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Guidelines and support for building application profiles in e-learning

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Foreword

This CEN Workshop Agreement (CWA) provides guidance on how to build application profiles for e-learning.

Application profiles enable “mixing and matching” metadata elements, in order to meet specific requirements for a particular context. As an example, some communities may want to make certain elements mandatory or restrict the value space of a particular element.

However, there is much confusion and only limited experience and expertise in the development and deployment of application profiles. That is why the CEN/ISSS Learning Technologies Workshop decided to develop guidelines on the use of application profiles for (e-)learning. This document is the concrete result of this work.

Although many of the guidelines presented in this document can be applied to any kind of application profile, the focus here is on application profiles for metadata, more specifically for learning object metadata. In addition, application profiles of other metadata standards, such as for instance the Learner Information Package (LIP), have also been considered.

In parallel to this CWA, an online registry for Application Profiles equally with a particular focus on the IEEE LTSC LOM standard has been developed.

The decision for this work item was taken by the Learning Technologies Workshop at the 19th meeting on July 05/06, 2004. Work on the CWA actually started at the 23rd meeting on June 16/17, 2005. The editing team consisted of Neil Smith (Knowledge Integration Ltd), Marc Van Coillie (Eifel) and Erik Duval (Dept Computerwetenschappen, Katholieke Universiteit Leuven).

The document has been developed through the collaboration of a number of contributing partners, representing a wide mix of interests, from universities to commercial companies representatives. The names of the individuals and their affiliations that have expressed support for this CWA is available from the CEN/ISSS Secretariat.

The final review/endorsement round for this CWA was started on 2006-02-17 and closed on 2006-04-21.

The final text of this CWA was submitted to CEN for approval and publication on 2006-04-28.

Comments and feedback are explicitly solicited, and can be sent by email to erik.duval@cs.kuleuven.be

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1 Scope

Although many of the guidelines presented in this document can be applied to any kind of application profile, the focus here is on application profiles for metadata, more specifically for learning object metadata[1]. In addition, we will also consider application profiles of other metadata standards, such as for instance the Learner Information Package (LIP)[2].

2 Normative references

This CEN Workshop Agreement incorporates by dated or undated reference, provisions from other publications.

These normative references are cited at the appropriate places in the text, and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications do not apply. However, parties to agreements based on this CWA are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies.

3 General references

1. Erik Duval, Wayne Hodgins, Stuart Sutton, Stuart L. Weibel, *Metadata Principles and Practicalities,* D-Lib Magazine, April 2002, Volume 8 Number 4 (http://www.dlib.org/dlib/april02/weibel/04weibel.html)
2. BS 8419:2005 *Interoperability between metadata systems used for learning, education and training*
3. CWA14855 - Dublin Core Application Profile guidelines
4. CWA15248 - Guidelines for machine-processable representation of Dublin Core Application Profiles
5. CWA15249 - Guidance for naming, versioning, evolution and maintenance of element declarations and Application Profiles
6. IMS Guidelines for Application Profiling, 2005 (http://www.imsglobal.org/ap/)
7. TELCERT : Technology Enhanced Learning Conformance European Requirements & Testing (http://www.opengroup.org/telcert)
8. Jehad Najjar, Stefaan Ternier and Erik Duval, *Interoperability of Learning Object Repositories: Complications and Guidelines,* IADIS International Journal of WWW/Internet, 2004. http://www.cs.kuleuven.ac.be/~najjar/papers/IadiswwwJournal.pdf

4 Terms and definitions

application profile: "An application profile is an assemblage of metadata elements selected from one or more metadata schemas and combined in a compound schema. […] The purpose of an application profile is to adapt or combine existing schemas into a package that is tailored to the functional requirements of a particular application, while retaining interoperability with the original base schemas." [1]

[1] http://ieeeltsc.org/wg12LOM/
[2] http://www.imsglobal.org/profiles/

5 Abbreviations

AP	Application Profile
CWA	CEN Workshop Agreement
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IMS	IMS Global Learning Consortium, Inc.
LOM	Learning Object Metadata

6 Introduction

This document provides guidance on how to build application profiles for learning. Section 7 introduces the concept of application profiles. The general principles for building application profiles are introduced in section 8. Section 9 provides step-by-step guidance for the actual development of an application profile. In section 10, we present some concrete examples. Implementation issues are discussed in section 11.

7 What is an application profile?

7.1 Background

The goal of standardisation is to produce a broadly acceptable specification which does not impose unnecessary restrictions that may mitigate against its wider uptake and use. The nature of standards dictates that they must cover every conceivable circumstance. On the other hand, implementers of a standard focus on the needs of their particular constituency and therefore choose subsets of possible options and interpretations which, whilst conforming to the underlying standards, may limit potential for interoperability in future. For example, a standard might have provisions for multi-linguality (wide character sets, etc.) but if a particular group of implementers use a common language they may be able to simplify their implementation considerably.

The normal way of addressing the need for interoperability is to define a **profile** of a standard. For example, the Library community in the 1990s saw wide interest in new standards such as Z39.50/ ISO 23950 (Information Retrieval) and ISO 10160/ 10161 (Inter-Library Loans). Users and vendors interested in implementing these standards set up Implementers' Groups (respectively the ZIG[3] and IPIG[4]) to work on interoperability issues. Both these groups addressed this by developing one or more profiles of the relevant standard and many of the profiles developed in the 1990s (e.g. the Bath Profile[5] of Z39.50) are still in use today.

In this document, we aim to provide guidance to communities of interest who have identified a need to interoperate. We use the term **'Application Profile'** in a very broad sense to refer to any profile based on one or more standards or specifications. In this document we have focussed primarily on Learning Objects and their associated metadata but we have also included examples of application profiles relating to learner information. An Application Profile is typically developed for a particular application with a particular constituency. Such a community may be large (for instance: the European Academic context) or small (for instance: a small enterprise in a particular domain).

[3] http://www.loc.gov/z3950/agency/zig/zig.html
[4] http://www.arl.org/access/maildd/ipig/ipig.shtml
[5] http://www.collectionscanada.ca/bath/bp-current.htm

It is important to understand that different communities use terms relating to application profiles in subtly different ways. ISO TR 10000: *Framework and Taxonomy of International Standardized Profiles* defines a profile thus:

> *A profile identifies a set of base standards, together with appropriate options and parameters necessary to accomplish identified functions for purposes including: (a) interoperability, and (b) methodology for referencing the various uses of the base standards, meaningful both to users and suppliers.*

Some people distinguish between different types of profile. For example the Z39.50 Maintenance Agency distinguishes between:

- **Application Profile**: a profile that applies to an application protocol (e.g. Z39.50) as opposed to a lower-level protocol (e.g. tcp).
- **International Standardized Profile (ISP)**: a formal document, internationally approved, that embodies one or more profiles.
- **Internationally Registered Profile (IRP)**: a profile that has been developed by a recognized group of users, with potentially wide use and applicability, that has been reviewed for technical conformance by the standards group responsible for the protocol to which the profile pertains.
- **Harmonized Profile**: a profile which has achieved some level of "global" (i.e. international) consensus
- **Implementer Agreement**: an informal agreement among a set of implementers aimed at achieving interoperability.

Within the eLearning community we do not currently have mechanisms in place for formally approving ISPs or registering IRPs. However, CEN-ISSS WS/LT is sponsoring work, in parallel with the production of this CWA, to put in place a registry of (Application) Profiles relating to eLearning[6]. This could in future form the basis of some form of recognition system as defined in ISO TR 10000. What is apparent, though, from experience within the eLearning community to date, is that interoperability is normally best served by stating the requirements in an open and accessible manner. An Application profile addresses interoperability requirements between systems or groups by:

- retaining conformance with a base standard or specification; and
- defining any new requirements in an open manner.

This can be contrasted with a bi-lateral Implementer Agreement which is often a 'quick fix' to get two systems to talk to each other without taking wider interoperability issues into account.

The main incentive for communities to develop Application Profiles rather than 'quick fix' Implementer Agreements or ad hoc specifications is to be able, in future, to:

- interoperate with outside partners: as an example, European academia may want to share resources with the corporate world;
- build an infrastructure with (adaptations of) tools that have been developed for the wider market of the global adopter community: as an example, a small enterprise may want to use off-the-shelf authoring tools and repositories that make use of Learning Object Metadata.

[6] http://registry.k-int.com

7.2 Characteristics of Application Profiles

7.2.1 Why?

As indicated above, the principle motivation for defining an Application Profile is the desire to meet specific requirements, while retaining **interoperability**.

Interoperability itself has been defined in a number of ways. In the context of metadata, however, it usually refers to the ability of a system to process metadata instances produced by a third party system. Throughout this document we will refer to the system which is the source of the metadata records as the **source system** and to the system which is attempting to process them as the **target system**.

As noted above, many standards and specifications are deliberately designed to be inclusive and therefore, for example,

- May permit a wide range of controlled vocabularies to be used to describe a given element (e.g. 'Subject'), or
- will tend to limit the number of mandatory elements.

Whilst these decisions encourage participation, they also limit interoperability to a basic level that is appropriate for the wide audience that they address. For example, the source and target system may use different controlled vocabularies for which there is no mapping or, more difficult still, may have chosen to populate mutually exclusive subsets of optional elements.

Application profiles provide the flexibility to combine and adapt base schemas and other application profiles, to meet the needs of a particular community of practice whilst **retaining interoperability with the base schema**. The principles which need to be adhered to in order to achieve this interoperability are set out in **section 8** of this document whilst the mechanics for achieving this in practice are described in **section 9**.

7.2.2 Who?

A Community of practice could represent a wide range of grouping – large or small, for example:

- National (e.g. UK LOM CORE[7])
- Subject specific (e.g. ManUeL for Computer Science[8])
- 'Application' oriented (e.g. Curriculum Online[9] or ADL-SCORM[10])

The developers of the profile will need to take account of a variety of interests - e.g. the requirements of originating and receiving systems - and must ensure that there is clarity on the specific purpose for which the profile is being developed. This will vary according to the nature of the community. For example, a national profile needs to be flexible and inclusive whereas a profile for use by a specific system may be much more focussed.

BS8419[11] identifies six classes of 'user' associated with a community whose interests should be represented in the development of an Application Profile. Note this does not mean that all groups, particularly end users, need to be exposed to the details of the profile, but it does mean that their requirements need to be taken into account.

1. practitioners with the community of practice for whom the application profile is being developed;

[7] http://www.cetis.ac.uk/profiles/uklomcore
[8] http://sticef.univ-lemans.fr/num/vol2004/passardiere-11/sticef_2004_passardiere_11.htm
[9] http://www.curriculumonline.gov.uk/SupplierCentre/Metadataguides.htm
[10] http://www.adlnet.org/scorm
[11] op cit (see general references)

2. the technical team who will implement the application profile and deal with interoperability issues;
3. other technical implementers operating in the same domain, who already use metadata systems that may be adopted or interoperated with;
4. metadata authors, who will be entering data using the application profile schema;
5. the end users of any systems that utilize the data entered using the application profile, such as people who need to retrieve learning resources using a search tool, with at least one use case for each end user group (for example, one for learners and one for teachers);
6. any groups who have a governance role over the domain, reflecting any mandate to use a particular application profile, or to start from a particular base schema or profile.

7.2.3 What?

A profile is always based, initially at least, on an existing base standard or specification (e.g. IEEE LTSC LOM).

> *The general underlying principle is that, where a new application profile is being produced, it should either be based on one or more standards or on one or more existing application profiles of those standards and it should not compromise interoperability by breaking conformance with the existing standards.*

The application profile itself is best expressed as a “conceptual data model”. This should take the form of a text document or table, and should include an explanation of the overall structure, coverage and target audience for the application profile along with an exhaustive listing of all the data elements included. Each data element should be described using one or more attributes. A simple textual representation such as this makes the application profile accessible to as wide a constituency as possible.

In addition to the conceptual data model, it is common practice to provide one or more “bindings” that express the data model in a machine-readable manner. These “bindings will reflect a particular technology and may change over time. Common bindings in current use include XML-Schema and RDF-Schema. The use of XML-DTD was common a few years ago, but has now been deprecated.

Where possible, sample files showing conforming instances for each binding should also be made available by application profile developers.

8 Principles and practicalities

As outlined in section 7.2 above, metadata application profiles take one or more base standards or specifications as their starting point. The profile then imposes additional restrictions on this baseline. Modifications of this kind limit the options available to a subset of those available in the original specification (e.g. reducing a vocabulary list). The goal is to increase interoperability beyond the level of the base standard, without breaking interoperability with those applications that are unaware of the profile.

- For instance, a target system that conforms to the base standard will be able to process a metadata instance from a source that conforms to the application profile
- Similarly, a target system that conforms to the application profile will be able to process a metadata instance that conforms to the base standard. However, in this case, the target system may be unable to process the values of elements based on the base specification but restricted in the application profile

What are not permitted, then, are modifications to the base specification that break its conformance rules. Such modifications (sometimes called extensive or not compatible

modifications in the literature[12]) could result in the inability of a target system conforming to the base standard to process instances that conform to the profile.

Note that metadata application profiles are permitted to extend the base specification by adding new elements, where this is permitted by the base specification.

9 How to develop a Metadata Application Profile

9.1 Start from your own requirements

The basic goal of an application profile is to support specific requirements of a particular context through a profile of a generic standard. In order to bootstrap this process, it is important to have an explicit understanding of those specific requirements. In the case of a metadata application profile, this means that a clear **scope and purpose** statement must be developed: in other words, what are the metadata going to be used for?

> **Example 1**: In the ARIADNE Foundation, the basic aim is to facilitate share and reuse of learning objects. Metadata are used to enable end users to focus on relevant resources. Thus, the main purpose of metadata in the ARIADNE Knowledge Pool System is to facilitate search, and the main scope is a learning context.
>
> **Example 2**: UK LOM CORE (op cit), has been developed from a slightly different stand-point. It aims to identify common practice and provide guidelines that are optimised for use within the context of UK education. However, it is not indented to be too restrictive in nature. Instead, it is designed to be used as a basis for other, narrower, communities of interest (see for example, the JORUM[13] profile).

A particularly effective way to elicit requirements is the definition of so-called **use cases** that describe how an end user would make use of the application to be developed. From such a description, requirements can be deduced for the application. From those application requirements, metadata requirements may be deduced.

> **Example 1**: A use case might mention that end users are able to filter the available resources so that only those in their mother tongue are retained. This interaction requirement strongly suggests that a metadata element should be included that describes the language of the resource.
>
> **Example 2**: A requirement to identify learning resources which are available free of charge might be identified in a use case. This would lead the application profile developers to look closely at the 'cost' element within LOM to see how this can be achieved.

9.2 Data elements

9.2.1 Selection of data elements

Once the requirements are clarified, a first important decision in the actual development of a metadata application profiles is the selection of data elements that the application profile will be

[12] IMS Application Profile Guidelines for example
[13] http://www.jorum.ac.uk/docs/pdf/japv1p0.pdf

built from. Often, the profile developers will start from a metadata schema that has a scope and purpose similar to that of the application profile:

- for a simple, generic context, the Dublin Core Metadata Element Set might suffice;
- in the case of more complex audio-visual resources with a generic context, the MPEG-7 metadata schema may be more appropriate as a starting point;
- in a learning context (be it schools, academic, corporate or military), the IEEE LTSC Learning Object Metadata (LOM) standard typically provides the basic data element set to start from.

As mentioned before, in this document we will focus on LOM based application profiles. In practice, application profile developers often start from a simple spreadsheet where the rows correspond to the standard data elements. Table 1 is a simple example for the category of general metadata elements in LOM and whether or not they are included in the ARIADNE and EUN application profiles.

Table 1 - inclusion of LOM general category elements in ARIADNE and EUN application profile

Nr	Name	Explanation	ARIADNE	EUN
1	General	This category groups the general information that describes this learning object as a whole.	**Y**	**Y**
1.1	Identifier	A globally unique label that identifies this learning object.	**Y**	**Y**
1.1.1	Catalog	The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.	**Y**	**Y**
1.1.2	Entry	The value of the identifier within the identification or cataloging scheme that designates or identifies this leaming object. A namespace specific string.	**Y**	**Y**
1.2	Title	Name given to this learning object.	**Y**	**Y**
1.3	Language	The primary human language or languages used within this learning object to communicate to the intended user.	**Y**	**Y**
1.4	Description	A textual description of the content of this learning object.	**Y**	**Y**
1.5	Keyword	A keyword or phrase describing the topic of this learning object.	**Y**	**Y**
1.6	Coverage	The time, culture, geography or region to which this learning object applies.	**N**	**Y**
1.7	Structure	Underlying organizational structure of this learning object.	**N**	**Y**
1.8	Aggregation Level	The functional granularity of this learning object.	**Y**	**Y**

9.2.2 Dealing with size and smallest permitted maximum

Values for some data elements may be allowed to be present multiple times in one metadata instance: in LOM, this is defined through the size of the data element. If the size equals one, then the data element can only have one value in an instance. If the size is more than one, then the data element can have multiple values in an instance. In that case, a smallest permitted maximum (spm) is defined: this is the smallest number of occurrences of a field that an application should support when reading, writing or otherwise processing metadata instances.

As a general rule, an application profile can reduce the size of a data element, or keep it equal to the value in the base standard. An application profile cannot increase the size of a data element.

- If the size of the data element is one in the base standard, then the application profile can:
  - Reduce the size to zero: in that case, the data element is not present in the application profile. As an example, in Table 1, the size of the data element 1.6:General.Coverage is reduced to zero in the ARIADNE application profile.
  - Maintain the size of one: in that case, the data element can have a value in an instance of the application profile.
- For data elements with a size larger than one in the base standard, an application profile can:
  - Reduce the size to zero: in that case, the data element is not present in the application profile and the smallest permitted maximum is no longer applicable.
  - Reduce the size to one: in that case, the data element is still present in the application profile, but it can only have one value in a metadata instance. The smallest permitted maximum is no longer relevant.
  - Reduce the original size, but not below two and
    - Maintain the original smallest permitted maximum, if that is not larger than the new size.
    - Reduce the smallest permitted maximum: though this is not encouraged, it does not formally break interoperability, as the smallest permitted maximum does not impose a strict requirement.
  - Maintain the original size of larger than one and
    - increase the smallest permitted maximum: in that case, the data element can still appear multiple times, and applications are encouraged to process more instances of the values than the base standard suggests.
    - Maintain the original smallest permitted maximum: in that case, the application profile is identical to the base standard.
    - Reduce the smallest permitted maximum: though this is not encouraged, it does not formally break interoperability, as the smallest permitted maximum does not impose a strict requirement.

Table 2 illustrates the general rule for the ARIADNE and EUN application profiles. As the table illustrates, the ARIADNE application profile is more restrictive than the LOM base standard, as it excludes the data elements 1.6:General.Coverage and 1.7:General.Structure. Moreover, it only allows one instance of the data elements 1.1:General.Identifier, 1.3:General.Language and 1.4:General.Description, whereas the LOM standard allows multiple values for those data elements. The EUN application profile is identical to the LOM base standard.

Table 2 - size and smallest permitted maximum (spm) of elements from the LOM general category in the ARIADNE and EUN application profile

Nr	Name	Explanation	size/spm	ARIADNE	EUN
1	General	This category groups the general information that describes this learning object as a whole.	1	**1**	**1**
1.1	Identifier	A globally unique label that identifies this learning object.	spm=10	**1**	**spm=10**
1.1.1	Catalog	The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.	1	**1**	**1**
1.1.2	Entry	The value of the identifier within the identification or cataloging scheme that designates or identifies this leaming object. A namespace specific string.	1	**1**	**1**
1.2	Title	Name given to this learning object.	1	**1**	**1**
1.3	Language	The primary human language or languages used within this learning object to communicate to the intended user.	spm=10	**1**	**spm=10**
1.4	Description	A textual description of the content of this learning object.	spm=10	**1**	**spm=10**
1.5	Keyword	A keyword or phrase describing the topic of this learning object.	spm=10	**spm=10**	**spm=10**
1.6	Coverage	The time, culture, geography or region to which this learning object applies.	spm=10	**0**	**spm=10**
1.7	Structure	Underlying organizational structure of this learning object.	1	**0**	**1**
1.8	Aggregation Level	The functional granularity of this learning object.	1	**1**	**1**

9.2.3 Data elements from multiple namespaces

In principle, an application profile can be based on more than one base metadata schema. In one sense, the LOM standard itself illustrates this, integrating for instance the complete vCard schema to describe people or organisations.

However, there seems to be very little practice doing something similar for a particular metadata application profile.

9.2.4 Adding local data elements

Besides mixing and matching data elements from several base standards, an application profile may also include local data elements.

For example, LOM contains a single optional element (6.1) entitled cost with a value space of ‘yes’ or ‘no’. UK LOM Core gives this element a status of ‘recommended’ and adds an implementation guideline “If "yes", details of the actual cost should be included in 6.3 Rights. Description”. The Curriculum Online application Profile goes beyond this and makes the element mandatory. It also mandates that, if the value is ‘yes’ then a number of local data elements are also completed. These data elements cover pricing information (including a controlled vocabulary for license model, cost and currency) and support information.

9.3 Obligation of Data Elements

Once the full set of metadata elements to be included in the application profile has been decided upon, the status of these data elements can be defined. Typical options include:

- **Mandatory**: a value for the data element shall always be present in a metadata instance;
- **Conditional**: if a certain condition is satisfied, then a value for the data element shall be present in a metadata instance; if the condition is not satisfied, then a value for the metadata element may or may not be present.
  - **Example 1**: In COL, either the author or the publisher must be included in every metadata instance. In other words, if the author is not included, then the publisher must be included; if the publisher is not included, then the author must be included.
  - **Example 2**: In the Europortfolio ePortfolio Europass CV Application Profile, if the IMS LIP <QCL> element is used to reflect the Europass Education and training experience then some sub-elements like <Organization> and <Date> are mandatory but if this main element is used to reflect the Europass Driving Licence(s) part then only the <Title> sub-element is mandatory.
- **Recommended**: Some application profiles recommend including values for
- **Optional**: a value for the data element may or may not be present in a metadata instance;

As always, an application profile can impose more stringent obligations on data elements than the base standard does. An application profiles cannot relax such obligations: for instance, a mandatory element cannot lose its mandatory status in an application profile. In the LOM standard, all data elements are optional: that means that application profiles can make some of the data elements mandatory or conditional, based on specific requirements.

Note that the ‘Recommended’ status of a data element does not imply any strict requirement. It should be viewed more as guidance to implementers than as a hard obligation. Therefore it is possible for an application profile to alter the status of ‘Recommended’ data elements to ‘Optional’, though such an approach is not encouraged.

Table 3 summarizes the obligation of the data elements of the LOM General category in the ARIADNE and EUN application profiles.

Table 3: obligation of elements from the LOM general category in the ARIADNE and EUN application profile (M=mandatory, O=optional, N/A=not applicable, R=recommended)

Nr	Name	Explanation	ARIADNE	EUN
1	General	This category groups the general information that describes this learning object as a whole.	**M**	**M**
1.1	Identifier	A globally unique label that identifies this learning object.	**M**	**M**
1.1.1	Catalog	The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.	**M**	**M**
1.1.2	Entry	The value of the identifier within the identification or cataloging scheme that designates or identifies this leaming object. A namespace specific string.	**M**	**M**
1.2	Title	Name given to this learning object.	**M**	**M**
1.3	Language	The primary human language or languages used within this learning object to communicate to the intended user.	**M**	**M**
1.4	Description	A textual description of the content of this learning object.	**O**	**M**
1.5	Keyword	A keyword or phrase describing the topic of this learning object.	**O**	**R**
1.6	Coverage	The time, culture, geography or region to which this learning object applies.	**N/A**	**O**
1.7	Structure	Underlying organizational structure of this learning object.	**N/A**	**R**
1.8	Aggregation Level	The functional granularity of this learning object.	**O**	**O**

9.4 Value Space

In parallel with, or after, the definition of the obligation of the data elements, their value space must be defined. In this context, the value space defines the set of values that the data element shall derive its value from.

Again, the application profile may be more restrictive about the value space of a data element than the base standard is; it cannot be less restrictive.

In LOM, a value space is typically defined through one of the options below:

- A vocabulary: in that case the set of values is enumerated.
- A reference to another standard (e.g. ISO/IEC10646-1:2000) or specification (e.g. vCard)

The application profile can restrict the value space through the corresponding options below:

- A vocabulary can be restricted to a subset of the vocabulary in the original base standard.
- A reference to another standard or specification can be replaced by a reference to an application profile of that other standard or specification.

  Example 1: In ARIADNE, the values for LOM data element 5.1:Educational.InteractivityType are restricted to “active” or “expositive”, i.e. the value “mixed” is not retained from the LOM value space.

Example 2: In the Europortfolio ePortfolio Content packaging Application Profile, the title for the main items in the organization of the manifest has been restricted to use only five possible values {“PortfolioParts”, “Owners”, “Views”, “Presentation”, “Relationships”}.

9.5 Relationship and dependency

More complex inter-relationships and dependencies between data elements can also be defined in an application profile.

As always, the application profile may be more restrictive about such inter-relationships than the base standard is; it cannot be less restrictive. As the LOM standard does not include such restrictions, a LOM application profile can include arbitrary such restrictions.

Example 1: In the ARIADNE application profile, the value space of 5.2:Educational.LearningResourceType depends on the value of 5.1:Educational.InteractivityType: if the value of the latter is “active” then the value space for the type element is restricted to {“exercise”, “simulation”,”questionnaire”,”exam”,”experiment”, “problem statement”,”self assessment”}. If the value of interactivity type is “expositive”, then only one of the other values of the value space in LOM for resource type is allowed.

Example 2: In the LOM FR Application Profile, the value space of 4.4.1.2: Technical.Requirement.OrComposite.Name depends on the value of 4.4.1.1:Technical.Requirement.OrComposite.Type: if the value of the latter is “`operating system`” then the value space for the name element is restricted to {“`pc-dos`”, ”`ms-windows`”, ”`macos`”, ”`unix`”, “`linux`”, “`multi-os`”, “`none`”}. If the value of type is “`browser`”, then the value space for the name element is restricted to {“`any`”, “`netscape communicator`”, “`ms-internet explorer`”, “`opera`”, “`amaya`”, “`firefox`”, “`safari`”}.

9.6 Data Type profiling

In the LOM standard, the datatype “indicates whether the values are LangString (see Clause 7), DateTime (see Clause 8), Duration (see Clause 9), Vocabulary (see Clause 10), CharacterString, or Undefined” (LOM, p.4).

In effect, the data type in LOM is a metadata schema in its own right. All the rules defined above for application profiles of metadata schemas are thus also applicable to data types.

9.7 Application Profile Binding

The above sections deal with conceptual restrictions on application profiles. The general rule is that an application profile can be more restrictive than the standard it is based on, not less restrictive. In this way, any instance of the application profile is by definition also an instance of the base standard and interoperability between different application profiles of the same standard is ensured.

There is a similar rule on the level of a binding of an application profile, for instance in XML or RDF: the goal is to make sure that any instance that conforms to the relevant binding of the base standard also conforms to the binding of the application profile.

In an XML context, it is important to make sure that application profile data element names are either the names from the corresponding data elements in the base standard, or declared explicitly as subclasses of these data elements. Of course, this rule does not apply to extension data elements that have no equivalent in the base standard.

Example: In the LOM FR Application Profile, the element names in the AFNOR document are translated in French but the elements name in the XML Schema binding still use the English names to be conformant and compatible with the IEEE LOM base schema. In the same manner, this profile used some extensions with new elements (“general.date”, “general.type”, “educational.activity”, “educational.assessment”) which still use English name even if they are only relevant for the French community.

9.8 Conclusion

In this section, we analysed step-by-step how application profiles can be defined.

Note: It is important to note that the requirement to include a value for a particular data element from a particular value space in a metadata instance does **not** imply that this value must be provided as such by end users!

Example 1: In ARIADNE, the data element 1.1.1:General.Identifier.Catalog is mandatory. However, end users never see it, never provide it, and can in no way make use of it. The value of that data element in ARIADNE is always “Ariadne”. Its only function is to indicate the source of the learning object and the metadata when they are exposed to external infrastructures.

Example 2: There are several initiatives that try to automate the generation or collection of metadata: see for instance http://ariadne.cs.kuleuven.ac.be/amg.

10 Examples

10.1 LOM based

- Ariadne: http://www.ariadne-eu.org/
- EUN: http://www.eun.org/
- UK LOM Core: http://www.cetis.ac.uk/profiles/uklomcore
- SCORM SCO, asset, aggregate: http://adlnet.org/

10.2 Learner Information Profile

- Europass CV (CWA14926:2004 - Guidelines for the production of learner information standards and specifications)
- Europass Diploma Supplement (CWA14926:2004 - Guidelines for the production of learner information standards and specifications, Telcert project: German and French Application Profiles)
- Europass Certificate Supplement (CWA … :2005 - A European Model for Learner Competencies)
- Europass Language Portfolio (CWA … :2005 - A European Model for Learner Competencies)
- UK-LeaP (BS-8878)

11 Implementation issues

This aim of this section is to describe some specific use cases of application profiling:

- Section 11.1 below outlines the general types of changes to a base specification that are and are not acceptable within an application,
- Section 11.2 outlines the different roles of source and target systems,
- Section 11.3 describes the specific case of cascading profile,
- Section 11.4 gives some information about dealing with some implementations issues in case of non compatible modifications,
- Section 11.5 outlines the basic principles of conformance testing of application profiles.

11.1 Overview of Modifications that are not allowed

Example of modifications which cannot be included in an application profile include

- Extensive modification:
  Modifications of this nature include extensions from the original specification (e.g. changing a mandatory element to an optional one).
- Not Compatible:
  This includes major modification from the original specification (i.e. changing a name of an element by an another name, extension of vocabulary by including new items, extending cardinality of elements).

Compatibility types

Restrictive	*Extensive*	*Not compatible*
Derived specification is a subset of the base specification: This is an Application Profile	Derived specification contains extensions from the base specification	*Derived specification contains major modification form the base specification*
Fully compatible with the base specification	Can be incompatible with the base specification	*Incompatible with the base specification*

Maintain interoperability ⇢ Major difficulties for interoperability

These include:

- Altering the relative location of an existing data element (not compatible modification, for example: moving a parent element to a child one)
- Creating a new element that mimics the semantic intent of an existing element (not compatible modification)
- Changing the meaning of an existing element (not compatible modification)
- Changing the name of an element (not compatible modification)
- Extending a schema other than at a specified extension point (not compatible modification, for example including a new element in a sequence where there is not specific extension point for that purpose)
- Making a mandatory element optional (extensive modification)
- Extending cardinality of an element (not compatible modification)
- Adding new items in a controlled vocabulary list (not compatible modification)
- …

Example of modifications which can be included in an application profile include:

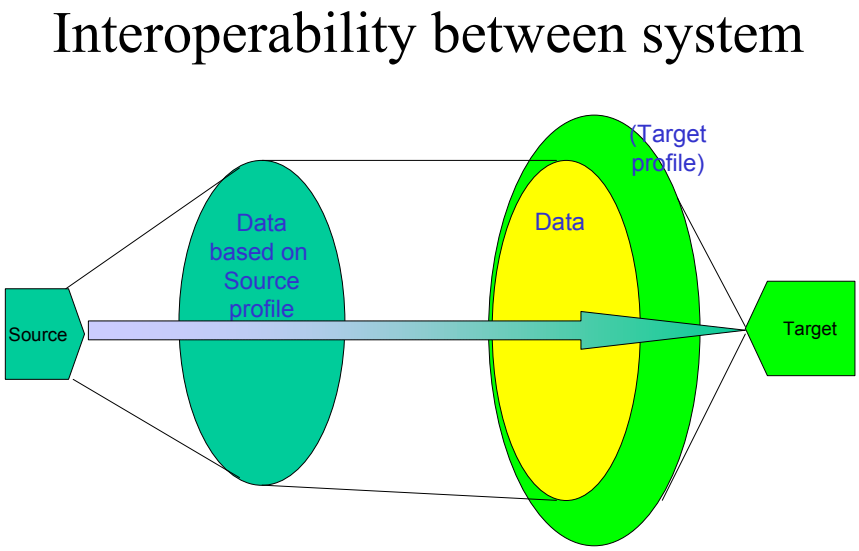
- Selection of data elements
- Changing/defining size and smallest permitted maximum
- Obligation of Data Elements (mandatory, conditional, recommended, optional)
- Value space modifications

11.2 Source / Target profiles

Section 7.2.1 introduced the concept of source and target systems when discussing issues of interoperability. Within a community of interest, application profiles must take account of the needs of both types of system. It is also important to consider the options for interoperability with systems from outside the community which are based on the base specification or some other application profile. The importance of this latter point will vary from community to community, as will the importance of enabling systems to be originators and/or receivers.

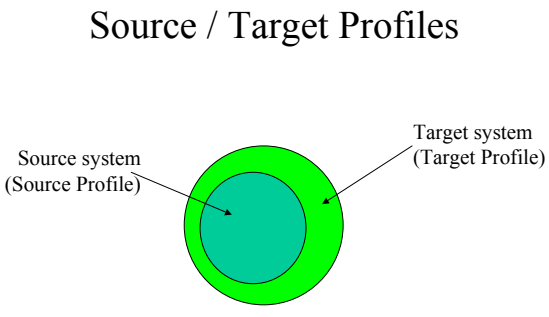
Example: The target system must be able to interpret metadata instances from a source system which are conformant with the base specification, ignoring (though not necessarily discarding) data which it does not understand.

Where both source system and target system have implemented application profiles based on the same base specification (e.g. IEEE LOM), then we can refer to the profile adopted by the source system as the 'Source' profile and that profile adopted by the target system as the 'Target' profile.

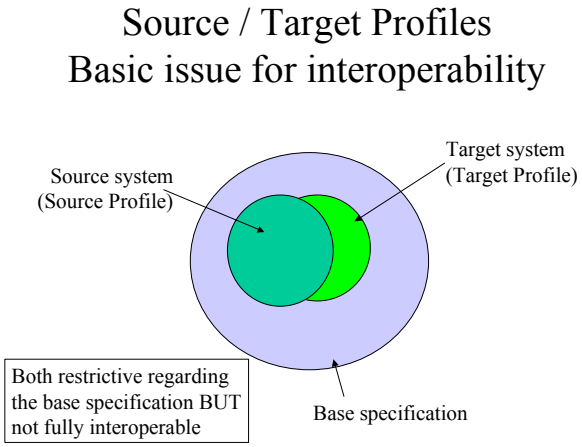


There is one particular scenario where interoperability between Source and Target profiles can be maximised:

- Where the "Source" profile is a restrictive profile of the "Target" profile



In reality, however, things are often more complex than this. Even where the Source and Target profiles are both application profiles from a based specification then each profile might be extensive, restrictive or include both extensive and restrictive elements, as illustrated by the diagram below:



Even in these most complex cases, a baseline level of interoperability will be maintained between any two systems so long as their application profiles have been developed according to the principles set out in section 8.2. Some level of data loss is, however, inevitable. In order to minimise data loss, it is best, where possible, to ensure that the Target AP is extensive regarding the Source AP and both APs are restrictive regarding the base schema ("recommended solution" below). So in that case all instances (metadata documents) coming from a system using the Source AP would be read by systems using the Target AP **and** all instances coming from a system using the Source AP or the Target AP would also be read by systems using the base specification.

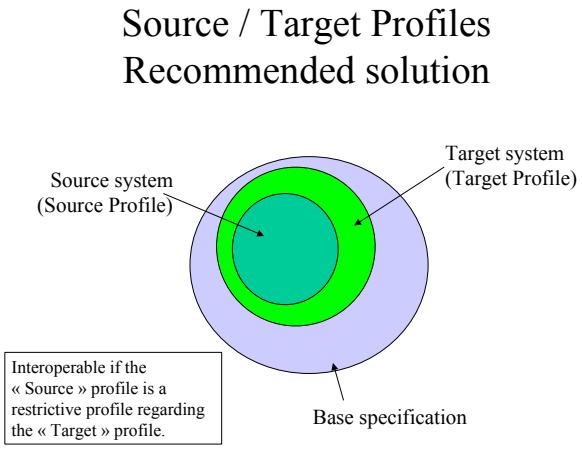


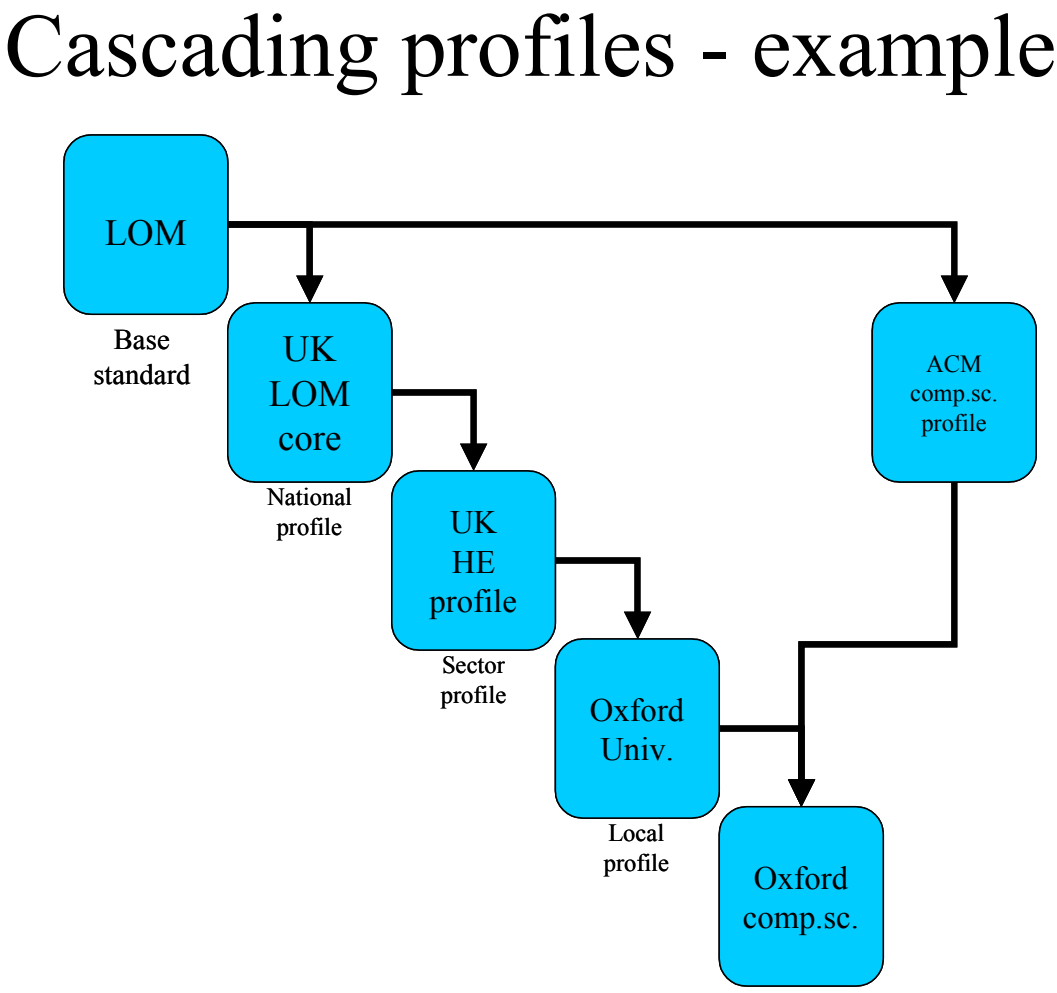
Figure - Scenario where interoperability between Source and Target profiles of a same based specification can be maximised ("Source" and "Target" profiles are restrictive profiles of the base specification)

11.3 Cascading profiles

In many cases, authors of an application profile will take as their starting point not a base specification but an already existing application profile of that specification. As the focus of the community producing a profile increases, it is possible to have several 'layers' of refinement with each successive layer representing a narrower community of interest with a more specific focus. All that has been said to date about assuring interoperability holds true here. A metadata instance

that conforms to a narrow profile must also conform to each of the higher level profiles on which it is based, including the base specification.

Where the situation becomes potentially more complex is where a community wishes to develop a profile which is based on two or more parent profiles whose only common reference point is the base specification, or a profile thereof. In the hypothetical situation illustrated below, the Oxford University Computer Science Department wishes to develop an application profile of IEEE LOM which is conformant to both the ACM Computer Science profile and the Oxford University profile, which is itself based on the UK HE profile which, in turn, is based on UK LOM Core,



11.4 Dealing with modifications and incompatible application profiles

The purpose of this section is to give some simple recommendations about how to solve the most simple interoperability issues which arise due to incompatible application profiles:

1. Two incompatible application profiles using the same base specification or standard.
2. Or an incompatible existing spec regarding a destination specification or standard (for example to transform a community metadata specification to be conformant with LOM).

11.4.1 Incompatible cardinality

It is sometimes possible to use a simple transformation to modify cardinality which will allow an incompatible metadata instance from an originating system to validate against the receiving system.

For example, if the receiving system only allows a single value and the originating system provides multiple values, the transformation may keep only the first value, or, in case of internationalisation, only the English value.

In case of XML schema based application profiles, XSLT can be used to do this kind of transformation.

11.4.2 Additional elements or sub-elements

Occasionally it will be possible to use a simple transformation to suppress the additional elements in the document prior to validation. However, the criticality of the data being discarded should first be assessed to reduce the possibility of a major loss of semantic value.

This technique can be used, for example, where the originating system uses an extension to the base data model without using an extension point provided by the base specification.

11.4.3 Different value spaces

Where the originating and receiving systems use values for an element drawn from different value spaces, the only way to ensure interoperability is to use an external crosswalk which maps relationships between terms in these vocabularies. (See CWA Harmonisation of Vocabularies for more details).

11.4.4 Extensive modification (changing mandatory element to optional one)

In this case, a receiving system which enforces conformance with the base specification should be able to simply ignore the extensive modifications. Similarly, a receiving system which enforces conformance to the application profile should have no problems with this type of modification as originating systems which conform to the base specification will not be populating these elements.

11.5 Validation / Testing / Conformance - XML Schema binding

For all modification allowed by W3C XML Schema specifications, it is possible to use a parser which checks the validity of a metadata instance with respect to an application profile binding. Most other types of modification (like validating a conditional modification) can be validated using Schematron[14] specifications.

IMS and the European Union Telcert[15] project have provided a set of open source tools and guidelines which allow users to build profiles including all these types of modification (Schemaprof), generating the schema for the application profile binding (STT) and editing metadata instances conforming to these Application Profiles (CRT). There is also a test suite provided by the Opengroup, a partner in the Telcert project, which allows the testing of all of these types of modification.

[14] Schematron spec: http://www.schematron.com/spec.html
[15] http://www.opengroup.org/telcert/ and http://www.imsglobal.org/telcert.html