security. Other methods are also available.

The RFID suppliers are already deeply involved in using RFID technology for security. Therefore the library scene can not dictate one particular solution but will have to face the type of solutions generally offered by suppliers to all market segments.

For the time being there are two types of general solutions: Non AFI based methods and AFI based method.

Security of the data written on the tag was a major concern for the Finnish group. Although RFID tools are rare now, in the future this technology may be embedded into other gadgets, such as mobile phones. At that point, unless write protection is used, very large portion of library users will be able to change the data stored on RFID tags.

It is possible to make part or all of the data on the tag write protected; existing RFID implementations in Finnish libraries all use write protection. The Finnish RFID group decided to protect the mandatory data element with this technique.

The biggest downside of write protection is that if one or more of mandatory elements change in the next version of the RFID model, a new RFID tag has to be created for the resource in order to carry out a version update. Moreover, Type of usage –code may change over time (for example when the item is moved from reference to circulating collection) and this change can only be implemented by generating a new tag to the item.

The Finnish group concluded however that these shortcomings do not outweigh the benefit of securing the mandatory data on the RFID tag against malicious attacks or deletion or modification by mistake.

Non AFI based methods
There are at least three different approaches of such security systems on the market. The following EAS bit method is one of them:

The EAS bit method
The EAS bit security function on tags allows the RFID system to record a code on the tag, which will indicate whether or not a patron has checked out the item. When the patron walks through the security gate, the detection system checks this code. If the code indicates, "Checked out", nothing happens. If the code indicates, "Checked in", an alarm goes off.

This process of checking the code needs to occur rapidly, especially when multiple items are present. Generally, that means that you would not want the system to have to read the code on each individual tag because that could take too long if a patron was carrying several items.

An approach is to use a method that will result in tags only responding if the item has NOT been checked out. If no tag responds, there is no alarm. If even one tag responds with "not checked out", then there is an alarm.

There are a number of different ways to do this. Philips, for example, has "EAS bit" capability built into a portion of their tag memory. When a reader issues an "EAS" command, the tag responds if it has not been turned off properly.

It can be observed that the EAS command is not a required part of standard ISO 15693-3 and that it will not necessary be supported by all ISO 15693-3/ISO 18000-3 Mode 1 tags.

AFI method
Some other library vendors use a different tag function, called the AFI (Application Family Identifier) function. This function is commonly supported in ISO 15693-3 tags, as the AFI is a specified part of the standard.

There is the necessity of two AFI's for a security system. One value indicates "Checked out" another value indicates "Checked in". The typical functionality is as above: The system calls for tags with the AFI value "Checked in". If any responds then the alarm starts.

There is a location in the systems part of the memory in the tag to hold the AFI. The standard is not specifying too much about this method.

A general remark
New items arriving to the library from media vendors should - if they have active RFID tags mounted - the values for security should be set for "Checked in".

Conclusion
The working group has had discussions on the desirability of having a unique security method for a multitude of cooperating libraries. The conclusion is that this can not necessarily be achieved if each library has the freedom to choose a system from the range of suppliers without excluding suppliers with one or another method for security system.

It will be desirable that general AFI values are to identify the library sector. If such values are achieved they can be used for identifying the library sector. And they can also be used for security. Systems not using AFI for security should use the AFI value for "Checked out" to avoid confusion.

Apart from this security issues are a part of the RFID data model for libraries

2.6.5 RFID and privacy
Discussions are for the time being ongoing on the subject of RFID and privacy. This is outside the scope of this data model. The working group can however endorse the statement made by ALA - The American Library Association. At the same time the working group acknowledges the existence of data protection agencies in most countries. Any library and any supplier will have to comply with guidelines set up by such agencies.

See Annex C: ALA: Resolution on radio frequency identification (RFID) technology and privacy principles

2.7 Conclusion
A revised table filled with the conclusions from the previous paragraphs shows the conclusions of the many items discussed:

	Mandatory part	Structured extension	Non-structured extension
Meta data elements	*AFI* *Check method* *Standard version* *Type of usage*	*Check method*	*Not defined*
Item data elements	*Primary item ID* *Number of parts in item* *Ordinal part number*	*Alternative item ID*	*Not defined*
Library data elements	*Country of Owner library* *Owner library*	*Extended owner library*	*Not defined*
Application data elements	*None*	*Media format*	***MARC media type code (block 101)***
Supplier data elements	*None*	*Supplier ID* *Item identification* *Order number* *Invoice number*	*Not defined*

The empty model of principles in section 2.2 can be combined with the discussions and conclusions in section 2.3 - 2.5 into a new matrix giving a principal overview of the data model.

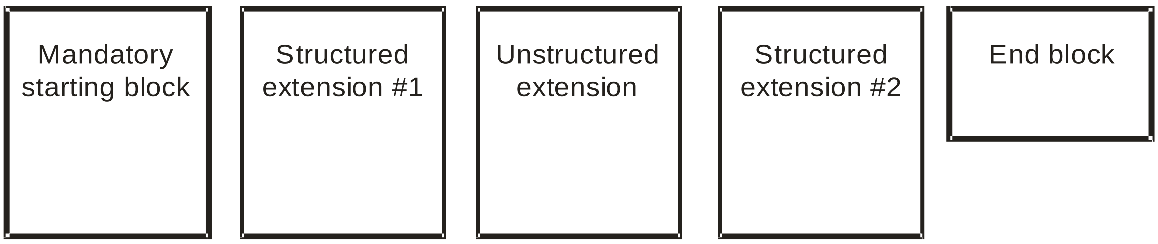
Part 3 - The Data Model proposal

This data model is the proposed normative content of this proposal and covers the user data area of the RFID tag and the AFI value. The data model can be used on tags with at least 32 bytes. The data model complies with the conclusions of the discussion in Part 2.

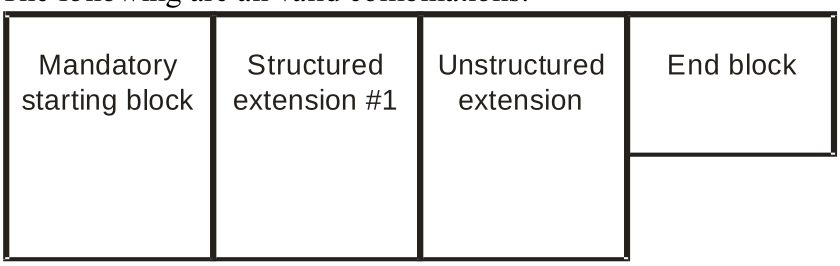
3.1 General structure

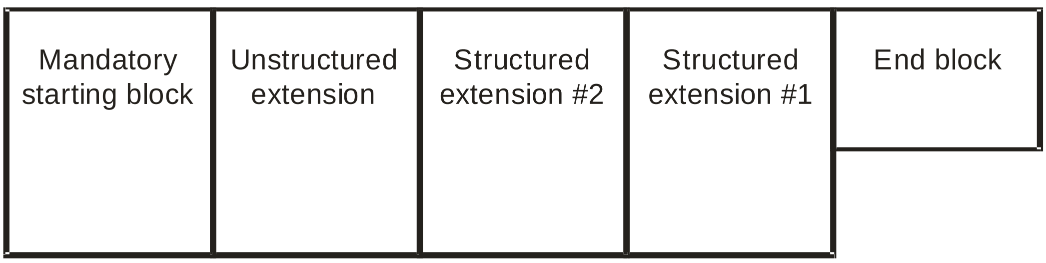
The data model is built with a mandatory starting block containing all the mandatory data of the data model, after this block optional data blocks can be placed up to the capacity of the chip.

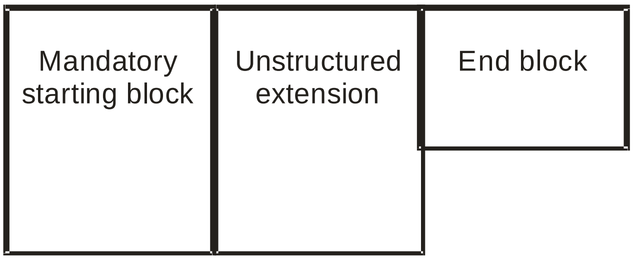
The optional data blocks use a common frame, this allows any application to get around any data block. The contents of each data block can be "structured extension", that any application can read or "unstructured extension" that can only be read by some applications (Library or vendor dependent). Using these blocks:

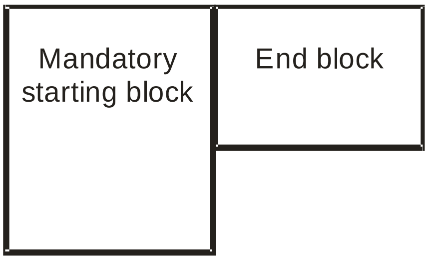


The following are all valid combinations:









Any application must be capable of reading all formats, but may not know how to decode the contents of the “Unstructured extension” or need the data in the “Structured extensions”. ***However any application supporting the Finnish data model should be able to utilise MARC media type code from unstructured extension block 101.***

The sequence of the data blocks may be optimized for the owner library. When new items are acquired by the library they may already contain a programmed tag. It is allowed to reprogram this tag, moving the data block to the best position for the library[1].

3.2 Mandatory starting block

3.2.1 Fields

3.2.1.1 Standard version

Description:

Version of this standard, the first version of the standard has number 1. This description will contain the Versioning number history.

Value:

1

Encoding:

4 bit unsigned integer.

---

[1] **Note: This is only allowed for own items, ILL items may not be reprogrammed (except when agreed upon with owner library).**

3.2.1.2 Type of usage

Description:

- Acquisition:
  Item has not been entered into the library inventory yet, it can not be circulated.

- Item for circulation:
  Any item for regular circulation.

- Item not for circulation:
  The patron must not be able to checkout these items (but may do a checkin).

- Discarded item:
  Item is discarded and permanently removed from circulation. It is recommended that security is in checked out state.

- Patron Card:
  Indicates that this RFID Transponder is a patron card.

Values:
The following values are assigned:

0: Acquisition
1: Item for circulation
2: Item not for circulation. The patron must not be able to checkout such items.
7: Discarded item, this item must not be circulated.
8: Patron Card

Encoding:

4 bit unsigned integer.

Please note that due to write protection of mandatory data elements it is not possible to change the value once it has been written on the tag.

Type of usage –information should normally be retrieved from the library system, and only if the connection from the circulation robot to the system is broken, the data on RFID tag could be used to confirm the circulation status of an item.

3.2.1.3 Number of parts in item

Description:

‘Number of parts in item’ and ‘Ordinal part number’ are used for media package handling. ‘Number of parts in item’ does tell the number of Transponders or parts in a media package.

Values:

The number of parts in this media package (See example below).

Encoding:
8 bit unsigned integer

3.2.1.4 Ordinal part number

Description:
'Number of parts in item' and 'Ordinal part number' are used for media package handling. 'Ordinal part number' does tell which number of Transponders this RFID tag is in a media package or that only one tag is used for the full package.

Values:
0: Only on RFID tag for the whole package. Verification that all parts are present is not supported by the RFID tag
>=1: the ordinal id of this RFID tag in the package. The number is unique among the RFID tags in the media package.

Encoding:
8 bit unsigned integer

Example 1:
A single item with one RFID tag:
"Number of parts in item" = 1
"Ordinal part number" = 1

Example 2:
A media package with 3 RFID tags will have the following numbers in the tag: an
"Number of parts in item" = 3 (in all 3 RFID tags)
"Ordinal part number" = 1 (in RFID tag 1)
"Ordinal part number" = 2 (in RFID tag 2)
"Ordinal part number" = 3 (in RFID tag 3)

Example 3:
A media package with 3 items but only one RFID tag.
"Number of parts in item" = 3
"Ordinal part number" = 0

This coding make it possible to display a message like:
"Media package, please verify that all n parts are present"

3.2.1.5 Primary item ID

Description:
The primary item id does identically identify the item in the library. This is in general the code that today is on the barcode.
This id code can be up to 16 characters long.
If the item id is too long for this field, it is possible to use an escape and place the primary item id in the "alternate item id" structured extension.

Encoding:

See “String encoding”.
If no primary item id is assigned (yet) all bytes are filled with chr(0).

If the first byte of the primary item id is chr(1), the item id is stored in the “alternate item id” structured extension.

3.2.1.6 CRC

Description:

A 16 bit CRC for the mandatory starting block. The CRC itself is excluded from this calculation.
The CRC is calculated using $x^{16} + x^{12} + x^5 + 1$ polynomial with hex(ffff) as start value.
This value must always be present.

The CRC will be calculated starting from the lowest address, first 19 bytes, then skipping the two CRC bytes, then 13 bytes for a total of 32 bytes (For chips with 32 data bytes only the last two bytes are assumed to be chr(0), see chapter 3.2.1.8 Owner library)'

Encoding:

Binary encoding with the lsb stored at the lowest memory location

Se an example of CRC calculations in Annex D.

3.2.1.7 Country of Owner library

Description:

Two character country code according to ISO3166-1. This standard specifies 7 bit characters and has to be converted.

Encoding:

See “String encoding”.

3.2.1.8 Owner library

Description:

Code for owner library, the ISIL code (International Standard Identifier for Libraries and Related Organizations ISO 15511) had been foreseen.

The ISIL is used without country code and the – delimiter, i.e. only the “Library identifier” part.

When used in libraries without ISIL codes a prefix byte (see Encoding) is added to the identifier. This only allows 10 or 8 bytes for the identification code.

This field can be either 11 or 9 bytes long, depending on the tag. When it is only 9 bytes long it is still treated as 11 bytes, but with the last two bytes as chr(0). It is very important for CRC calculations that the two missing bytes are included as two chr(0) in the calculation.

Encoding:

See “string encoding”.

If the first byte of “Owner library” is chr(1), the “Owner library” is stored in the “alternate item id” structured extension.

When using national standardized codes that are not part of ISIL, the code must be prefixed with chr(2)

When using library codes that are not standardized, the code must be prefixed with chr(3).

3.2.2 Chip layout of mandatory starting block

Offset	**Length**	**Field**
0 bit 0..3	4 bit	Version
0 bit 4..7	4 bit	Type of usage
1	1 byte	Parts in item
2	1 byte	Part number
3	16 bytes	Primary item id
19	2 bytes	CRC
21	2 bytes	Country of owner library
23	11 bytes or 9 bytes	Owner library
34 or 32		

3.2.3 Special handling in 32 bytes tags

32 bytes tag can only be used when the “Library identifier” is 9 bytes or less.

When a tag only has 32 bytes user data space a modified version of the mandatory starting block is used. In this version the “Owner library” is reduced to 9 bytes in the tag. This makes the mandatory starting block exactly 32 bytes long. No other data can be stored in the tag.

3.3. Optional data blocks

3.3.1 Frame encoding

The frame for the optional data blocks uses 4 or 6 bytes.

3.3.2 Length

Description:

This field includes the length of this data block. This length includes all bytes in the frame, including the length itself.

Using 0 or 1 as length has a special meaning (0: End, 1: Filler).

Encoding:

8 bit unsigned integer

3.3.3 Data block ID

Description:

This number identifies this data block and its format, see list of defined data blocks later in this document.

Encoding:

16 bit unsigned integer (lsb stored at the lowest memory location), but with an escape for 32 (24) bit encoding. When the high byte is hex(ff) is a 16 bit number, two more bytes must be read:

Offset	16 bit value	32 (24) bit value
0	Lsb	Lsb
1	Msb	Hex(ff)
2		Middle byte
3		Msb

3.3.4 Checksum

Description:

As checksum for optional data block is only used an 8 bit XOR of the data.
For calculations a new XOR checksum:
Set the checksum field to chr(0), then calculate the XOR for all bytes including length, id and checksum field. Store this value in the checksum field.
For verifying the XOR checksum: calculate the XOR for all bytes including length, id and checksum field, it must be chr(0).

3.3.5 Special frame encoding in optional data blocks

Description:

It is allowed to use a shorter frame than the specified layout, any data/fields missing from the frame data are assumed to be chr(0).

Example: A frame is supposed to contain two fields: A and B each 10 bytes long, but according to the frame length, there are only 5 data bytes.
These 5 bytes are the start of A, the last 5 bytes in A is chr(0) and all 10 bytes in B are chr(0).

A frame can also be specified longer than the data requires, this can be used to align the next frame on a block boundary in the tag.

It is allowed for any application to modify the frame structure in the library's own tag, including changing the length of frames with a known format, frames with an unknown format can only be moved or deleted in the tag. This changing of the tag must only be done on request of the library.

3.4. Special optional data blocks

3.4.1 End data block

Description:

This block signals the end of data blocks. Other data can be present after this block, but they will not be part of this data model, and may be changed during a reprogramming of the tag.

Encoding:

Length=0
Data block id=not present
Checksum=not present
This makes the "End data block" one byte long, containing only a chr(0) byte

3.4.2 Filler data block

Description:

This block is used to align other data blocks on page boundaries.

Encoding:

Length=1
Data block id=not present
Checksum=not present
This makes the "Filler data block" one byte long, containing only a chr(1) byte
This block can not be specified longer, to fill more bytes use multiple "filler data blocks"

3.5. Structured extension data blocks

3.5.1 Media format and alternate item ID (ID=1)

Description:

This block contains a possible media format and can optional also contain an alternate item id. This code can be used for offline sorting.

3.5.1.1 Media format

Description:

A byte specifying the type of item.

Values:

0: Undefined
1: Book
2: CD/DVD/etc.
3: Magnetic tape (Video or music)
4: Other
5: Other, careful handling is required
6: Very small item, special handling may be required with sorting equipment.

Encoding:

8 bit unsigned integer

3.5.1.2 Alternate item id

Description:

An alternate id code for the item or used as the primary id code when it is longer than 16 characters.

Encoding:

See "String encoding".
One terminating chr(0) must be used if the "Extended owner library" is present.

Since alternate item ID is on non-write protected area, Finnish libraries must not use this data block.

3.5.2 Extended owner library

Description

This field is used for long "owner library" codes.

Encoding

See "String encoding".
This field is placed after the terminating chr(0) of "Alternate item id"

When using national standardized codes that are not part of ISIL, the code must be prefixed with chr(2)

When using library codes that are not standardized, the code must be prefixed with chr(3).

Offset in block	Length	Field
0	1	Length
1	2	Data block ID (=1)
4	1	XOR checksum
5	1	Media format
6	Unspecified	Alternate item id
	Unspecified	Extended owner library

Since extended owner library code is on non-write protected area, Finnish libraries must not use this data block. Helsinki University Library will not assign any ISILs that exceed the maximum length of the primary item ID; thus there should be no need to use this code.

3.5.3 Acquisition (ID=2)

Description:

This block can be used by a book supplier to supply information about the order. It is recommended to remove most of these data before releasing the item for circulation.

Encoding:

All fields can be encoded with variable length, the total block length is controlled by the frame length byte. Either a fixed length block or a variable length block encoding is allowed.

3.5.3.1 Supplier ID

Description:

Supplier identification. To be defined by the involved parties.

Encoding:

See “String encoding”.

3.5.3.2 Item Identification

Description:

An item identification, this number must be removed before the item goes into circulation. To be defined by the involved parties

Encoding:

See “String encoding”.
This field is placed just after the terminating chr(0) of “Supplier id”.

3.5.3.3 Order number

Description:

An order number. To be defined by the involved parties

Encoding:

See "String encoding".
This field is placed just after the terminating chr(0) of "Item Identification"

3.5.3.4 Invoice number

Description:

An invoice number. To be defined by the involved parties.

Encoding:

See "String encoding".
This field is placed just after the terminating chr(0) of "Order number"
From the last character up the end of the block are use chr(0) as filler. No chr(0) will be present if the string goes to the end of the block.

Offset in block	**Length**	**Field**
0	1	Length
1	2	Data block ID (=2)
4	1	XOR checksum
5	Variable	Supplier ID
	Variable	Item identification
	Variable	Order number
	Variable	Invoice number

3.5.3.5 Other (ID=3-100)

These ID codes are reserved for other standardized "Structured extensions", adding of new structured extensions will not change the "Standard version" number in the mandatory starting block.

3.6 Unstructured extension data blocks

Nothing can be specified about the contents of the unstructured data blocks, this can be controlled by either the vendor or the library. Before using these unstructured extensions it is required to obtain a data block id.

UTF8 may be used in these blocks.

3.7 String encoding

All string fields are encoded in UTF-8 with the first character of the string stored in the lowest memory location.

The end of a string can be defined in different ways:

With a chr(0)
The length of a fixed with field.
The end of a structured extension block.

For fixed length fields all unused bytes must be filled with chr(0).
For variable length fields one chr(0) is used between each field.
Strings beyond the end of an extension block is assumed to be empty.

3.8 Writing the tag

Some general rules when writing to a tag.

3.8.1 Tags with 32 bytes user data space

The mandatory starting block will be truncated two bytes, but the CRC must be calculated for a full length header, the two missing bytes are just assumed to be chr(0).

3.8.2 CRC

The CRC must always be filled in with the correct value, even when not used by the readers in the library. When doing ILL, other readers will need to read the tag, and they may do CRC verification.

3.8.3 Unused space

Any unused space in blocks must be filled with chr(0), i.e. a 6 byte item id must be written as the 6 bytes id followed by 10 bytes chr(0). It is very important for reading optimization that this rule is followed.

3.8.4 End of tag

If a data block ends on the last user byte of a tag no “end block” is required.
The length specified in the last data block, must not indicate a size larger than the tag.

3.9 Reading the tag

Optimize reading the tags

3.9.1 Fast reading

When the primary item id is 12 bytes or less, it is possible to make a faster but less reliable reading. Read the first 16 bytes and verify that the last byte is chr(0).
This reading can not verify the CRC, or if the item belongs in this library. It can even be a non-library tag.

3.9.2 Optimized reading

When the “owner library” is 8 bytes or less. The full mandatory header can be read and checked by reading 32 bytes, it must be verified that the last byte is chr(0).

3.9.3 Structured or Unstructured extensions

Any application must be able to handle any item, by just reading the mandatory starting block. But an increased speed/service level may be provided if the correct extensions are present.

3.10 Security

RFID tags offer several methods for usage in security systems. Some are using the AFI for security. Other methods are also available. It is up to the customer, which security mechanism will be used.

To avoid problems with RFID systems used for other purposes the AFI for “Checked out” items have to be set to 0x9D and the AFI for "Checked in" have to be set to 0x9E. Please refer to section 2.6.3.