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Libraries and Information Systems Need XML/RDF... but Do They Know It?

Eva-María Méndez-Rodríguez

This article presents an approach to the uses of XML (eXtensible Markup Language) and Semantic Web technologies in the field of information services, focusing mainly on the creation and management of digital libraries compared to traditional libraries, while paying special attention to the concept and application of metadata, and RDF based integration.

Keywords: DCMI, Libraries, Metadata, Semantic Web, Standards, XML/RDF.

1 Introduction: Some Prior Considerations Regarding XML/RDF and Libraries

The XML (eXtensible Markup Language) metalanguage has already conquered the Internet and, when combined with other technologies from the World Wide Web Consortium (W3C), is capable of increasing the potential and flexibility of the Web as an information representation and retrieval system. As readers will be more than aware, XML is used to describe types of documents from any domain and with any purpose, thereby providing Internet communities with a flexible syntax with which to create the languages that best meet the needs and idiosyncrasies of documents and information from different disciplines. Hundreds, perhaps thousands, of applications of this markup language have been developed, and will doubtless continue to be developed, and it is clear that libraries and information services cannot, or should not, ignore this global trend towards the structuring or semi-structuring of a new XML based Web. However, the use of XML in libraries means different things to different people, ranging from the simple redefinition of traditional library standards such as MARC (MAchine Readable Cataloguing) into XML or XML Schema, to the creation of all manner of digital information services and systems, under the ad hoc name of digital libraries. The operation of these digital libraries is based on metadata schemas and/or the creation of specific RDF (Resource Description Framework) vocabularies, or on the use of various mechanisms to exploit the integration capabilities of XML technologies (metadata extraction protocols, parameters of a semantic nature such as ontologies, or even by creating Web Service architectures (WS), etc.).

Traditionally libraries have acted as repositories of information, normally in a physical form (books, journals, films, etc.), and forming accession catalogues and patterns have grown up around these documents, normally in the form of bibliographic databases. The design of most catalogues was based on the descriptive information (cataloguing and classification) of each document acquired by the library, on the assumption that that information would not change, and used a standard coding syntax (MARC) appropriate to these circumstances. This approach is valid while the descriptive characteristics of book in print format do not change. However, the popularization not only of the Internet, but also of the production of digital documents and the concomitant need to provide access to them, has meant that libraries have been obliged to restructure. This, as in other informational environments, is where XML comes in, as the basic technology for sharing and combining data in a bibliographic, library and/or document management environment.

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Meanwhile libraries, or rather library websites, are becoming digital content aggregators, and as such need to make use of XML or RDF markup standards and applications such as RSS (RDF/Rich Site Summary), increasingly popular for the syndication of news URLs, or the open archive protocol (OAI-PMH, Open Archive Initiative-Protocol for Metadata Harvesting) which uses XML to harvest metadata about the content of distributed sites. The bounds between traditional libraries which present their online public access catalogues in the Web (WebPACS, also known as OPACS, Online Public Access Catalogues), and digital, virtual or electronic libraries are becoming ever more fuzzy with the generation of bibliographic or library portals, hybrid libraries, and content management systems. Given this scenario, the importance of XML, and of a number of associated technologies of a clearly semantic nature such as RDF, would seem to be beyond any doubt in present day libraries, especially given XML's capability to represent complex information structures in an open and non-proprietary manner. In spite of this, the use of XML in the creation of library services is neither so apparent nor so widespread, accustomed as libraries are to using off-the shelf applications and a very well established, traditional description standard. In this article we aim to present some of the most important trends in libraries and their functionalities, with the ultimate goal of integrating traditional library services and digital library services within the infrastructure of the Semantic Web, in which "*information is given well-defined meaning, better enabling computers and people to work in co-operation*", as explained by Berners-Lee, Hendler and Lassila (see Bibliography.)

2 XML in Traditional Libraries

In spite of the fact that Roy Tennant (see Bibliography), one of the staunchest defenders of the use of XML in libraries, believes that libraries use XML in almost all areas, tasks and services - Integrated Library Management Systems (ILMS), inter-library loans, cataloguing and indexing, collection and database creation, information migration, etc. - in our opinion, the traditional library community's interest in XML technologies is still in its infancy. That said, there is a fairly explicit consensus regarding the role that XML technologies should play in the library management systems, which attempts to clarify how XML will work in practice and how it will fit in with legacy library standards. In this latter respect, the most important debate is centred around how MARC and MARC21 formats compare to XML, and the suitability of flat MARC files compared with the advantages provided by XML records for exchanging bibliographic information between catalogues. More specifically, different patterns of use are emerging, in response to a constant evolution of bibliographic databases and their need to be global. Among these patterns or trends are:

- Simple MARC to XML conversion; in other words, a direct mapping or crosswalk between the MARC elements and the XML labels which are to represent them, the result of which is an XML DTD (Document Type Definition), equivalent in functionality to ISO standard 2709.
- The design of a more semantically rich XML structure in order to reflect the meaning of a number of MARC data elements. Sometimes this conversion parameter may generate self-describing records, as in the case of BiblioML, a French project, pre-dating MARC21, to create a representation in XML of UNIMARC (Universal MARC Format) bibliographic and authorities formats.
- Another trend is the creation of simplified element sets to facilitate the integration of information systems external to the catalogue. In this case, MARC is converted into a non-reversible XML converted simplified structure, for example, by converting MARC codes to XML encoded Dublin Core, especially when cataloguing web documents and integrating them into catalogue databases in MARC.
- A subsequent, relatively recent, study involves the creation of an XML schema to losslessly encode the data of an entire MARC record with no loss of semantic meaning. Once the XML schema was encoded, the Library of Congress developed a series of XSL (eXtensible Stylesheet Language) stylesheets to facilitate conversion from one format to another, even between MARC DTD and MARC XML (Schema).
- Last but by no means least is the XML conversion of Z39.50 services. Z39.50 is a standard application level protocol for retrieving information, specifically designed for searching across distributed servers and to improve the integration of MARC catalogues. Z's philosophy is similar to WS's, and its evolution with regard to the Web is moving along similar lines, towards a set of applications with Web interoperability.

The international initiative ZING (Z39.50 Next Generation) comprises a variety of web service oriented Z developments, involving the integration of XML and XML schema technologies. Among the various development initiatives from this new generation of protocol Z39.50 are: SRW/SRU (Search/Retrieve for the Web/URL) using CQL (Common Query Language) as its query language; an object oriented version of Z (ZOOM) keeping the original protocol but shedding its complexity; e39.50, ensuring the interrogation services of Z39.50 but using XER (XML Encoding Rules for ASN.1) over SOAP (Simple Object Access Protocol) in Web service architecture; and the most recent development, ZeeRex (Z39.50 Explain, Explained and Re-Engineered in XML) which is an XML schema to describe Z and SRW servers. In our opinion, this evolution towards the concept of Web Services for exchanging descriptive information of a bibliographic or functional nature is a response to the growing need to integrate meta-information at different levels (at a strictly catalogue level or at a metadata level), mainly


```
<?xml version="1.0" ?>
- <rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:dc="http://purl.org/dc/elements/1.1/">
- <rdf:Description rdf:about="http://es.dublincore.org/">
<dc:title>Pagina principal del mirror en espanol de la Iniciativa de Metadatos Dublin Core(DCMI)</dc:title>
<dc:description>La Iniciativa de Metadatos Dublin Core es un foro abierto comprometido con el desarrollo de
  normas de metadatos interoperables online que mantienen una amplia gama de objetivos y modelos de negocio.
    Las actividades de la DCMI incluyen grupos de trabajo impulsados por acuerdos generales, talleres globales,
  conferencias, comunicacion de normas, y esfuerzos educativos para promover la aceptacion generalizada de
  practicas y normas de metadatos.</dc:description>
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<dc:contributor>Iniciativa de Metadatos Dublin Core</dc:contributor>
<dc:contributor>Eva Mendez</dc:contributor>
<dc:relation>http://www.dublincore.org/index.shtml.rdf</dc:relation>
</rdf:Description>
</rdf:RDF>
```

Figure 1: Example of DC Metadata Encoded in RDF, <http://es.dublincore.org/index.shtml.rdf>.

encoded in XML and/or RDF, especially in various types of digital library or content management environments which require greater interoperability with 'legacy' bibliographic databases.

3 XML/RDF and Digital Libraries: Metadata and Metadata Schema

Although we have made a passing reference to the term metadata in the previous section, this concept really comes into its own in the context of digital libraries and virtual collections, in which description and retrieval systems lay the foundations for fully digital libraries, i.e., those in which both data and metadata are in numeric code formats. It would be impossible to summarise the uses of XML and its digital library related technologies here, especially if we bear in mind that every community, every academic or disciplinary group, every type of Web based information, has developed its own encoding standards to structure, organise, disseminate and retrieve its own information (all manner of DTDs, metadata schemas and/or semantics). Thematic or specialised development of metadata ranges from the definition of specific DTDs in XML, in some cases redefined from an SGML (Standard Generalized Markup Language) version, constructed or adapted *ad hoc* for a specific project, to the definition of schemas and their coverage and use, and even the study of the possible values and specific vocabularies these attributes may have (content oriented metadata, such as ontologies, thematic thesauri, or, for example, values of the element type in DCMI, Dublin Core Metadata Initiative). This subject oriented and/or specialised nature of the description and organisational processes of digital information objects is either the logical consequence of, or is at least due to, the following circumstances:

· The heterogeneous nature of information resources, and the different ways of representing them on the WWW (World Wide Web): text based information (online books and journals), images (digital surrogates of works of art, maps, plans, commercial photographs), multimedia objects (digital films and video), etc.

· The different ways of creating digital objects, either by digitalizing traditional documents or by creating them in a digital format.

· The verticalization of information; that is, the general tendency towards thematic specialisation of electronic information services and systems on the Net, giving rise to commercial thematic portals and virtual collections of scientific resources specialising in a single discipline, which in turn will develop a meta-information or vocabulary format which is specific and tailored to that subject.

· The different information realities that we refer to as digital libraries, and which meet the needs of various public and/or private institutions, not only to give information, but also to generate services. Among the most important of these services are e-government and e-learning in the public sector, and all kinds of e-commerce systems in the private sector. In both cases there is a need to describe and retrieve the digital objects which are vital to their activities or business models.

· The sheer versatility of XML/RDF syntax, which uses namespaces to adapt to the needs of each community of interest and to encode information consistently and independently of any specific semantics.

Aside from their importance as the subject of international standardisation processes, metadata schemas play an important role in many cases, precisely because they can be designed to serve specific user communities, and also because once a consensus is reached regarding their structure, they are relatively simple to implement, which makes it

possible to experiment with schemas and refine them. This is the case of DCMI which, despite being a general purpose standard, that is, one aimed at organising and describing any information object, it has also become ISO standard 15836-2003 in the operational infrastructure of the Semantic Web. The success of Dublin Core is due, among other things, to:

· Its ability to adapt to the description needs of specific information.

· The possibility of qualifying its metadata terms, which allows this format to be used with greater descriptive precision, thereby tailoring it to the needs of a specific community or a particular type of information object.

· Its syntactical independence. The set of 15 Dublin Core Element Set (DCMES) can be encoded in HTML, XHTML (Extensible HyperText Markup Language), XML, or RDF (as in Figure 1), or by using a field definition in a database, thereby making it suitable for use in both virtual collections and in digital libraries which edit their collections electronically.

· The possibility of creating specific application profiles based on RDFS (RDF Vocabulary Description Language) schemas which enable a set of entities to be defined to declare which elements from which namespaces underlie a local schema used to organise the information of a particular application or project.

Resource Description Framework (RDF), is the W3C (World Wide Web Consortium) standard for encoding meta-information in any Web information system, but also, and perhaps especially, for digital libraries. More than just a metadata model, it uses RDF/XML syntax to transport that model to describe any URI (Uniform Resource Identifier) identified resource on the Semantic Web by defining triples. In addition to this syntactical framework, RDF also has a vocabulary definition language (RDFS, RDF schema), which is an RDF application. The model and syntax are used to determine how XML documents can be constructed in accordance with the RDF metadata standard, while RDFS ensures that a an RDF/XML document is constructed so as to convey the correct meaning with its corresponding attached semantics. The use of XML to create (mark up or structure) the documents making up a digital library's collection, together with RDF to encode, adapt or create their associated descriptive semantics, is the perfect combination for creating the data systems which will allow libraries to enter the domain of the Semantic Web. RDF and RDFS, together with other more specific vocabulary definition standards (SKOS-Core, Simple Knowledge Organisation System; OWL, Web Ontology Language) also enable us to have control over content oriented meta-information in a discipline specific digital library, thereby increasing interoperability. Obviously, we are simplifying many of the presuppositions underlying these statements, the complexity of which is the reason why the various uses and applications of XML/RDF are so necessary in digital library environments, and why there is a need to have not only semantic definition structures like Dublin Core, but also protocols such as OAI which can extract and retrieve meta-information. These protocols, combined with WS architec-tures such as Search/Retrieve for the Web (SRW) and other technologies, will enable libraries to be a true data and metadata management and retrieval system for Web environments.

4 Conclusions

To sum up what we have set out, albeit briefly, in this article, the future (and present) of libraries or information systems in general lies in the adoption of XML technologies capable of diversifying the traditional role of libraries towards interoperable integration models in a new Web dimension. For libraries, this new Web dimension will involve the implementation of at least two aspects which are juxtaposed and are even tending to integrate with each other:

- On the one hand, there are the languages that libraries use to interact within their principal domain, in which all matters relating to the impact of XML technologies in the management of bibliographic data are of special importance, especially with regard to the reuse and conversion of MARC records.
- On the other hand, there are the services that libraries need to provide on the Web, driven by the integration of various digital libraries, and achieved by applying information service standards arising from either the Web Services (WS) paradigm or from the adoption of Semantic Web (SW) standards..

In addition to all the above, the idea of the Semantic Web also creates the need for structural constraints to provide unequivocal semantic expression methods, and RDF currently provides such constraints thanks to the way it encodes, exchanges and reuses structured metadata. XML only supplies the language, not the vocabulary, semantics and syntax required to support interoperability. Nevertheless, XML provides a basic format for documents structured independently of any specific semantics, while XML and RDFS schemas are now mature technologies which enable a specific markup to be used in digital libraries for storing, querying, searching for and retrieving either any information object or any description about such an object.

Librarians and information professionals in general need to learn how to get the most out of XML, since they provide a set of technologies which will enable them to communicate and retrieve data and information in a global environment, easily, unambiguously and independently of any platform. This, at the end of the day, is what library and information science has always aspired to.

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Related Web Sites

• **BiblioML,** <http://www.biblioml.org>**.**

• **CoverPages (Metadata Initiatives),** <http://xml. coverpages. org/metadata00.html>**.**

• **DCMES** (Dublin Core Metadata Element Set), ISO 15836), <http://www.niso.org/international/SC4/n515.pdf>.

• **DCMI** (Dublin Core Metadata Initiative), <http://www. dublincore. org>

• **DCMI-ES,** Spanish mirror of DCMI, <http://es. dublincore. org>.

• **EAD** (Encoded Archival Description), <http://www.loc.gov/ead>.

• **FGDC** (Federal Geographic Data Committee), <http://www.fgdc.gov>.

• **FRBR** (Functional Requirements for Bibliographic Records), <http://www.ifla.org/VII/s13/frbr/frbr.htm>.

• **GILS** (Global Information Locator Service), <http://www.gils.net>.

• **MIX,** NISO Metadata for Images in XML, <http://www.loc.gov/standards/mix>.

• **MOA** (Making Of America), <http://sunsite.berkeley.edu/MOA2>.

• **MODS** (Metadata Object Description Schema), <http://www.loc.gov/standards/mods>.

• **OAI-PMH** (Open Archives Initiative- Protocol for Metadata Harvesting), <http://www.openarchives.org>

• **ONIX** (Online Information eXchange), <http://www. editeur.org/onix.html>.

• **OpenURL,** <http://library.caltech.edu/openurl>.

• **OWL** (Web Ontology Language), <http://www.w3.org/2004/OWL>.

• **RDF** (Resource Description Framework), <http://www.w3. org/RDF>.

• **RSS** (RF Site Summary), <http://web.resource.org/rss/1.0>.

• **SCHEMAS,** Forum for Metadata Schema Implementers, <http://www.schemas-forum.org>.

• **SOAP** (Simple Object Access Protocol), <http://www. w3.org/TR/SOAP>.

• **SKOS-Core,** <http://www.w3.org/2004/02/skos/core>.

• **SRW** (Search/Retrieve Web Services), <http://www.loc.gov/z3950/agency/zing/srw>.

• **SW,** Semantic Web Activity (W3C), <http://www.w3.org/2001/sw>.

• **SWWS** (Semantic Web Web Services), <http://swws. semantic web.org>.

• **TEI** (Text Encoding Initiative), <http://www.tei-c.org>.

• **UDDI** (Universal Description, Discovery and Integration), <http://www.uddi.org>.

• **W3C** (World Wide Web Consortium), <http://www. w3.org>.

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• **WSDL** (Web Services Description Language), <http://www.w3.org/TR/wsdl>.

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• **XML4Lib** (XML for Libraries), discussion list, <http://sunsite.

berkeley.edu/XML4Lib>.

- **XMP** (eXtensible Metadata Platform), <http://www. adobe.com/products/xmp>.
- **XSL** (XML Style Language Family), <http://www.w3.org/Style/XSL>.
- **Z39.50,** Information Retrieval (Z39.50): Application Service Definition and Protocol Specification (ISO23950), <http://lcweb.loc.gov/z3950/agency>.
- **ZING,** Z39.50 International Next Generation, <http://www.loc.gov/z3950/agency/zing>.

Notes

[1] The Library of Congress (USA) is developing several tools, schemas, stylesheets, etc. to make it easier to work with MARC data in an XML environment. See <http://www.loc.gov/standards/marcxml>. They even aim to develop a Web Services workplace based on MARC21 data.

[2] The portalization of libraries, or the creation of library portals or portals in or of libraries, is a recurring theme in professional literature, as exemplified by the monograph published by the journal *Vine* in 2003 (vol. 33, no. 1), or the symposium in June 2004 organised by LITA (Library & Information Technologies Association), <http://www. ala.org/ala/lita/litamembership/litaigs/internetportals/symposium.htm>. This trend towards the pooling of library resources, information sources, etc. in libraries has led to the development of commercial applications based on the integration of metadata, link servers and XML technologies such as ZPORTAL <http://www.fdusa.com/products/zportal.html> or SFX <http://www. exlibrisgroup.com/sfx.htm> which uses the OpenURL standard.

[3] For more in depth information about the concept of *crosswalk*, see: <http://es.dublincore.org/es/glossary. shtml#C>.

[4] In MARC XML Schema, MARC fields are treated as labelled XML elements, indicators as attributes, and subfield codes as subelements with the subfield code as an attribute. See. <http://www.loc.gov/standards/marcxml/schema/MARC21slim.xsd>.

[5] This is the case of TEI (Text Encoding Initiative) and of EAD (Encoded Archival Description) for example, which are de facto standards for structuring and defining information about humanities or information of an archival nature respectively, which initially defined their DTDs in SGML.

[6] DCMI type Vocabulary: <http://dublincore.org/documents/dcmi-type-vocabulary>.

[7] See *DCMI Metadata Terms* <http://www.dublincore.org/documents/dcmi-terms>. This document replaces DCMI's obsolete recommendation <http://dublincore.org/documents/2000/07/11/dcmes-qualifiers>.

[8] For further information about these different methods of DC encoding, see the following DCMI recommendations: *Expressing Dublin Core in HTML/XHTML meta and link elements* <http://www.dublincore.org/documents/dcq-html>, and *Expressing Dublin Core in RDF/XML* <http://www.dublincore.org/documents/dcmes-xml>.