IMS Meta-Data Best Practice and Implementation Guide

Final Specification
Version 1.1

About This Document

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Revision History

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Final 1.0	August 20, 1999	The version 1.0 of the IMS Meta-Data Best Practice and Implementation Guide.
Final 1.1	May 5, 2000	All element names changed to lower case only. Comments on namespace use changed.

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Introduction

Purpose

Designers and developers of online learning materials have an enormous variety of software tools at their disposal for creating learning resources. These tools range from simple presentation software packages to more complex authoring environments. They can be very useful in allowing developers the opportunity to create learning resources that might otherwise require extensive programming skills. Unfortunately, the wide variety of software tools available from a wide variety of vendors produce instructional materials that do not share a common mechanism for finding and using these resources.

Descriptive labels can be used to index learning resources to make them easier to find and use. Such labels are "data about data" and are referred to as "meta-data." An example of meta-data is the label on a can of soup, which describes the can's ingredients, weight, cost, and so forth. Another example is a card in a library's card catalog, which describes a book, its author, subject, location within the library, and so forth.

A meta-data specification makes the process of finding and using a resource more efficient by providing a structure of defined elements that describe, or catalog, the learning resource, along with requirements about how the elements are to be used and represented.

Background

In 1997, The IMS Project, part of the non-profit EDUCOM consortium (now EDUCAUSE) of US institutions of higher education and their vendor partners established an effort to develop open, market-based standards for online learning, including specifications for learning content meta-data.

Also in 1997, groups within the National Institute for Standards and Technology (NIST) and the IEEE P.1484 study group (now the IEEE Learning Technology Standards Committee - LTSC) began similar efforts. The NIST effort merged with the IMS effort, and the IMS began collaborating with the ARIADNE Project, a European Project with an active meta-data definition effort.

In 1998, IMS and ARIADNE submitted a joint proposal and specification to IEEE, which formed the basis for the current IEEE Learning Object Meta-data (LOM) base document, which is a classification for a pre-draft IEEE Base Document. IMS publicized the IEEE work through the IMS community in the US, UK, Europe, Australia, and Singapore during 1999 and brought the resulting feedback into the ongoing specification development process.

Scope

The IEEE LOM Base Document defines a set of meta-data elements that can be used to describe learning resources. This includes the element names, definitions, datatypes, and field lengths. The specification also defines a conceptual structure for the meta-data. The specification includes conformance statements for how meta-data documents must be organized and how applications must behave in order to be considered IEEE-conforming.

The IEEE Base Document is intended to support consistent definition of meta-data elements across multiple implementations, but does not (at the time of this writing) include information on how to represent meta-data in a machine-readable format, necessary for exchanging meta-data. The number of items defined within the IEEE Base Document was large and many participating organizations within the IMS community recommended that a select Core of elements must be identified to simplify initial implementation efforts. The IMS developed a representation of the meta-data in XML (eXensible Markup Language) and surveyed its member institutions around the world to identify the Core elements.

The IMS Meta-data Best Practice and Implementation Guide therefore includes or references:

IEEE Learning Object Meta-data Base Document Version 3.5

IMS Learning Resource Meta-data XML Binding Specification Version 1.1

IMS Core and Standard Extension Library Version 1.1

IMS Taxonomy and Vocabulary Lists

The IMS Meta-data Best Practice and Implementation Guide identifies a minimum set of IEEE meta-data elements called the IMS Core. The remaining IEEE LOM Ver. 3.5 meta-data elements form the IMS Standard Extension Library (SEL). Choosing this smaller set of elements will foster a base level of meta-data interoperability and will enable easier implementation of basic meta-data capabilities into software vendors' existing products.

The IMS Meta-data Best Practice and Implementation Guide provides general guidance about how an application may use the Core and Extended meta-data elements. The IMS Learning Resource XML Binding Specification provides a sample XML representation and document type declaration (DTD) of a conforming meta-data record to assist developers with their meta-data implementations. Both the IEEE and IMS documents do not address details of meta-data implementation, such as its architecture, programming language, and data storage approach.

The IMS will continue to offer guidance and support documents related to the IEEE meta-data efforts. Most often, these documents will focus on implementation and binding issues. The IMS community will continue to present the IEEE community with reference binding and implementation documents for a variety of learning resource needs such as enterprise interoperability, content packaging, and learning management. It is hoped that such reference documents may be helpful in the development of IEEE sanctioned binding and implementation guidelines.

Meta-data system

Overview

The IEEE conceptual model for meta-data definitions is a hierarchy. At the top of the hierarchy is the "root" element. The root element contains many sub-elements. If a sub-element itself contains additional sub-elements it is called a "branch." Sub-elements that do not contain any sub-elements are called "leaves." This entire hierarchical model is called the "tree structure" of a document. The relationship between the root, branches, and leaves is depicted in Figure 1 using sample elements from the IEEE Base Document.

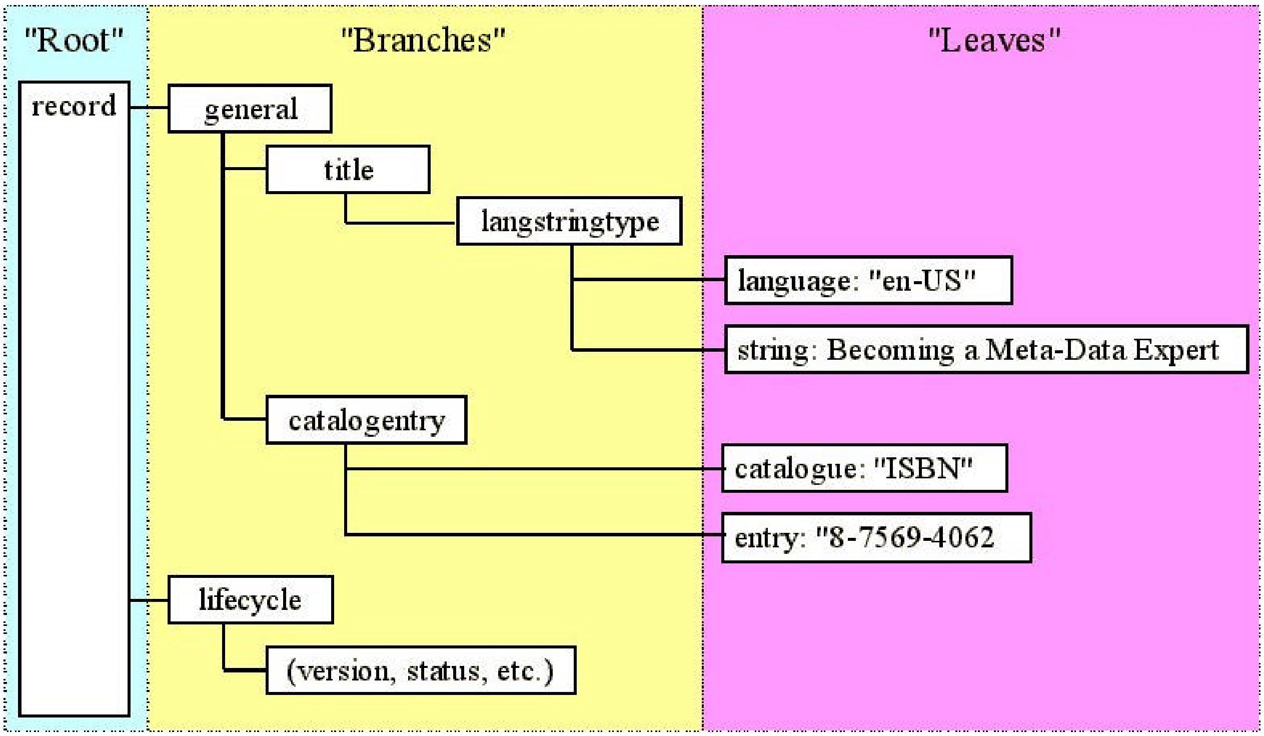

Figure 1. Hierarchical view of meta-data elements

Each element in the meta-data hierarchy has a specific definition, datatype, and allowable value. All of the details about each individual meta-data element can be found in the IMS Information Model Document that is available at: http://www.imsproject.org/metadata/mdinfov1p1.html The information model is based on the IEEE LTSC LOM V3.5 Base Document available at http://ltsc.ieee.org/doc/wg12/scheme.html

IEEE Meta-data Elements and Structure

The IEEE LOM Base Document lists all of the meta-data elements in a tabular format. Such a format enables easier reading of the element definitions, datatypes, notes, and examples as well as making it easier for printing. Sometimes it is useful to see a full representation of the meta-data as a hierarchy of elements. That representation is provided below.

The IMS community has taken IEEE meta-data and divided it into IMS Core and Standard Extension Library (SEL) elements. This is not meant to change any aspect of the elements, but rather identifies those elements the IMS community feels are fundamental as a Core set of meta-data. The IMS Standard Extension Library is based upon the remaining set of IEEE LOM elements that are not used in the IMS Core.

The listing below shows the Core elements underlined and in red text and the label "Core" whereas the SEL elements are identified by blue text and the label "SEL". Only the actual data "leaves" are labeled as "Core" or "SEL". With this categorization, the full set of IMS meta-data elements contains 19 IMS Core elements and 67 SEL elements.

IMS Core and SEL Meta-data Elements

Number	Element Name				IMS Core or SEL
1	**general**				
1.1		idenfier:Reserved			
1.2		title			
			langstring		
				language	SEL
				string	Core
1.3		catalogentry			
1.3.1			catalogue		Core
1.3.2			entry		Core
1.4		language			Core
1.5		description			
			langstring		
				language	SEL
				string	Core
1.6		keywords			
			langstring		
				language	SEL
				string	SEL

1.7	coverage			
		langstring		
			language	SEL
			string	SEL
1.8	structure			SEL
1.9	aggregationlevel			SEL
2	**lifecycle**			
2.1	version			
		langstring		
			language	SEL
			string	Core
2.2	status			SEL
2.3	contribute			
2.3.1		role		Core
		entity		Core
		date		
			datetime	Core
			description	
			language	SEL
			string	SEL
3	**metametadata**			
3.1	identifier:Reserved			
3.2	catalogentry			
3.2.1		catalog		SEL
3.2.2		entry		SEL
3.3	contribute			
3.3.1		role		SEL
3.3.2		entity		SEL

3.3.3			date				
				datetime			SEL
				description			
					langstring		
						Language	SEL
						string	SEL
3.4		metadatascheme					Core
3.5		language					Core
4	**technical**						
4.1		format					Core
4.2		size					SEL
4.3		location					Core
4.4		requirements					
4.4.1			type				
				langstring			
					language		SEL
					string		SEL
4.4.2			name				
				langstring			
					language		SEL
					string		SEL
4.4.3			minimumversion				SEL
4.4.4			maximumversion				SEL
4.5		installationremarks					
			langstring				
				language			SEL
				string			
4.6		otherplatformrequirements					
			langstring				
				language			SEL
				string			

4.7		duration				
			datetime			SEL
			description			
				langstring		
					language	SEL
					string	SEL
5	**educational**					
5.1		interactivitytype				SEL
5.2		learningresourcetype				
			langstring			
				language		SEL
				string		SEL
5.3		interactivitylevel				SEL
5.4		semanticdensity				SEL
5.5		intendedenduserrole				SEL
5.6		learningContext				
			langstring			
				language		SEL
				string		SEL
5.7		typicalagerange				
			langstring			
				language		SEL
				string		SEL
5.8		difficulty				SEL
5.9		typicallearningtime				
			datetime			SEL
			description			
				langstring		
					language	SEL
					string	SEL

5.10		description			
			langstring		
				language	SEL
				string	SEL
5.11		language			SEL
6	**rights**				
6.1		cost			Core
6.2		copyrightandotherrestrictions			Core
6.3		description			
			langstring		
				language	SEL
				string	Core
7	**relation**				
7.1		kind			
			langstring		
				language	SEL
				string	Core
7.2		resource			
7.2.1			identifier:Reserved		
7.2.2			description		
				language	SEL
				string	SEL
8	**annotation**				
8.1		person			SEL

8.2		date			
			datetime		
			description		
				language	SEL
				string	SEL
8.3		description			
			langstring		
				language	SEL
				string	SEL
9	**classification**				
9.1		purpose			Core
			langstring		
				language	SEL
				string	Core
9.2		taxonpath			
9.2.1			source		SEL
9.2.2			taxon		
9.2.2.1				id	SEL
9.2.2.2				entry	SEL
9.3		description			
			langstring		
				language	SEL
				string	Core
9.4		keywords			
			langstring		
				language	SEL
				string	Core

Conformance

As of this writing, the IEEE LOM group is still working on the exact conformance statements that will be included in the LOM specification. Conformance is a difficult matter to settle as the language used in conformance statements must be very precise and meaningful. The main intent of conformance statements has been identified by the IEEE LOM working group. They have agreed that meta-data conformance statements must exist that help to:

- Preserve the conceptual, semantic, and structural integrity of the meta-data
- Allow for complete preservation of meta-data when storing and transmitting meta-data records

The efforts within the IEEE to arrive at sound conformance statements are ongoing. The conformance statements provided below serve as example statements that try to capture the intent of the IEEE effort as outlined above. They are taken directly from the current IEEE working group's documents. They are only provided here to illustrate the types of rules that IEEE conforming documents and applications may be held to.

Meta-data Instance Conformance

A meta-data instance conforms to the LOM if it satisfies the following four requirements:

The meta-data instance must contain one or more LOM element(s).

All LOM elements in the meta-data instance are used to describe characteristics as defined by the LOM spec. (This means that one shall not abuse for instance the title element to describe the fonts used in the document.)

Values for LOM elements in the meta-data instance are structured as defined by the LOM specification and this structural information is carried within the instance.

(This means that the grouping in categories and subelements must be maintained. But it does not mean that representations cannot define mappings of this structure as they see fit. More specifically, an XML representation can use the lang attribute to represent the Language element of a langstringType value.)
or
Bindings must carry equivalent information about the meta-data so that conversions between bindings do not induce loss of information as defined within the specification.

If the instance contains extensions to the LOM structure, then extension elements do not replace elements in the LOM structure.

Meta-data Application Conformance

A meta-data application conforms to LOM if it satisfies the following two requirements:

A LOM conforming application must be able to process at least one LOM element.

If an application receives a conforming LOM meta-data instance, stores it, and then transmits it, then the application preserves the original meta-data instance during retransmission. The application is not required to preserve elements beyond the min-max items of a list or the characters beyond the min-max of a string.

Caveat: Preservation means that the original instance is not changed in any way. i.e. that it "doesn't change a comma".

Extensions

There has been, and continues to be, much debate on how to best handle meta-data extensions. There is widespread consensus that developers must be able to extend the IMS meta-data, but there has been little agreement on how this is best done. In the end, it is left up to individual developers and implementers to make decisions on how to best extend the IMS meta-data. The IMS Learning Resource Meta-data XML Binding Specification provides an "extension" element to facilitate extending the meta-data.

As pointed out above, the rule regarding extensions is that they do not conflict with or alter specified meta-data elements. While the IEEE will provide the final wording on this, the intent is to discourage developers from extending their meta-data records in non-conforming ways. For example, a meta-data instance should not have a new element, say *TitleAndVersion*, that is used as a replacement for already existing elements; in this case the *title* and *version* of the meta-data structure. It does allow such an element to be present, but then the information must be replicated in the *title* and *version* elements of the meta-data.

IMS Best Practice Core

Overview

The IMS represents a number of large and small educational institutions, training organizations, and software vendors who are interested in incorporating learning resource meta-data into their software products. The IMS conducted a survey of these institutions and organizations to determine which meta-data elements from the IEEE LOM Ve r. 3.5 Base Document were more fundamental than others. The IMS then adopted a Core set of meta-data elements chosen from these survey responses gathered from the IMS community in the U.S., Australia, Asia, and Europe.

Implementing at least a Core set of elements will greatly assist meta-data tool and product implementers by reducing the full set of possible elements to a manageable number of expected elements. The definition of Core elements is:

"The Core represents a set of elements considered as fundamental by a broad learning community for describing learning resources. Many elements will have a different value to various communities of use. The Core elements should not be interpreted as mandatory."

Rationale

Many meta-data implementers were initially optimistic that their participation in the IMS consortium would help produce a relatively small but well defined and agreed upon set of meta-data elements. This optimism soured as the set of proposed meta-data elements grew increasingly larger. Many vendors expressed little or no interest in developing products that were required to support a set of meta-data with over 80 elements.

The implementers' reasoning is quite simple: Most software vendors are not in the learning resource business or the learning resource meta-data business exclusively. Most have existing products that they hope could support a minimum baseline of elements that the learning resource community would agree to be essential. They also want to be able to make marketing statements such as "IEEE/IMS meta-data conforming document." While initial support of a core set of elements could lead to a future iteration of the software product that will support many more elements, the burden to support 80+ meta-data elements on the first iteration of a product is too great for most vendors to choose to bear.

The result of trying to force too large a set of elements on implementers would most likely be that implementers themselves would reduce the size of the entire set to what they considered to be a more manageable number. This might be done in collaboration with other vendors, or individual companies might choose to define their own minimal set. As user communities begin specifying requirements for certain subsets, the vendors would be forced to support the union of those requirements that would again push the total number of fields that must be supported upwards. The issue for most implementers is not whether to support many fields, but when to support them. The IMS community feels that broad adoption requires a smaller set of suggested fields at first.

IMS Core Meta-data Elements and Structure

By removing all of the Standard Extension Library elements already identified in the LOM specification, one can easily see the IMS Core set of meta-data elements. All of the detailed information regarding each individual element is found in the IEEE LOM Base Document. The representation found below of the IMS set of Core elements is provided as a quick overview of those elements and how they are hierarchically structured.

IMS Core Meta-data Elements

1	**general**				
1.1		idenfier:Reserved			
1.2		title			
			langstring		
				string	Core
1.3		catalogentry			
1.3.1			catalogue		Core
1.3.2			entry		Core
1.4		language			Core
1.5		description			
			langstring		
				string	Core
2	**lifecycle**				
2.1		version			
			langstring		
				string	Core
2.3		contribute			
2.3.1			role		Core
			entity		Core
			date		
				datetime	Core
3	**metametadata**				
3.1		identifier:Reserved			
3.4		metadatascheme			Core

3.5		language			Core
4	**technical**				
4.1		format			Core
4.3		location			Core
6	**rights**				
6.1		cost			Core
6.2		copyrightandotherrestrictions			Core
6.3		description			
			langstring		
				string	Core
9	**classification**				
9.1		purpose			Core
			langstring		
				string	Core
9.3		description			
			langstring		
9.4		keywords			
			langstring		
				string	Core

Taxonomy and Vocabulary Guide

Taxonomies and vocabularies are structured collections of terms that can serve as values for the meta-data elements discussed previously. They are part of the IEEE/IMS set of meta-data and are subject to best-practice policies. This subsection outlines current IMS best-practice guidelines for taxonomies and vocabularies.

Rationale

Just as meta-data elements must accurately describe resources, the taxonomies and vocabularies that are their values also need to be precise. Just as meta-data elements must be easy to identify and use, taxonomies must be familiar both to developers and consumers of learning resources. Useful and useable meta-data elements and taxonomies together provide the foundation for a vigorous market in learning resources. Hence, best-practice considerations apply to taxonomies and vocabularies as forcefully as to other aspects of IMS meta-data.

Viewed from this perspective, the goal of IMS meta-data best practices as applied to taxonomies and vocabularies is to work with various communities interested in learning resources -- including developers, catalogers and consumers -- to foster the adoption of taxonomy standards that are shared as widely as possible. IMS wants to make the communities aware of standardized (or at least popular and useful) taxonomies that might suit their needs; and to try to minimize the creation of new "home-grown" taxonomies by communities, when existing ones are perfectly adequate for their purposes.

Best practices guidelines concerning taxonomies and vocabularies do not require or even recommend a single taxonomy. As we learned from our earlier IMS taxonomies work, no single controlled vocabulary such as, say, the Library of Congress Subject Headings (whose elements might be values for the discipline characteristic of *classification.purpose*) will be acceptable to all communities. Rather, the guidelines are based on a broad survey of various fields of use and of several IMS meta-data properties or elements that take taxonomies as values. The guidelines will provide information about the many vocabularies that are "best" -- or at least commonly used -- to describe learning resources in these communities and for these meta-data properties.

Targeted Elements

The initial set of elements (the ones above the double line in the following table) was selected simply by looking at all properties in the IEEE LOM Base Document that take vocabularies or taxonomies as values. The criteria used to select important elements included:

whether they were part of the IMS Core, or in SEL (Core ones were deemed more important)

whether the element was well-defined, understood by communities of users and also had emerging standard taxonomies associated with them (the "low hanging fruit" was generally viewed as more important)

This initial list of elements was extended through discussions with key contacts in the different fields of use. In particular, several of these groups were already developing and using vocabularies for additional IMS meta-data properties (often ones that on our estimate appeared formative or even ill-defined). These have been included in cases where the controlled vocabularies appear to be relatively broadly used within a significant community or practice . and even though, in some cases, the vocabularies may not yet be stable. This means that some of the included vocabularies and taxonomies were ones that were popular in one field of use, but not necessarily in others; further, some whole elements or properties seem to be important in one field, but are rarely used in others, if at all.

Element[2]	Source	Description[3]
general.language	IMS Core	The human language used by the typical intended user of the resource.
classification.purpose [discipline]	IMS Core	Subject area (note: general.keywords may also be used to record subject information)
technical.format	IMS Core	Technical data type of the resource
educational.learning context	SEL	Typical kind of learners; grade or competence level usually associated with a resource (note classification.purpose [Educational Level] may also be used to record level or grade-related information)
technical.requirements.Name	SEL	Operating systems(s) under which resource can run (only if Type='Operating System')
general.aggregation level	SEL	The functional size of the resource.
classification.purpose [Educational Objectives]	IMS Core	Learning goal
educational.learning resourcetype	SEL	Specific kind of resource, most dominant kind first.
educational.interactivity type	SEL	The type of interactivity supported by the resource
educational. interactivitylevel	SEL	Level of interactivity between an end user and the resource
educational.intended enduserrole	SEL	Normal user of the resource, most dominant first
educational.difficulty	SEL	How hard it is to work through the resource for the typical target audience
educational.typical learningtime	SEL	Approximate or typical time it takes to work with the resource

[2] In some cases the elements listed here are not ones that have values; rather values are associated with subelements. For example, values are associated with *educational.typicallearningtime.datetime*, not, strictly speaking, with *educational.typicallearningtime.* For simplicity, we use the ellipsis where it creates no ambiguity.

[3] In most, but not all cases, these descriptions are taken from the IMS meta-data specification.

Results

Discussions with key contacts in the various fields of use have enabled us to find several dozen vocabularies and taxonomies for targeted meta-data. The vocabularies differ across many dimensions. They range from small vocabulary lists, such as five options for *educational.difficulty* ({0,1,2,3,4}), to multi-level discipline taxonomies comprising hundreds of terms. In many cases, such as *classification.purpose* [discipline], vocabularies are long-established; in others they are of relatively recent (home-grown) origin, and often used only by that field, or perhaps even a small community within a sector. For some elements (discipline again is an example), there are several competing taxonomies, even within a single field of use. For other elements, no dominant vocabulary has emerged for any field. The following paragraphs present our survey results in some detail, and summarize some best-practice guide lines.

Conclusions and Recommendations

The following table summarizes the results of our survey of taxonomies and vocabularies, listing formal and informal designations for schemes that were nominated for the elements discussed above by various fields of use. The table also points to sources (URLs for locations that list the vocabularies in complete detail, and in some cases that represent a controlling authority which maintains this information). Finally, the Table also notes some summary characteristics for each taxonomy or vocabulary, limited mainly to comments on overall structure, origins, relationships to other vocabularies, stability and maturity, and whether the vocabulary is open or controlled.

For a couple of reasons not all of these vocabularies can be viewed as "best practices" in any strict sense, nor even highly recommended choices for their associated meta-data element. First, in some cases, such as discipline, several very mature alternative taxonomies are popular -- even within a single field of use. No single one emerges as best, except, perhaps, in very specialized fields, such as medicine. Second, many of the vocabularies are relatively unstable and immature. For these reasons, the taxonomies summarized below are, in general, best viewed as common practice guidelines, rather than best practice recommendations. In most cases, prospective users of taxonomies -- whether using them to describe known resources or to construct searches for unknown ones -- should consider their needs, the appropriate topic area and field, as well as the credibility of sources of alternative vocabularies, as part of the process of deciding what practice is best for them.

The Table of common practice taxonomies also suggests several features of several taxonomy services that could help users learn about available vocabulary alternatives and select ones appropriate to their meta-data needs. Perhaps the most important insight is that to choose the right vocabularies -- ones in particular that are shared by wide communities of practice -- users will need more than simple access to registries or repositories that catalog taxonomies and vocabularies. In addition, they will need access to information that can quickly educate them about the features of the various vocabulary alternatives available to them. The kinds of information that have surfaced during this survey and analysis include:

- element name
- field of use
- source location
- maintaining agency
- extensibility policies
- user community or audience
- stability
- completeness (and related quality judgements)

- relationships (with other taxonomies and vocabularies)

first pieces of info are just basic identification; others identify the source and communities of practice; the final ones are (sometimes subjective) assessments of the maturity of the vocabulary, relative to its user community. This list is not complete. A fully functional collection of taxonomy services built along these lines would not only allow users to choose the most appropriate vocabularies, but would also help extend the terms, as needed, in coordination with the maintaining authorities.

Element	Taxonomy/ Vocabulary Scheme	Fields of Use	Characteristics	Sources
general.language	RFC 1766	US Higher Ed AU Higher Ed	Stable and mature; national/international scope; controlled vocabulary	http://www.imc.org/rfc1766
	ABS 1267	AU Higher Ed, AU K12	Relatively stable and mature; national scope; controlled vocabulary	
	ISO639; ISO3166	AU Higher Ed, US Higher Ed	Stable and mature; national/international scope; controlled vocabulary	http://www.iso.ch/
	Z39.53	US Higher Ed	Stable and mature; national/international scope; controlled vocabulary	http://www.oasis-open.org/cover/nisoLang3-1994.html
classification. purpose [discipline] (also general.keywords, applied to subjects)	LCC (Library of Congress Classification)	US Higher Ed	Stable and mature; national/international scope; controlled vocabulary	http://lcweb.loc.gov
	LCSH (Library of Congress Subject Headings)	US Higher Ed	Stable and mature; national/international scope; controlled vocabulary	http://lcweb.loc.gov

	DDC (Dewey Decimal Classification)	US Higher Ed	Stable and mature; national/international scope; controlled vocabulary	http://www.oclc.org/oclc/fp/
	UDC (Universal Decimal Classification)	EU Higher Ed	Stable and mature; national/international scope; controlled vocabulary	http://zeus.slais.ucl.ac.uk/udc/
	CIP (Classification of Instructional Programs)	US Higher Ed US Workforce Training	Stable and mature; national scope; controlled vocabulary	http://nces.ed.gov/
	DDC (top level with selective deepening)	US Higher Ed	Relatively unstable and immature; home-grown (variant of DDC with a terms from second- and third-levels added to first-level of DDC taxonomy)	http://merlot.csuchico.edu/FMPro?-db=Categories.fp3&-token=library&-format=/library/library.htm&class=Branch&-max=all&-find
	Doleta Subject Headings	US Workforce Training	Somewhat stable and mature; national scope; controlled vocabulary	http://www.fed-training.org/workspace/Flx-data/flx-provider.htm
	GEM subject taxonomy	US K12	Relatively stable and mature; home-grown (began as DDC variant); controlled vocabulary	http://www.geminfo.org/Workbench/Metadata/Vocab_Subject.html
	SCIS Subject Headings	AU Higher Ed	Stable and mature; national scope; controlled vocabulary	http://www.curriculum.edu.au/scis
	Singapore HE Subject taxonomy	Asia Higher Ed	New vocabulary, evolving; national scope; home-grown; controlled vocabulary	??

	Singapore K12 Subject taxonomy	Asia K12 Ed	New vocabulary, evolving; national scope; home-grown; controlled vocabulary	??
general.aggregation level	DoD cross-services harmonization	US Military Training	New and immature vocabulary; home-grown harmonization of vocabularies from different services	http://www.rhassociates.com/ADL-TWG/SCORM(0.7.3).doc
	Singapore granularity list	Asia Higher Ed	New vocabulary, evolving; national scope; home-grown; controlled vocabulary	??
technical.format	RFC 1521	AU Higher Ed, US Military Training	Relatively stable and mature; national/international scope; controlled vocabulary	http://www.isi.edu/in-notes/iana/assignments/media-types/media-types
	GEM format controlled vocabulary	US K12	Relatively stable and mature; home-grown (Subset of RFC 1521 media types); controlled vocabulary	http://www.geminfo.org/Workbench/Metadata/Vocab_Format.html
	Merlot format list		New vocabulary, evolving; home-grown; restricted vocabulary	http://merlot.csuchico.edu/FMPro?-db=Categories.fp3&-token=Library&-format=/library/addobject.htm&class=Branch&-max=all&-find
educational.learning context (also classification.purpose [Educational Level]	DoL default level		Uncertain stability and maturity; home-grown; restricted vocabulary	http://www.alx.org/alxoffer.html

	Edna.UserLevel	AU Higher Ed, AU K12	Somewhat stable and mature; home-grown; restricted vocabulary	http://www.edna.edu.au/EdNA/genericpage.html?file=/edna/aboutedna/metadata/schemes.html&sp=eec099eeeeeb#EDNA.Userlevel
	Singapore use level list	AU Higher Ed	New vocabulary, evolving; national scope; home-grown; controlled vocabulary	
	Gem grade controlled vocabulary	US K12, US Higher Ed	Relatively stable and mature; home-grown; controlled vocabulary	http://www.geminfo.org/Workbench/Metadata/Vocab_Grade.html
	Merlot educational level list	US Higher Ed, US K12 Education	New vocabulary, evolving; home-grown; restricted vocabulary	http://merlot.csuchico.edu/FMPro?-db=Categories.fp3&-token=Library&-format=/library/addobject.htm&class=Branch&-max=all&-find
educational.learning resourcetype	IMS default	US Military Training	New vocabulary, evolving; home-grown; open vocabulary	http://www.rhassociates.com/ADL-TWG/SCORM(0.7.3).doc
	DC.Type "current thinking"	US Higher Ed	Relatively unstable and immature; home-grown; open vocabulary	http://www.agcrc.csiro.au/projects/3018CO/metadata/dc_tf/type_simple.html or http://purl.org/dc/documents/working_drafts/wd-typelist.htm
	GEM resource-type controlled vocabulary	US K12	Somewhat stable and mature; home-grown (Extension of DC recommended list); controlled vocabulary	http://www.geminfo.org/Workbench/Metadata/Vocab_Type.html
	Edna.Type	AU Higher Ed AU K12	Relatively unstable and immature; home-grown (based on DC.Type recommendation); controlled vocabulary	http://www.edna.edu.au/EdNA/genericpage.html?file=/edna/aboutedna/metadata/schemes.html&sp=eec099eeeeeb#EDNA.Type

	Singapore resource type list	Asia Higher Ed	New vocabulary, evolving; national scope; home-grown; controlled vocabulary	??
	Merlot form list "current thinking"	US Higher Ed	New vocabulary, evolving; home-grown; restricted vocabulary	http://merlot.csuchico.edu/FMPro?-db=Categories.fp3&-token=Library&-format=/library/addobject.htm&class=Branch&-max=all&-find
educational. interactivitytype	Singapore pedagogical approach list	Asia Higher Ed	New vocabulary, evolving; national scope; home-grown; controlled vocabulary	??
	GEM pedagogy controlled vocabulary	US K12	Somewhat stable and mature; home-grown; controlled vocabulary	http://www.geminfo.org/Workbench/Metadata/Vocab_Pedagogy.html
educational. interactivitylevel	Singapore interactivity list	Asia Higher Ed	New vocabulary, evolving; national scope; home-grown; controlled vocabulary	??
educational.intended enduserrole	Singapore user role list	Asia Higher Ed	New vocabulary, evolving; national scope; home-grown; controlled vocabulary	??
	GEM Audience controlled vocabulary	US Higher Ed	Somewhat stable and mature; home-grown; controlled vocabulary	http://www.geminfo.org/Workbench/Metadata/Vocab_Audience.html
educational.difficulty	Singapore difficulty list	Asia Higher Ed	New vocabulary, evolving; national scope; home-grown; controlled vocabulary	??

IMS Implementation Guide

Planning

Identify necessary elements

One of the first things you will need to do in planning your meta-data implementation is to identify all of the meta-data elements you believe your implementation will need to support. This can be done a couple of ways. One approach is to simply pick the IMS Core elements. Another is to imagine how you will need to label the learning resources with which your implementation will deal. What kind of information should the resources carry with them? You might want to try this exercise without first looking through the IMS meta-data structure or IEEE LOM Base Document.

Another approach is to imagine the information about learning resources that your implementation will need to work with and go through the IMS meta-data list checking off each element that may serve your needs. You must keep your end users in mind as you begin listing meta-data elements. You should constantly ask yourself whether an element is really critical to your implementation or whether it is one that is just "nice to have." Meta-data elements are similar to features of a modern software application. Just as software engineers must be wary of "feature creep" so should learning resource implementers be wary of "meta-data creep." In a worst case scenario, your users could be expecting a convenient manner for easily identifying an online learning resource but instead, your application requires them to fill out enough fields to qualify them as an expert library resource cataloger.

Identify appropriate taxonomies and vocabularies

It is often impossible to tell whether a meta-data element will meet your needs simply by its listed name and definition. There are quite a few elements within the IMS meta-data whose true value lies in the taxonomy or vocabulary items that may serve as element values. An element such as LearningResourceType from the Educational category has at least six different taxonomies and vocabularies to choose from. You should select the taxonomy or vocabulary that best meets you needs from the common practice table above.

Taxonomies and vocabularies can be very useful in helping the meta-data creator avoid duplicative meta-data elements. For example, a meta-data creator may wish to indicate that the learning resource being created can be best classified as a "Prerequisite" type. If you do not carefully review the meta-data elements that have taxonomy and vocabulary listings, you may not notice that element number 9.1, called *classification.purpose*, has an associated, open vocabulary with the term "Prerequisite" in the listing. Those meta-data implementers who quickly add a proprietary extension when none is needed will thwart the efforts of others who expect to find resources labeled as "Prerequisite" by looking at element 9.1 for that information. The suggested practice is to always review the available taxonomies and vocabularies before creating new elements.

Define proprietary extensions

As you go through the exercise of identifying elements, you may come up with information that simply cannot be adequately captured using any of the available IMS meta-data elements. Fortunately, the IEEE Base Document allows for the extension of the meta-data record with proprietary meta-data elements and structures. As mentioned above, the decision to implement new extensions to the IMS meta-data should not be taken lightly. Great care was taken by many people representing many different learning and training interests to make as comprehensive a meta-data specification as possible.

If you do find it necessary to create a new element, the IEEE Base Document does allow it, but the specification will not give you additional guidance on the details of how you may implement your extension. The IMS Learning Resource Meta-data XML Binding Specification defines a manner for treating all user-defined, proprietary extensions in a uniform manner. The XML binding document defines the *extension* element that is an optional element for every branch of the meta-data tree structure. This is an XML-specific way to tackle the problems of extensions, but the example XML files may prove useful for reference regarding other implementations of extension elements. It is very likely that additional XML bindings will be created using other standards, such as Resource Description Framework (RDF) and XML Namespaces. Links to both of these approaches for handling extensions is found in the Appendices.

The W3C Recommendation for **Namespaces** (http://www.w3.org/TR/1999/REC-xml-names-19990114) does not specify how namespaces are to be used. The introductory abstract is as follows:

"XML namespaces provide a simple method for qualifying element and attribute names used in Extensible Markup Language documents by associating them with namespaces identified by URI references."

Namespaces provide a simple way of qualifying element and attribute names to create uniqueness and/or to indicate the source of the element or attribute, particularly if there may be conflicts with other systems that have created the same element or attribute name. The manner in which namespaces may be interpreted by applications is not specifed.

Currently there are two general approaches to namespaces:

1. Use to point to a specific encoding schema for machine interpretation, and
2. Use as a reference for uniqueness and possibly defnition (semantics).

These two approaches are not mutually exclusive. A namespace is applied as a prefix to an element or attribute name:

`<dc:subject>`.

The prefix of *dc:* is the qualifier, and must be defined elsewhere in the document. The user is directed to the W3C Namespace recommendation for more details on application. IMS does not specify how namespaces are to be resolved (semantically or for machine interpretation).

Create a meta-data record

With your elements, taxonomies, and extensions chosen, it is time to create your meta-data record. The IMS community has chosen XML as the first "language" in which the IMS meta-data will be represented. Creating an XML record is quite straightforward and will seem very familiar to those developers who have spent a lot of time working with HTML. XML uses many of the tagging and formatting conventions found in HTML. Just as early HTML editing involved writing out tags by hand, this is how most XML documents are created. There are, however, increasing numbers of XML content and Document Type Definition (DTD) editing tools appearing on the market. There are also more systems being developed that generate XML programmatically. See the Additional resources section of this document for the locations of some of these tools.

Your primary resource in creating proper meta-data records will be the IMS Learning Resource Meta-data XML Binding Specification. This document provides the IMS meta-data DTD and a sample XML content file with all of the IMS meta-data elements present, but empty. There are also additional sample files that illustrate how a record would be properly organized once data has been added to it.

Preserve meta-data

If a meta-data application does not create meta-data records, then it likely will have some capacity for retransmitting records or preserving them. The idea from the IEEE suggested conformance wording is that if an application receives a conforming meta-data record and then retransmits that record, it must do so without altering the record at all. That means not even a single comma is changed. If an application is going to receive a record and then make changes to that record, then what the application has done is to create a new meta-data record. This is an important point that implementers must adhere to.

The IEEE specifies values for the number of list elements and the number of allowable characters for string data. These value constraints are called "min-max" because they represent the maximum value a conforming application is required to preserve. If a string such as General.Title is allowed only 1024 characters and a meta-data record is received that exceeds that number by, say 40 characters, the minimum level of conformance forced upon an application is that it preserve 1024 of those characters. That is not to say the application is not allowed to preserve more, it is just that a limit was set on values so that implementers can expect their application to be conforming if they preserve the min-max values.

Reading a meta-data record

Almost every application making use of meta-data will need to at least be able to properly read a meta-data record. Fortunately, there are quite a number of very good XML parsers on the market that can assist with this task. In reality, parsing an XML record is a relatively easy task. The more difficult tasks are determining your data structures for handling the parsed elements and presenting a coherent, well-designed user interface to your end users.

On the issue of data structures, you have many options available to you. The IMS meta-data is logically organized as a tree structure. Many applications will find it sufficient to use a parser that builds a tree structure in memory and then traverse the tree for those elements called for by the user interface. Others may find an event-based API, such as the Simple API for XML (SAX) to be more useful. Some developers might want to represent the entire meta-data record as an object with individual properties to it. Others might take each category such as *general* or *lifecycle* and represent them as objects with properties. Many choices and approaches are available. You must choose which approach best serves your needs and the needs of your end users.

Testing a record's conformance

The IEEE has not yet issued its formal statements on meta-data record conformance, but there are still some conformance issues with which you should be concerned. As you try out your meta-data records with various parsers and other tools, here are some questions to keep in mind:

- Does the record validate against the DTD found in the IMS Learning Resource Meta-data XML Binding Specification? Or, have you created a DTD that includes the elements of the IEEE you are using plus any proprietary extensions?
- Are any extensions conflicting with the semantics or structure specified by the IEEE?
- Is the record well-formed? Is the markup used intelligible from a parser's point of view?
- Are the restricted vocabulary items specified by the IEEE adhered to?
- Is the structure correct? Are elements found where you would expect to find them based upon the IEEE Base Document?
- Are the values for elements within the specified min-max constraints?

If your answer to any of the questions above is "no," then you should investigate further. Just because you may have found some unexpected elements or different structures doesn't mean the record should be thrown out or considered as non-conforming. There are often good reasons for a record to not validate against the provided DTD or to exceed the min-max value. One must simply be careful to identify those reasons and account for them in implementations.

Exception handling

When exceptions to an expected meta-data record occur, how should they be handled? This is a very general question and unfortunately there is no easy answer. As pointed out previously, there are a number of ways in which a meta-data record might be encountered that has special processing requirements. It is possible some items might render the record non-conforming while others just need extra processing work done by the meta-data-reading application. The three most likely exceptions to an expected IMS meta-data record are records that are generally malformed, proprietary extensions added to the record, and records that exceed the suggested min-max constraints.

Malformed records

The most typical example of a "malformed" meta-data record, using XML as our sample binding, is a record that does not pass the XML test of being well-formed. These problems are likely to be found by XML parsers because almost every parser cannot handle a malformed XML document without signaling an exception. Meta-data records that are not well-formed are usually just missing an open or closed tag somewhere in the file. These types of problems are usually flagged by a good parser and are relatively easy to diagnose and repair.

It is important to note that a well-formed document is not necessarily a valid document. A valid XML document declares conformance to a specific schema, usually a document type definition (DTD), and conforms to that DTD. An XML document must have an associated DTD to be declared valid. However, it can be well-formed without a DTD. The IMS Learning Resource Meta-data XML Binding Specification contains a DTD for IMS meta-data for those who wish to confirm their meta-data record's validity.

Handling proprietary extensions

The IMS Learning Resource Meta-data XML Binding Specification defines a manner for treating all user-defined, proprietary extensions in a uniform manner. The *extension* element is an optional element for every branch of the meta-data tree structure. The difficulty of allowing for proprietary extensions is that developers are completely on their own as to how best to handle them. The XML binding specification helps only a little by defining a generic placeholder for extension elements. The how, when and where of extension handling is up to each individual developer.

Records that exceed min-max constraints

If an application encounters a record whose elements and data values exceed min-max constraints, that application is under no obligation to preserve the data exceeding the values. Records that exceed min-max values can still be conforming and some applications may not enforce a data value limit. The min-max values are provided in the IEEE Base Document to suggest a manner for keeping meta-data records to a reasonable size and to reduce the burden on application developers who may not wish to preserve arbitrarily large amounts of data.

Dublin Core Mapping

Introduction

The IEEE Learning Object Meta-data (LOM) specification contains elements that can be mapped to the Dublin Core Meta-data Element set. The Dublin Core element set can be found at http://purl.org/DC/about/element_set.htm. The Dublin Core Home Page is found at http://purl.org/dc/.

The current list of Dublin Core elements and their general definitions were finalized in December 1996. The elements and their names are not expected to change substantively, though the application of some of them is currently experimental and subject to varying interpretation from implementation to implementation.

Dublin Core elements have a descriptive name intended to convey a common semantic understanding of the element. To promote global interoperability, a number of the element descriptions may be associated with a controlled vocabulary for the respective element values. It is assumed that other controlled vocabularies will be developed for interoperability within certain local domains. In the element descriptions below, a formal single-word label (expressed in all upper case) is specified to make the syntactic specification of elements simpler for encoding schemes. Each element is optional and repeatable.

It is important to note that just because it is possible to map Dublin Core and IEEE LOM elements to each other, this does not mean the elements are semantically or structurally equivalent. The reader should carefully study and understand both the meaning and intended usage of each element before utilizing it in a meta-data record.

Dublin Core Element Descriptions

Dublin Core #	Dublin Core Name	Dublin Core Label	IEEE Learning Object Meta-data
1	Title	TITLE	general.title
	The name given to the resource by the CREATOR or PUBLISHER.		
2	Author or Creator	CREATOR	*lifecycle.contribute* when *lifecycle.contribute.role* has a value of "Author".
	The person or organization primarily responsible for creating the intellectual content of the resource. For example, authors in the case of written documents, artists, photographers, or illustrators in the case of visual resources.		

3	Subject and Keywords	SUBJECT	*general.keywords*. For those wishing more specificity of Subject, a category of *classification* can be used with a *purpose* of "Subject". *classification* has elements for *description*, *keywords*, and *taxonpath*(s) that are specific for the *purpose*.
	The topic of the resource. Typically, subject will be expressed as keywords or phrases that describe the subject or content of the resource. The use of controlled vocabularies and formal classification schemas is encouraged.		
4	Description	DESCRIPTION	*general.Ddescription*
	A textual description of the content of the resource, including abstracts in the case of document-like objects or content descriptions in the case of visual resources.		
5	Publisher	PUBLISHER	*lifecycle.contribute* when *lifecycle.contribute.role* has a value of "Publisher".
	The entity responsible for making the resource available in its present form, such as a publishing house, a university department, or a corporate entity.		
6	Other Contributor	CONTRIBUTOR	*lifecycle.contribute* with the type of contribution specified in *lifecycle.contribute.role*. *lifecycle.contribute* can be repeated.
	A person or organization not specified in a CREATOR element who has made significant intellectual contributions to the resource but whose contribution is secondary to any person or organization specified in a CREATOR element (for example, editor, transcriber, and illustrator).		
7	Date	DATE	*lifecycle.contribute.date* when *lifecycle.contribute.role* has a value of "Publisher".
	The date the resource was made available in its present form. Recommended best practice is an 8 digit number in the form YYYY-MM-DD as defined in http://www.w3.org/TR/NOTE-datetime, a profile of ISO 8601. In this scheme, the date element 1994-11-05 corresponds to November 5, 1994. Many other schema are possible, but if used, they should be identified in an unambiguous manner.		

8	Resource Type	TYPE	*educational.learningresourcetype*.
	The category of the resource, such as home page, novel, poem, working paper, technical report, essay, dictionary. For the sake of interoperability, TYPE should be selected from an enumerated list that is under development in the workshop series at the time of publication of this document. See http://sunsite.berkeley.edu/Metadata/types.html for current thinking on the application of this element.		
9	Format	FORMAT	*technical.format*
	The data format of the resource, used to identify the software and possibly hardware that might be needed to display or operate the resource. For the sake of interoperability, FORMAT should be selected from an enumerated list that is under development in the workshop series at the time of publication of this document.		
10	Resource Identifier	IDENTIFIER	*general.catalogentry*. *greneral.identifier* is currently a RESERVED term, as there is no specified method for creation of a GUID.
	String or number used to uniquely identify the resource. Examples for networked resources include URLs and URNs (when implemented). Other globally-unique identifiers, such as International Standard Book Numbers (ISBN) or other formal names would also be candidates for this element in the case of off-line resources.		
11	Source	SOURCE	*relation.resource* when the value of *relation.kind* is "IsBasedOn". This reduction is currently under consideration within the Dublin Core Community.
	A string or number used to uniquely identify the work from which this resource was derived, if applicable. For example, a PDF version of a novel might have a SOURCE element containing an ISBN number for the physical book from which the PDF version was derived.		
12	Language	LANGUAGE	*general.language*
	Language(s) of the intellectual content of the resource. Where practical, the content of this field should coincide with RFC 1766. See: http://ds.internic.net/rfc/rfc1766.txt		
13	Relation	RELATION	*relation.kind*, *relation.resource*
	The relationship of this resource to other resources. The intent of this element is to provide a means to express relationships among resources that have formal relationships to others, but		

	or items in a collection. Formal specification of RELATION is currently under development. Users and developers should understand that use of this element is currently considered to be experimental.		
14	Coverage	COVERAGE	*general.coverage*
	The spatial and/or temporal characteristics of the resource. Formal specification of COVERAGE is currently under development. Users and developers should understand that use of this element is currently considered to be experimental.		
15	Rights Management	RIGHTS	*rights.description*
	A link to a copyright notice, to a rights-management statement, or to a service that would provide information about terms of access to the resource. Formal specification of RIGHTS is currently under development. Users and developers should understand that use of this element is currently considered to be experimental.		

Appendix

Additional resources

IEEE Learning Object Meta-data (LOM)

The IEEE Learning Object Meta-data (LOM) base document can be found at:
http://ltsc.ieee.org/doc/wg12/scheme.html

Additional notes concerning the LOM version 3.5 can be found at:
http://ltsc.ieee.org/doc/wg12/release_notes.html

IMS Meta-data Documents

The IMS Learning Resource Meta-data XML Binding Specification v 1.1 can be found at:
http://www.imsproject.org/metadata/mdbindv1p1.html

The IMS Learning Resource Meta-data Information Model v1.1 document can be found at:
http://www.imsproject.org/metadata/mdinfov1p1.html

vCard Information

A variety of vCard related links can be found at: http://www.imc.org/pdi/

XML Resources

The XML specification and additional links can be found at: http://www.w3.org/XML/

The Microstar web site has XML editing tools and the Aelfred parser:
http://www.microstar.com/products.html

Information about the Simple API for XML (SAX) can be found at:
http://www.megginson.com/SAX/index.html

Articles, software and many things related to XML can be found at: http://www.xml.com/

Information about Resource Description Framework (RDF) is located at: http://www.w3.org/RDF/

Information about the XML Namespaces recommendation can be found at:
http://www.w3.org/TR/1999/REC-xml-names-19990114/