LUISA

Learning Content Management System Using Innovative Semantic Web Services Architecture

IST- FP6 - 027149

Deliverable D3.7
Standard Translators

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EXECUTIVE SUMMARY

This deliverable D3.7 (Standard Translators) reports on the efforts within the LUISA project to improve the level of semantic compatibility in popular metadata standards. If successful, these efforts will make more of the metadata standards available for automatic reuse by LUISA and other semantic technologies, thus improving the level of metadata harmonization.

Two main approaches are involved:

1. Rewriting of the core standards to make them directly compatible with semantic technologies.
2. Specifications of well-integrated mappings from the standards into semantic metadata expressions. If these mappings are standardized, the need for manually created mapping decreases significantly.

The deliverable documents the LUISA contributions on three standards:

- The DCMI set of standards, because of their extremely widespread usage, both in the e-learning domain and outside.
- IEEE LOM, because it is the de facto standard used in many e-learning applications.
- ISO MLR, because it has the potential to become a very influential standard in the e-learning domain.

The majority of the LUISA contribution to the semantic interoperability has been in the form of work on public documents. This deliverable therefore includes these documents by reference.

Document Information

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Abstract (for dissemination)	This deliverable reports on the efforts within the LUISA project to improve the level of semantic compatibility in popular metadata standards. If successful, these efforts will make more of the metadata standards available for automatic reuse by LUISA and other semantic technologies, thus improving the level of metadata harmonization.			
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1 INTRODUCTION

Metadata allows systems, applications and users to manage and access resources without a need for interaction with the resource itself. For this reason, the administration and exchange of metadata is a central activity in systems that manage learning objects. Metadata considerations are fundamental when creating interoperable e-learning tools, and metadata standards have been among the very first learning technology standards to mature.

However, despite enormous progress in the harmonization of learning object metadata standards, culminating in the release of the IEEE Learning Object Metadata standard in 2002, there remains a core of unsolved issues with respect to metadata interoperability and metadata harmonization. Today there is a plethora of metadata specifications (such as IEEE LOM, Dublin Core, METS, MODS, MPEG-7, etc.), many of which are useful in whole or part for activities related to teaching and learning. While each specification in itself is designed to increase system interoperability, we are increasingly seeing systems that need to work with more than one of these specifications. Adding support for an additional specification generally presents a significant amount of added complexity in implementation. The reason for this is a lack of harmonization between specifications. If harmonization was a reality, adding support for an additional metadata specification would be a simple matter of slightly extending the existing system.

Existing solutions to the metadata harmonization issue are few - systems are either limited to a single specification, or implement ad-hoc solutions that only work in that particular environment. In short, the solutions to metadata harmonization can be put into two categories: manual “crosswalks” or “mappings” that translate metadata expressed using one standard into metadata expressed using another standard; and solutions that depend on rewriting the standards to co-exist in a common framework.

There are many examples of "mappings" between specifications that provide partial solutions to the problem, but generally fail due to low-fidelity translations and lack of generality (i.e. the mapping only works for limited parts of specifications). Another kind of mapping is to create a top-level data model that encompasses the common aspects of all the specifications. This has proven to be feasible in relatively well-constrained domains such as resource aggregation, where the work on the RAMLET[1] top-level ontology for resource aggregation has proceeded well within the IEEE. RAMLET works relatively well as a mapping model because there is a common conceptual underpinning of the standards being mapped using the model. In the field of general metadata, where there is no such common ground, such an approach is substantially less likely to be successful.

The LUISA project instead approaches this issue through the use of a common framework based on semantic technologies (RDF and WSMO), making it possible to combine metadata fragments from multiple standards without a need for manually created translations. This requires a basic level of “semantic

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[1] IEEE P1484.11.4, http://www.ieeeltsc.org/working-groups/wg11CMI/ramlet

compatibility” in the used metadata standards, which is not the case in several of the affected standards.

Instead of relying on manually crafted translators from non-semantic standards to RDF, we have chosen within this deliverable to attack the issue at its very core – the metadata standards themselves. This deliverable reports on the efforts within the LUISA project to improve the level of semantic compatibility in popular metadata standards. If successful, these efforts will make more of the metadata standards available for automatic reuse by LUISA and other semantic technologies, thus improving the level of metadata harmonization.

Two main approaches are involved:

1. Rewriting of the core standards to make them directly compatible with semantic technologies.
2. Specifications of well-integrated mappings from the standards into semantic metadata expressions. If these mappings are standardized, the need for manually created mapping decreases significantly.

2 OVERVIEW OF METADATA STANDARDS IN THE LEARNING DOMAIN

The terms "metadata standard" or "metadata schema" are often used to refer to the various kinds of specifications for metadata available from different organizations. Note that in the notion of "standard" we include both international de jure standards, as well as metadata specifications from established specification organizations.

Metadata standards come in different forms and with different kinds of audiences, and for the purpose of this deliverable it is useful to look at the following broad categories of standards, exemplified by a few widespread standards.

Generic, framework-level models

These abstract models define frameworks for expressing metadata and metadata records without specifying any actual metadata elements or metadata syntaxes.

- RDF, the Resource Description Framework, a general-purpose, web-oriented metadata framework, defined by the W3C[2].
- The DCMI Abstract Model (DCAM), defining the underlying model for Dublin Core metadata terms[3].

Generic, framework-level syntaxes

These syntaxes encode an abstract metadata model but without specifying any metadata elements.

- Expressions of Dublin Core in RDF/XML/XHTML[4], describing syntaxes for encoding DCAM-compatible metadata in various syntaxes.
- RDF/XML and other RDF syntaxes such as N3.

Element sets to be reused in many different contexts and domains

Element sets do rely on a particular abstract model, but can otherwise be useful for many different purposes.

- DCMI Metadata Terms[5], defining a set of metadata terms conforming to the DCMI Abstract Model.

Domain-specific complete element sets and schemas

These metadata specifications contain interlinked abstract models and metadata elements, which puts them in a different category to metadata frameworks.

- IEEE LOM Data Model[6], defining the basic metadata elements and how they combine into a LOM instance. IEEE LOM currently has an XML syntax only.

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2 http://www.w3.org/RDF/

3 http://dublincore.org/documents/abstract-model/

4 http://dublincore.org/documents/dc-rdf/, http://dublincore.org/documents/dc-ds-xml/, http://dublincore.org/documents/dc-html/

5 http://dublincore.org/documents/dcmi-terms/

- MODS[7], Metadata Object Description Schema - an XML schema for encoding MARC21 library records defined by the Library of Congress.
- MPEG-7 MDS, defining a complex XML format for multimedia metadata.

There is also ongoing work within ISO/IEC JTC1 SC36 on an ISO standard for Metadata for Learning resources (ISO 19788). As of the writing of this deliverable, the details and characteristics of this standard remain unclear (see below).

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6 IEEE 1484.12.1, http://ltsc.ieee.org/wg12/

7 http://www.loc.gov/standards/mods/

3 LUISA CONTRIBUTIONS TO SEMANTIC COMPATIBILITY

The LUISA contributions have focused mainly on three standards:

- The DCMI set of standards, because of their extremely widespread usage, both in the e-learning domain and outside.
- IEEE LOM, because it is the de facto standard used in many e-learning applications.
- ISO MLR, because it has the potential to become a very influential standard in the e-learning domain.

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3.1 Dublin Core Metadata Initiative

DCMI has been the maintainer of a large list of cross-domain metadata terms for over ten years. The terms are heavily used in many metadata applications of very varying kinds, including a wide variety of e-learning systems. The terms, while compatible with basic semantic principles, have started to suffer from a lack of machine-process able semantics. A long-term effort has been coordinated by ULL, through the position of Mikael Nilsson as chair of the DCMI Architecture Forum since March 2007, and previous involvement. This has resulted in the following updated and improved specifications.

The improvements are all designed to improve the usability of Dublin Core metadata for semantic applications, such as LUISA. Before these changes, while the Dublin Core specifications were heavily used, the usage was not rooted in clear definitions of semantics, and also suffered from ambiguities in the technical specifications. This means that much metadata using Dublin Core specifications is unusable, in various degrees, for LUISA. It it our belief that the LUISA contributions have had a significant impact, in particular in combination, on the possibility of reusing metadata from Dublin Core-based metadata sources.

Document	Status	Contributions from	Comment	Significance for LUISA
The DCMI Abstract Model[8]	Published in March 2005, revised in June 2007	Mikael Nilsson and Ambjörn Naeve are co-authors	The purpose of the abstract model is to define the underlying framework within which the DCMI metadata terms are defined. The updated abstract model is defined directly on top of the RDF semantics, making Dublin Core metadata directly compatible with RDF metadata – a primary requirement of the specification.	Improved semantic compatibility for Dublin Core metadata is a core issue for LUISA, as many, if not most, metadata applications provide some level of support for Dublin Core metadata. Improved semantics in the core DCMI specifications improves semantic compatibility on all levels.

[8] http://dublincore.org/documents/abstract-model/

Document	Status	Contributions from	Comment	Significance for LUISA
DCMI metadata terms[9]	Revised January 2008	Mikael Nilsson has provided comments and chaired the development.	A revised version of the Dublin Core Metadata Terms recommendation that includes specification of domains and ranges for DCMI properties, as well as updates to better conform to the updated Abstract Model. This specification makes the machine-processable semantics of the widely-used DCMI metadata terms available to RDF applications (through RDF schema declarations).	This greatly increases the usefulness to LUISA of metadata from external sources that use DCMI terms.
Expressing Dublin Core metadata using RDF[10]	Published January 2008	Mikael Nilsson is main author, Ambjörn Naeve co-author.	A recommendation for using Dublin Core terms in RDF applications, based on the revised abstract model. The new specification, compared to older proposed recommendations, takes advantage of the improved semantic compatibility of the revised abstract model.	LUISA benefits through a natural, semantically rich, RDF encoding of Dublin Core metadata, without needing complex translators or heuristical approaches.
Expressing Dublin Core metadata using HTML/XHTML[11]	Published August 2008	Mikael Nilsson has provided comments and chaired the development.	A new recommendation for encoding Dublin Core metadata using HTML/XHTML <meta> tags. The new recommendation is RDF-compatible and uses GRDDL, the new W3C recommendation that provides automatic extraction of RDF metadata from XHTML documents – a "semantic style sheet" for XHTML.	LUISA benefits from RDF-based semantic technologies integrated with traditional, HTML-embedded metadata.
Expressing Dublin Core metadata using XML[12]	Proposed Recommendation September 2008	Mikael Nilsson has provided comments and chaired the development.	A new recommendation for encoding Dublin Core metadata using XML. The new specification is RDF-compatible and also uses GRDDL.	LUISA benefits from access to the RDF-based semantics of XML-encoded Dublin Core metadata.
Dublin Core Description	Working Draft,	Mikael Nilsson is main author,	A new recommendation that provides a machine-	LUISA benefits through a standards-based solution

9 http://dublincore.org/documents/dcmi-terms/

10 http://dublincore.org/documents/dc-rdf/

11 http://dublincore.org/documents/dc-html/

12 http://dublincore.org/documents/dc-ds-xml/

Document	Status	Contributions from	Comment	Significance for LUISA
Set Profiles[13]	March 2008	Matthias Palmér and Fredrik Enoksson has provided comments	processable format for encoding Application Profiles. The work has been heavily influenced by the work on Annotation Profiles in LUISA.	for machine-processable application profiles. Work is in progress on implementing automatic translations from Description Set Profiles to to LUISA Annotation profiles.
Dublin Core Singapore Framework [14]	Published January 2008	Mikael Nilsson is main author	A conceptual framework for providing the right documentation of DCMI application profiles. The Singapore framework consolidates the experience from many years of development of application profiles, and summarizes best practice in application profile development and documentation, based on the DCMI Abstract model.	LUISA benefits through better designed DCMI Application Profiles that in turn can be used to create Annotation profiles.
Dublin Core Interoperability Levels[15]	Working Draft, June 2008	Mikael Nilsson is main author	An overview document that presents the various levels of interoperability with Dublin Core that applications and specifications can aim for..An important purpose of the document is to emphasize the importance of semantic interoperability on a global scale.	LUISA benefits through improved knowledge about semantic interoperability (as compared to other forms of interoperability) in metadata communities.

3.2 IEEE Learning Object Metadata

The IEEE LOM standard, published in 2002, is an important and widely-used metadata standard for learning resources. It has suffered from lack of semantic compatibility, making it difficult to reuse LOM metadata in semantically-enabled applications such as LUISA. Within the LUISA project, ULL has initiated and led the “Joint DCMI/IEEE LTSC Taskforce”, a collaboration between IEEE LTSC and the DCMI, with the explicit aim of providing two IEEE standards enabling the use of IEEE LOM metadata in semantic applications. The task force is chaired by Mikael Nilsson.

The two proposed standards do not change the core LOM standard, but instead defines a standardized semantic compatibility layer for IEEE LOM. In this way,

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13 http://dublincore.org/documents/dc-dsp/

14 http://dublincore.org/documents/singapore-framework/

15 http://dublincore.org/architecturewiki/InteroperabilityLevels

there will be a canonical mapping from IEEE LOM metadata to RDF, defined by IEEE, making IEEE LOM metadata much more useful in semantic technologies, and in particular, LUISA.

Document	Status	Contributions from	Comment	Significance for LUISA
RDF vocabulary for IEEE LOM[16]	Draft in progress	Mikael Nilsson is co-author	The Standard includes the specification of RDF terms, including properties, classes, vocabularies, syntax encoding schemes and vocabulary encoding schemes, covering the semantics of data elements defined in IEEE LOM.	Improved semantic compatibility for IEEE LOM metadata is a core issue for LUISA, as many, if not most, metadata applications for e-learning provide some level of support for IEEE LOM metadata.
Expressing IEEE LOM instances using the DCMI abstract model[17]	Draft in progress	Mikael Nilsson is main author	This Recommended Practice describes how to construct IEEE LOM instances using the Dublin Core Abstract Model (DCAM). It describes how to use the IEEE LOM RDF terms together with DCMI metadata terms for expressing IEEE LOM conforming instances as DCAM description sets	LUISA benefits through the posibility of using the full semantic technologies enabled by the above mentioned DCMI specifications with IEEE LOM metadata. In particular, DCMI Description Set Profiles become usable together with IEEE LOM, making it easier to design cross-standard annotation profiles in an interoperable way.

The ongoing work of the task force is documented here:

http://dublincore.org/educationwiki/DCMIIEEELTSCTaskforce

3.3 ISO/IEC JTC1 SC36

There has been some progress over the last few years on a new standard: “Metadata for Learning Resources” (MLR) by the ISO committee on Learning Technologies (SC36). It has, however, become increasingly clear that the approach taken does not lend itself to semantic interoperability.

The MLR standards is a multi-part standard, where the first part defines an abstract metadata framework, while subsequent parts are expected to define metadata elements and application profiles based on these elements. In this

16 http://dublincore.org/educationwiki/DCMIIEEELTSCTaskforce/LomTerms

17 http://dublincore.org/educationwiki/DCMIIEEELTSCTaskforce/LomDCAMAnalysis

formulation, Part 1 of the standard fall into the category of framework-level metadata models.

However, the currently proposed frameworks is based on a hierarchical model not unlike the IEEE LOM standard. The model is not compatible with semantic approaches, and would require manual translation to be useful to LUISA.

Due to the potential influence of this standard, ULL has engaged in the ISO process in an effort to change the path of the ISO MLR standard, with some success. In January 2008, a group led by Mikael Nilsson submitted a document to ISO outlining the issues with the current, non-semantic approach.[18]

In the March 2008 SC36 meeting, the working group decided to give the group behind the document the task of proposing a rewrite of the MLR drafts. This proposal, together with a large set of comments on the current drafts in the direction of semantic interoperability, was written by ULL and submitted in August 2008.[19] The proposal includes a specification of an abstract model for MLR that is based directly on RDF, and therefore immediately compatible with semantic technologies.

Work continues on implementing these suggestions in the actual standard.

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18 http://isotc.iso.org/livelink/livelink/7121268/WG4_N0238_Requirements_for_ISO_MLR__interoperability.pdf?func=doc.Fetch&nodeid=7121268

19 http://isotc.iso.org/livelink/livelink/7551381/WG4_N0278_An_Abstract_Model_for_MLR.pdf?func=doc.Fetch&nodeid=7551381

4 CONCLUSIONS

Through the important LUISA contributions to international standardization bodies in the area of semantic interoperability, the landscape for semantically-enabled applications has already changed. Several of the large, influential standardization efforts are moving in the direction of semantic metadata thanks to the LUISA efforts.

With built-in semantic support in metadata standards, the need for manual metadata mappings decrease significantly, and opens up ontology-based processing for all metadata based on these standards. This way, the cost and effort involved in combining metadata standards also decreases.

Now that ULL has been able to demonstrate international expertise in the field of metadata standardization, the engagement of ULL in these bodies will be able to continue using future projects, both EU-funded and other, some of which have already been secured. These standardization efforts have a direct positive impact on the value proposition for semantic technologies in the European Community.

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