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CLEO White Paper

CLEO Extensions to the IEEE Learning Object Metadata

Version 1.1 (February 2003)

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Abstract

This document describes recommended extensions to the IEEE LOM made by CLEO Lab partners. The extensions are in the form of alternate and additional vocabularies to existing LOM elements, and new elements extending or adding to the LOM Base Schema v1.0 model for the Education category.

Additional vocabularies are proposed to further refine LOM 1.8: General Aggregation Level

Alternate vocabularies are proposed for

- LOM 5.2: Educational.Learning Resource Type, and
- LOM 9.1: Classification.Purpose.

New elements proposed for the Educational category include

- Typical Learning Time Range (a child of LOM 5.9: Typical Learning Time),
- Cognitive Domain (with controlled vocabulary), and
- Cognitive Strategy (with controlled vocabulary).

Best practice recommendations and examples are also provided to guide implementation decisions.

Revision History

Version	Description of Version	Date Completed
1.0	Approved for Public draft	2002-10-03
1.1	Aggregation level update to match LOM binding	2002-02-15

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1 Introduction

1.1 Overview

This document defines a profile of IEEE 1484.12.1-2002 Learning Object Metadata (LOM) created by the Customized Learning Experience Online (CLEO) Lab. The LOM standard defines many data elements that may be used to characterize learning-related content. Communities of practice adopt the LOM standard to their specific requirements by creating profiles. The CLEO Lab represents a community of practice comprising several commercial content providers. The CLEO Lab created this profile to facilitate inter-organizational exchange of business-oriented learning content.

Scenarios considered in defining this profile include:

- Exchanging content with 3rd parties contracted to develop content and using different support technologies;
- Reducing content integration costs by defining common searchable features, links to development processes, and mappings to skill models;
- Enabling a better learner experience from delivery systems that can assemble or select the most appropriate content.

This profile adapts the LOM standard to CLEO Lab requirements by:

- Selecting for inclusion those data elements from the LOM standard relevant to CLEO Lab community of practice;
- Defining additional data elements required by the CLEO Lab community of practice and not present in the LOM standard;
- Defining new vocabularies for LOM data elements where the default vocabularies in the LOM standard are not sufficiently precise for the CLEO Lab community of practice;
- Defining an XML Schema "binding" of the LOM standard that reflects the CLEO Lab extensions;
- Defining a set of best practices for creating content using the CLEO Lab LOM profile that considers the perspectives of both the content developers and learners.

The CLEO Lab is a collaboration of commercial content providers to promote content interoperability by defining profiles of relevant specifications and standards. Several corporate sponsors founded the CLEO Lab including Cisco Systems, Inc., IBM Corporation, Microsoft Corporation, Thomson NETg. The CLEO Lab is a program of the IEEE Industry Standards and Technology Organization (IEEE-ISTO), a forum to facilitate activities that support the implementation and acceptance of standards in the marketplace.

This CLEO lab technical report reflects a scenario-based design methodology highlighting scenarios for e-learning that are important to the CLEO partners and may also have relevance in the wider e-Learning community. The report addresses the requirements raised by scenarios, testbeds, and

evaluative activities undertaken to explore them, and resulting research conclusions. The conclusions report technical findings relevant to specification development organizations, descriptions of models for e-learning, and related findings on pedagogical effectiveness.

CLEO Lab's proposed metadata extensions straddle two realities:

- a concept model fixed on LOM v1.0
- an IMS metadata binding fixed on LOM working draft 6.1, (not working draft 6.4 on which LOM v1.0 is based)

CLEO's metadata extensions are proposed to alert the IEEE LTSC LOM working group and community of LOM users with the following:

- how this group of content vendors known as CLEO will extend the LOM information model to meet their content transfer requirements,
- the fruit of recent labors to the LOM community at large -- validating the LOM Base Schema and inviting all to consider and comment on the potential for these CLEO extensions to support content transfer requirements in other venues, and
- concrete requirements for those actively working on bindings for LOM v1.0 so that such extensions as envisioned in the CLEO extensions to the LOM conceptual model can be supported effectively in any bindings of LOM v1.0.

CLEO's extensions to the conceptual LOM Base Schema are listed as separate vocabularies to be referenced in existing LOM elements or enumerated as elements of the Base Schema, continuing the numbering found in the Base Schema. This use of the Base Schema's numbering is designed solely to guide readers into CLEO's mindset as to the proper placement of the proposed extensions within, or in one case, surrounding existing elements of the Base Schema. The CLEO extensions are not meant to be the only elements that could occur at the enumerated positions. That decision is up to the IEEE LTSC LOM working group.

1.2 Related Documents

The following documents are indispensable for the creation and application of this document.

IEEE Information Technology - Learning Technology - Learning Objects Metadata (IEEE 1484.12.1-2002). Available at: http://ltsc.ieee.org/.

IMS Learning Resource Meta-data Specification Version 1.2.1 (Includes: IMS Learning Resource Meta-data Information Model, XML Binding Specification, and Best Practices and Implementation Guide). Available at: http://www.imsglobal.org/.

IMS Content Packaging Specification Version 1.1.2
Available at: http://www.imsglobal.org/.

The Advanced Distributed Learning (ADL) Initiative Sharable Content Object Reference Model (SCORM) Version 1.2. Available at: http://www.adlnet.org/

2 Overview

2.1 Process for determining LOM Extensions

The CLEO team had a specific problem to solve: align the metadata requirements of Cisco, Microsoft, IBM and Thomson NETg to provide a foundation for collaboration using shared content.

To this end the team members identified key personnel to work on the project. These personnel familiarized themselves with the IEEE LOM. They reviewed their internal business processes. Beginning in March 2002 the team met for weekly telephone conferences using network collaboration tools.

Working through the IEEE LOM and using their internal business processes, the team recommended suggestions for LOM extensions. To this end the team member companies recommended sets of controlled vocabularies used in their internal business process. In some instances additional LOM elements were required and in others additional vocabulary were proposed.

From the proposed extension, an XML schema was developed in addition to XML examples. The result of this effort is detailed in this white paper as a set of LOM extensions.

2.2 How Metadata will be used

Different enterprises and organizations have their own metadata or cataloguing schema for learning content, and often have their own taxonomies as well. LOM was designed to allow them to exchange information by mapping it to interoperable metadata records that use the LOM information model. LOM was also designed to allow communities of practice to define extensions and alternative vocabularies. The proposed CLEO extensions to LOM provide additional mappings for the exchange of information that is specific to enterprise training content, based on requirements and existing practices common to the CLEO participants.

The LOM standard does not allow redefinition of the elements it specifies, but it does allow the definition of alternative vocabularies for specific elements, as well as extending the LOM Base Schema v1.0 with new elements. CLEO's extensions to the conceptual LOM Base Schema consist of separate vocabularies to be referenced in existing LOM elements, and of elements that can be woven into the appropriate places in the Base Schema. The CLEO proposal uses the “dot notation” element numbering system of the LOM Base Schema, adding some numbers for the elements that it inserts as extensions. This use of the Base Schema's numbering is designed solely to indicate to the reader where the CLEO extensions fit in the hierarchical organization of the Base Schema.

Table 1 shows what a typical metadata instance can contain.

Table 1. Possible LOM interplay with CLEO recommendations

Category	Description
LOM	No changes recommended to LOM v1.0
CLEO LOM extensions	Recommended extensions to LOM Base Schema v1.0 Educational category and element
Corporate-specific LOM extensions	CLEO recommended methods to extend LOM v1.0 for vocabularies which are expected to vary between corporations
CLEO Alternative Vocabularies	CLEO recommends the use of alternative vocabulary terms

In a typical usage scenario, the metadata will be associated with the content when it is created or when existing content is cataloged. When the content is packaged for archival, transmission or publication, for example in a SCORM package, the metadata will be packaged with it. In the LOM standard, all metadata elements are optional, but meaningful interoperability requires the predictable existence of some of the data. Therefore, the trading partners that use the CLEO metadata will set policies that dictate which of the metadata elements and extensions are mandatory for a particular scenario.

3 CLEO Extensions to IEEE LOM

The Information Model in this section describes the meta-model for extending the Learning Object Metadata, which can be used by any compliant system. This model provides:

- a containing framework that includes a generalized object model and a structured vocabulary for describing specific elements within the LOM, i.e., a more specific way of defining the various types of learning objects.
- a mechanism for expressing contextual relationships between learning objects and object aggregations.
- the appropriate metadata applications and extensions to support the framework and context mechanism.

The Bindings in Section 4 describe and explain, in a machine-readable format, at least one system for representing the information described above. Corresponding control documents will be delivered using XML, XSD, and other appropriate technologies.

CLEO's metadata extensions are proposed to alert the IEEE LTSC LOM working group and community of LOM users how CLEO collaborators propose to:

- extend the LOM information model to meet their content transfer requirements
- describe requirements for those actively working on bindings for LOM v1.0 so CLEO extensions to the LOM conceptual model can be supported effectively in any bindings of LOM v1.0

CLEO's extensions to the conceptual LOM Base Schema are listed as separate vocabularies to be referenced in existing LOM elements or enumerated as elements of the Base Schema, continuing the numbering found in the Base Schema. This use of the Base Schema's numbering is designed solely to guide readers into CLEO's mindset as to the proper placement of the proposed extensions. The CLEO extensions are not meant to be the only elements that could occur at the enumerated positions. That decision is up to the IEEE LTSC LOM working group.

In addition to the extensions and new elements, you may find Appendix C and D useful. Appendix C: CLEO Use Scenario: Content Creation and Exchange Using Metadata provides a scenario describing how metadata is used in the Content Creation process. Appendix D: CLEO LOM Profiles for "Publishing" shows the relationship of metadata to CLEO Aggregation Hierarchy Levels.

3.1 CLEO Extensions for Controlled Vocabularies and New Elements

LOM Number	Name	Explanation	Described in Section	Taxonomy Category
1.8.1	Aggregation Sub Level	Identifies the aggregation hierarchy level of the content at a deeper level than with the LOM vocabulary	3.1.1	CLEO LOM extension – New Element
5.2	Learning Resource Type	Identifies the instructional purpose of the object	3.1.2	CLEO Vocabulary
5.9.1	Typical Learning Time Range	Identifies the approximate or typical length of time (range) it takes to work with or through this learning object for the typical intended target audience	3.1.3	CLEO LOM extension
5.12	Cognitive Domain	Identifies the cognitive level	3.1.4	CLEO LOM extension

LOM Number	Name	Explanation	Described in Section	Taxonomy Category
5.13	Cognitive Strategy	Identifies the cognitive strategy used in conjunction with Cognitive Domain and Learning Resource Type	3.1.5	CLEO LOM extension
9.1	Purpose	Extends purpose to include vocabulary to identify business purpose	3.1.6	Corporate-specific LOM extension

For each extension there is a controlled vocabulary. The complete LOM with CLEO extensions is displayed in Appendix B. The values being used in the vocabularies below are often in English as it is easier to work with terms that can be looked up in a dictionary than with language neutral abstract tokens.

3.1.1 LOM 1.8.1, Aggregation Sub Level, Controlled Vocabulary

The CLEO LOM Extension Aggregation Hierarchy defines additional levels detail for content used by the collaborating companies. There are several different use cases for aggregation level information:

1. Content mining (search): desire to find blocks (i.e. example, non-example, definition learning resource types), production content (i.e. text, finalized graphics or simulations, French text, English text, and source content (i.e. Photoshop files, English text used as basis for translations)
2. Editing content: need source content
3. Reuse: need blocks and production content (not source content)

CLEO recommends a LOM extension, 1.8.1 Aggregation Sub Level. This extension uses a vocabulary with tokens free of semantic association; i.e. it does not use terms like course, section, etc. Implementers are free to associate with their own labels in any way they want, including defining a parallel vocabulary, lookup table, etc. The table below shows the vocabulary and how it can be "privately" mapped to specific implementations.

The source label for this vocabulary is `http://www.cleolab.org/vocab/aggregationSubLevel`.

Table 2. Aggregation Sub Level recommendation

LOM Level	Sub Level Value	Definition	Terms used for this level by the organization			
			AICC	Cisco	Microsoft	Sometimes
1	a	Source content		Source Content	Source Content	
1	b	Finalized content from above. Object that is intended to be used only within a containing context	Object	Asset	Production Content	Elements
1	c	A meaningful visual image and any interaction associated with that image. The contents of a single CRT presentation that appears at a single point in time during a lesson. Equates to list of Learning Resource Types	Frame Screen	Block		
2	d	Smallest sequence-able unit of aggregation. Satisfies an enabling objective	Sequence	Topic	Item / Topic	RIO, SCO

LOM Level	Sub Level Value	Definition	Terms used for this level by the organization			
			AICC	Cisco	Microsoft	Sometimes
2	e	Step (can be recursive) e.g. assessment, tutorial parts within a lesson	Topic			
2		Lesson (typically maps to a "terminal learning objective")	Lesson/AU	Lesson	Lesson	RLO, Objective
3	g	Undifferentiated Block	Module Block			
3	h	Segment of "Level 9", e.g. assessment, tutorial (can be recursive). A block where you have assigned a specific purpose	Sub Chapter Block	Module (no recursion allowed)	Module	Chapter
3	i	Particular path through a course	Chapter Block			Possible use of “Track” within Aspen
3		Course or similar aggregation of resources intended for distribution as a complete unit	Course	Course	Course	
4	k	Collection of "Level 9" selected from a curriculum. Particular path through a curriculum		Track	Track Job Role	For example, a visual mapping to a Systems Administrator certification
4	m	Collection of learning resources for a field of study	Curriculum	Curriculum	Curriculum Job Hierarchy (IT Pro/Dev)	
4	n	Library (super-collection)			Library	

An implementation-specific LOM extension could contain an "aggregation level label". This label would be from a vocabulary. For example, the Cisco vocabulary could be:

Table 3. Organizational specific application profile example

LOM Aggregation Level	CLEO Aggregation Sub Level	Corresponding Cisco Label
1	a	Source Content
1	b	Asset
1	c	Block
2	d	Topic
2	e	(undefined)
2		Lesson
3	g	(undefined)
3	h	Module
3	i	(undefined)
3		Course
4	k	Track
4	m	Curriculum
4	n	(undefined)

When going from Cisco to another system, every Cisco label maps to a CLEO aggregation level. When going from another system that uses a CLEO level not defined in the Cisco model, there is no corresponding Cisco label and therefore a problem. CLEO recommends that the problem be solved by a rule that is associated with the data model. The rule is the following:

If there is no matching label, use the next highest label in the target vocabulary. If there is no highest level (as when trying to map level 12 into Cisco nomenclature), the highest defined level should be used.

The re-mapping is not intended to be reciprocal as you may lose information in the re-mapping process.

CLEO also proposes a new set of elements that allow an open declaration of a term to provide context for, or refine, the LOM vocabulary value and to declare how that term maps to the terms of other known systems or trading partners. This allows semantic mappings to be established easily and allows metadata creators to use whichever classification system(s) seem appropriate without having to force fit a preferred set of terms to a declared vocabulary. It also eliminates any maintenance or odd restructuring of a hierarchical set of vocabulary terms when new terms arise that must be added.

This new element **`otherTerms`** is an additional child of LOM's Base Schema element 1.8 General.Aggregation Level that serves as a collector element. Further, **`term`** and **`source`** are children of **`otherTerms`** with a String datatype. **`otherTerms`** is optional with a multiplicity of 0..1. Further **`term`** has a multiplicity of 1..unbounded. **`usedBy`** has a multiplicity of 1..1.

Table 4. Aggregation Level Information Model Detail

Nr	Name	Explanation	Size	Order	Value space	Datatype
1.8	**Aggregation Level**	The functional granularity of this learning object.	1	unspecified	1 through 4	Vocabulary (Enumerated)
1.8.1	**Aggregation Sub Level**	Additional levels of detail	1	unspecified	"a": Source content "b": Finalized source content; intended for use only within a containing context "c": A meaningful visual image and any interaction associated with that image. The contents of a single CRT presentation that appears at a single point in time during a lesson. Equates to list of Learning Resource Types.: "d": Smallest sequence-able unit of aggregation. Satisfies an enabling objective. "e": Step (can be recursive) e.g. assessment, tutorial parts within a lesson. "g": Undifferentiated Block "h": Segment of LOM 1.8: General.Aggregation Level "3", e.g. assessment, tutorial (can be recursive). A block where you have assigned a specific purpose. "i": Particular path through a course "k": Collection of LOM 1.8: General.Aggregation Level "3" selected from a curriculum. Particular path through a curriculum "m": Collection of learning resources for a field of study "n": Library (super-collection)	Vocabulary (State)

Nr	Name	Explanation	Size	Order	Value space	Datatype
					Data type -- CLEO Vocabulary (State) Note: The CLEO Vocabulary model is the same as the LOM Base Schema Vocabulary model defined in 1484.12.1-2002 Clause 10. Importing a LOM binding is unnecessary since the LOM vocabulary model's elements are redeclared within a CLEO namespace.	
1.8.1.1	**Other Terms**	A collection of semantically equivalent values from different user environments that map to a CLEO sub-level vocabulary term	1	unspecified		
1.8.1.1.1	**Term**	A single clarifying term mapped from a specific context	smallest permitted maximum: 10 items	unordered	Repertoire of ISO/IEC 10646-1:2000	Open Vocabulary (declare) Note: The Open Vocabulary model is the same as the LOM Base Schema Vocabulary model defined in 1484.12.1-2002 Clause 10 except that no values are declared at this time. It is an "open" model: values may be declared when adding the CLEO Sub Level extension to a LOM 1.8:General.Aggregation Level element. Importing a LOM binding is unnecessary since the LOM vocabulary model's elements are redeclared within a CLEO namespace.

3.1.2 LOM 5.2, Learning Resource Type, Controlled Vocabulary

CLEO recommends a CLEO-specific controlled vocabulary for 5.2, Learning Resource Type. The CLEO vocabulary Learning Resource Type is more precise than the LOM default vocabulary. This vocabulary also supports the use of this data element to identify where the learning object fits in the context of common learning content strategies or instructional methodologies such as the Cisco RLO/RIO model.

Since the LOM specifies that Learning Resource Type can be an ordered list of learning resource type elements, with the most dominant kind listed first, elements that use the CLEO vocabulary can be combined with elements that use the LOM default vocabulary or other vocabularies. This provides broad compatibility with other systems, while allowing the CLEO trading partners to achieve the precision they require in the description of the learning resource type.

The source label for this vocabulary is `http://www.cleolab.org/vocab/learningResourceType`.

Table 5. Learning Resource Type vocabulary

Value space	Description
additional resource	Supplementary information provided to the learner
analogy	Presents an analogy for the topic
assessment	Assesses learner performance
assessment item	Single assessment item, typically intended for inclusion in an assessment, practice or learning sequence as a check on learning
attractor	Attracts the learner's attention. Typically has little or no instructional intent.
community	Unspecified collaboration or community resource, such as chat room, etc.
definition	Provides a definition
demonstration	Demonstrates (more engaging than presentation)
example	Provides an example
feedback	Provides feedback (usually related to another resource such as a practice resource)
glossary	Resource is a glossary
guidance	Provides learning guidance on the topic (e.g. roadmap, hints, etc.) Usually related to another resource such as a practice resource
guideline	Provides rules that require principle-based judgment
illustration	Graphical or other media representation (i.e. cycle chart, decision path)
importance	Impresses the importance of the topic
introduction	Introductory information, smaller in scope than an overview
non example	Counter-example of the topic
note	Note or gloss
objective	Inform learner of learning objectives
outline	Provides an overview of content structure
overview	Provides a comprehensive overview
practice	Elicits learning through practice (generic)
prerequisite	Informs learner about prerequisites
presentation	Non-specific exposition of information about a topic
recall	Recall prior knowledge on the same topic
reference	Resource contains unspecified reference information (other than Glossary)
reinforcement	Enhance retention or transfer of learning

Value space	Description
scenario	Scenario illustrating instance of the topic
summary	Provide a comprehensive summary of a collection of objects

3.1.3 LOM 5.9.1, Typical Learning Time Range, New Element

The CLEO LOM Extension Typical Learning Time Range defines the approximate time range it takes the typical intended target audience to work with or through this learning object. CLEO recommends a LOM extension, 5.9.1 Typical Learning Time Range.

This new element contains two sub-elements in sequence:
- minimumlearningtime
- maximumlearningtime

Both are of the duration datatype. For example "PT1H30M" represents 1 hour and 30 minutes and is based on ISO standard 8601:2000. More information on the representation of duration and other datatypes can be found within the published standard IEEE Information Technology - Learning Technology - Learning Objects Metadata (IEEE 1484.12.1-2002).

3.1.4 LOM 5.12, Cognitive Domain, Controlled Vocabulary

CLEO recommends a LOM extension, 5.12 Cognitive Domain. The Cognitive Domain element describes the "kind" of topic addressed by the learning object. It uses values that are common classification schemes for learning objectives. Identification of a cognitive domain can help in the choice of design or assessment strategies. For example, the type of test one would choose to assess knowledge is different than the type of test used to assess a skill that requires analysis.

Also, if metadata is initially created as part of an instructional design process prior to the creation of the actual learning object, the Cognitive Domain element can be used to guide the choice of an appropriate instructional strategy in the construction of the learning object.

The source label for this vocabulary is `http://www.cleolab.org/vocab/cognitiveDomain`.

Table 6. Cognitive Domain vocabulary

Value Space	Conceptual Reference	Description
knowledge	Bloom	Verbs: Define, memorize, name, recall, repeat
comprehension	Bloom	Verbs: Describe, discuss, explain, express, identify, locate, recognize, report, restate, review, tell
application	Bloom	Verbs: Apply, calculate, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, translate, use
analysis	Bloom	Verbs: Analyze, compare, contrast, debate, diagram, differentiate, distinguish, examine, inspect, inventory, relate, solve, question
synthesis	Bloom	Verbs: Arrange, assemble, collect, compose, construct, create, design, formulate, manage, organize, plan, prepare, propose, reorganize, set up
evaluation	Bloom	Verbs: Appraise, assess, choose, conclude, discriminate. estimate, evaluate, judge. justify, measure, rate, revise, score, select, value

Value Space	Conceptual Reference	Description
remember	Merrill	The learner is required to search and recall from memory a particular item of information (can be equated to Blooms at Knowledge and Comprehension)
use	Merrill	The learner must directly apply the information to a specific case (can be equated to Blooms at Application and higher)
find	Merrill	(Generalization) The learner uses the information to derive a new abstraction (concepts, principles, etc.)

3.1.5 LOM 5.13, Cognitive Strategy, Controlled Vocabulary

CLEO recommends a LOM extension, 5.13 Cognitive Strategy. The Cognitive Strategy element identifies the instructional strategy associated with the described object. For learning objects at a small level of granularity, the Cognitive Strategy element can be used to identify the type of strategy in which the learning object fits. For learning objects at a larger level of granularity, it can be used to describe the instructional strategy supported or implemented in the learning object.

Also, if metadata is initially created as part of an instructional design process prior to the creation of the actual learning object, the Cognitive Strategy element can be used to guide the choice of an appropriate instructional strategy in the construction of the learning object.

The source label for this vocabulary is `http://www.cleolab.org/vocab/cognitiveStrategy`.

Table 7. Cognitive Strategy vocabulary

Value Space	Conceptual reference	Description
concept	Clark	Used to teach a group of objects, symbols, ideas, or events that, 1) are designated by a single word or term, 2) share a common feature, 3) Vary on irrelevant features
fact	Clark	Used to teach unique, specific, one-of-a-kind pieces of information. Facts are presented as statements, data, or pictures of specific objects.
procedure	Clark	Used to teach a procedure performed on the job. In order to be successful, the procedures must be clear and must provide job-based practice for transfer to the job. Specifically: 1) A procedure is a sequential set of steps to be followed by one individual to accomplish a task or make decisions, 2) A procedure lists directions for procedural tasks, 3) Actions within a procedure must be done the same way each time (within a given situation).
process	Clark	Used to teach how a system works. Helpful in supporting underlying job tasks, providing motivation, and ensuring overall quality of job performance. A process can be defined as, 1) A flow of events that describes how something works 2) Not a task to be done by one person, 3) A task that involves many persons or organizations, 4) Mechanical, business, or scientific
principle	Clark	Used when you need to create a job task that requires judgment, or when guidelines must be applied to a job situation.

3.1.6 LOM 9.1, Purpose, Controlled Vocabulary - Add Business Purpose

CLEO recommends a CLEO specific controlled vocabulary addition for 9.1, Purpose. This vocabulary adds the Business Purpose to the existing controlled vocabulary for Purpose (idea, discipline, objective, etc), which identifies the business purpose of this resource. CLEO is still refining vocabularies associated with this tag. Below is a sample listing:

- Abstract
- Advertisement
- Alert
- Best Practice
- Biography
- Brochure
- Case Study
- Checklist
- Code Sample
- Competitive Analysis
- Configuration Guide
- Contents
- Course
- Creative Brief
- Customer Feedback
- Data Sheet
- Demo
- Deployment Guide
- Design Guide
- Editorial Comments
- Error message
- EULA
- Exam
- FAQ
- Feature Guide
- Glossary
- Graphic
- How-To Article
- Index
- Industry Profile
- Instructions
- Journal
- Learning Map
- Lesson
- Licensing Information
- Meeting Minutes
- News
- Overview
- Presentation
- Press release
- Proposal
- Quick Reference
- Release Notes
- Security Bulletin
- Service Level Agreement
- Specification
- Survey
- Training

4 Best Practices Guide

While providing best practices, CLEO does not intend to define how a learning technology system will internally represent or use a metadata instance for a learning object. However, the Best Practices Guide presents scenarios detailing how the members look to exchange and utilize objects among authoring, management, and delivery systems.

The Best Practice Guide includes, as appropriate, examples of how the libraries can be represented, and guidance on the proper use of the model.

The Guide includes a description and examples to show how object metadata can be represented in a new schema beyond the LOM schema definition. The Best Practice Guide also includes Use Cases and other XML examples of the use of the Information Model in practice.

Initial updates to the Best Practice Guide may be warranted following the publication of the Information Model described below and the use of extensions contained therein.

The following XML and XML Schema (XSD) examples are for illustrative purposes only. An actual binding of this proposal may differ from these examples. In the examples, a CLEO metadata namespace URI is assumed to have been declared the namespace “cleomd”.

A LOM binding is also shown. This binding is for illustrative purposes only. Any match between an actual LOM binding and the following examples is purely coincidental. In the examples, a LOM metadata namespace URI is assumed to have been declared with a namespace name “lom”.

The use of separate namespace names in the examples is intended to keep LOM base schema elements and CLEO extension elements clearly distinguishable. Some simple types in the examples shown below (sourceURIType and vocTokenType) have been shown using the CLEO metadata namespace. As the LOM binding is created it is expected that these simple types will appear in the LOM namespace and the CLEO schema will be updated.

All XML examples are presented as a fragment of a larger XML instance.

4.1 General Guidelines for Extending the LOM XMLSchema

4.1.1 XMLSchema Example: Extending LOM With New Metadata Elements

In the following example, CLEO proposes to define new metadata elements as standard IMS LOM extensions, Aggregation Sub Level, Cognitive Strategy, Cognitive Domain and Typical Learning Time Range. These proposed extensions are considered standard because they are not extensions that are unique to a particular organization but are applicable and useful to a broad range of organizations.

```
<?xml version="1.0"?>
<!-- filename=cleo_md_ext_v003.xsd -->
<!-- Conforms to w3c http://www.w3.org/TR/xmlschema-1/ 2000-10-24-->
<xsd:schema targetNamespace="http://cleolab.org/xsd/cleo_md_ext_v012"
                      xmlns="http://cleolab.org/xsd/cleo_md_ext_v012"
```

```
                  xmlns:xsd="http://www.w3.org/2001/XMLSchema"
                  elementFormDefault="unqualified"
                  version="CLEO Version 0.0.1.1">
      <!-- ******************** -->
      <!-- ** Change History ** -->
      <!-- ******************** -->
      <xsd:annotation>
            <xsd:documentation>Version 0.0.1.1</xsd:documentation>
            <xsd:documentation>December 10, 2002</xsd:documentation>
            <xsd:documentation>To test LOM extension models for
CLEO</xsd:documentation>
            <xsd:documentation>Specific to current IMS LOM
binding</xsd:documentation>
      </xsd:annotation>

      <!-- ************************* -->
      <!-- **      Attributes     ** -->
      <!-- ************************* -->
  <xsd:attributeGroup name="typicalLearningTimeRangeAtts">
    <xsd:attribute name="minimumLearningTime" type="xsd:duration"/>
    <xsd:attribute name="maximumLearningTime" type="xsd:duration"/>
  </xsd:attributeGroup>

      <!-- ************************* -->
      <!-- **     Simple Types     ** -->
      <!-- ************************* -->

      <xsd:simpleType name="term" type=" xsd:string"/>      <xsd:simpleType
name="itemModeType">
            <xsd:restriction base="xsd:string">
                  <xsd:enumeration value="browse"/>
                  <xsd:enumeration value="review"/>
                  <xsd:enumeration value="normal"/>
                  <xsd:enumeration value=""/>
            </xsd:restriction>
      </xsd:simpleType>
      <xsd:simpleType name="sourceURIType">
            <xsd:restriction base="xsd:anyURI"/>
      </xsd:simpleType>
      <xsd:simpleType name="vocTokenType">
            <xsd:restriction base="xsd:string"/>
      </xsd:simpleType>

      <!-- ************************* -->
      <!-- ** Complex Types  ** -->
      <!-- ************************* -->

      <xs:complexType name="sublevelType">
           <xs:sequence>
           <xs:element name="source" type="xs:string" minOccurs="0"/>
           <xs:element name="value" type="xs:string" minOccurs="0"/>
           <xs:element name="otherTerms" minOccurs="0">
                <xs:complexType>
                <xs:sequence>
                <xs:element name="term" minOccurs="0" maxOccurs="unbounded">
                     <xs:complexType>
                     <xs:sequence>
```

```
                        <xs:element name="source" type="xs:string"
      minOccurs="0"/>
                        <xs:element name="value" type="xs:string" minOccurs="0"/>
                    </xs:sequence>
                    </xs:complexType>
                </xs:element>
                </xs:sequence>
            </xs:complexType>
            </xs:element>
            </xs:sequence>
      </xs:complexType>
      <xsd:complexType name="cognitiveStrategyVocType">
            <xsd:sequence>
                  <xsd:element ref="sourceURI"/>
                  <xsd:element ref="vocToken"/>
            </xsd:sequence>
      </xsd:complexType>
      <xsd:complexType name="cognitiveDomainVocType">
            <xsd:sequence>
                  <xsd:element ref="sourceURI"/>
                  <xsd:element ref="vocToken"/>
            </xsd:sequence>
      </xsd:complexType>
      <xsd:complexType name="typicalLearningTimeRangeType">
                <xsd:attributeGroup ref="typicalLearningTimeRangeAtts"/>
      </xsd:complexType>

      <!-- ************************* -->
      <!-- ** Element Declarations ** -->
      <!-- ************************* -->

      <xs:element name="sublevel" type="sublevelType">
      <xs:annotation>
      <xs:documentation>CLEO element extending LOM 1.8:Aggregation
Level</xs:documentation>
      </xs:annotation>
      </xs:element>
      <xsd:element name="typicalLearningTimeRange"
type="typicalLearningTimeRangeType"/>
      <xsd:element name="cognitiveDomain" type="cognitiveDomainVocType"/>
      <xsd:element name="cognitiveStrategy" type="cognitiveStrategyVocType"/>
      <!-- mode element to be used with content pkg item until simple sequencing
spec available  -->
      <xsd:element name="mode" type="itemModeType"/>
</xsd:schema>
```

4.1.2 XMLSchema Example: Extending LOM With Organization-Specific Metadata Elements

In the following example, a number of metadata elements have been defined relevant specifically to an organization. These extensions are would be communicated to a content partner and agreed upon between both parties.

```
<!-- filename=csco_md_ext_v001.xsd -->
<!-- this sample is to test a way to extend certain elements in the -->
<!-- LOM xmlschema to support Cisco specific attributes -->

<xsd:schema xmlns:xsd="http://www.w3.org/2001/XMLSchema"
         targetNamespace="http://www.cisco.com/elearning/xsd/ciscomd_v001"
         xmlns="http://www.cisco.com/elearning/xsd/ciscomd_v001"
         xmlns:lom="http://www.imsglobal.org/xsd/imsmd_rootv1p2p2"
         elementFormDefault="qualified" version="csco_elearning Version 0.0.1">

<xsd:import namespace="http://www.imsglobal.org/xsd/imsmd_rootv1p2p2"
         schemaLocation="imsmd_rootv1p2p2.xsd"/>

<!-- ************************ -->
<!-- ** Element Declaration ** -->
<!-- ************************ -->

<!-- example of how to create a new element not in LOM -->
<xsd:element name="ciscocompetency" type="ciscocompetencyType"/>
<xsd:element name="ciscoskill" type= "lom:taxonpathType"/>
<xsd:element name="ciscoproficiencylevel" type= "lom:taxonpathType"/>

<!-- ******************* -->
<!-- ** Complex Types ** -->
<!-- ******************* -->

<xsd:complexType name="ciscocompetencyType" minoccurs="0" maxoccurs="unbounded">
   <xsd:sequence>
      <xsd:element ref="ciscoskill">
      <xsd:element ref="ciscoproficiencylevel">
   </xsd:sequence>
</xsd:complexType>
</xsd:schema>
```

4.2 General Guidelines for Restricting the LOM xmlschema

At present, CLEO members know of no way to further restrict the IMS LOM defined elements in a schema. If restriction or refinement is necessary, it is recommended that the organization redefine the element in their own namespace.

A metadata instance created for a private schema could be translated to a LOM standard instance through an XML transform. For example, an element named csco_elearning:location with a restricted value space could be transformed to a standard LOM element location through an XSL sheet. The client would use the Cisco XSD that restricts the value space, and that XSD could be used for validation, but then the XML document would be tranformed via XSLT into a standard LOM XML document.

4.2.1 XMLSchema Example: Element required, restricted valueset

Below is a representation of the element location in the current IMS Metadata binding.

```
<xsd:element name="location" type="locationType"/>

<xsd:complexType name="locationType">
   <xsd:simpleContent>
      <xsd:extension base="xsd:string">
         <xsd:attributeGroup ref="attr.type"/>
      </xsd:extension>
   </xsd:simpleContent>
</xsd:complexType>

<xsd:attributeGroup name="attr.type">
   <xsd:attribute name="type" use="optional" default="URI">
      <xsd:simpleType>
         <xsd:restriction base="xsd:string">
            <xsd:enumeration value="URI"/>
            <xsd:enumeration value="TEXT"/>
         </xsd:restriction>
      </xsd:simpleType>
   </xsd:attribute>
</xsd:attributeGroup>
```

In the following example locationType is restricted to only two enumerated values and defined as required.

```
<xsd:element name="location" type="locationType" use="required"/>

<xsd:complexType name="locationType">
   <xsd:simpleContent>
      <xsd:extension base="xsd:string">
         <xsd:enumeration value="URI"/>
         <xsd:enumeration value="Filepath"/>
      </xsd:extension>
   </xsd:simpleContent>
</xsd:complexType>
```

4.3 XML Example

4.3.1 XML instance using CLEO standard extensions to IMS schema

This XML example exhibits only the CLEO standard schema extensions

```
<?xml version="1.0" encoding="UTF-8" ?>
<lom xmlns="http://www.imsglobal.org/xsd/imsmd_v1p2"
     xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
     xmlns:cleomd="http://cleolab.org/xsd/cleo_md_ext_v003"
     xsi:schemaLocation="http://www.imsglobal.org/xsd/imsmd_v1p2 imsmd_v1p2p2.xsd
http://cleolab.org/xsd/cleo_md_ext_v003 cleo_md_ext_v003.xsd">
<general>

  <title>
    <langstring xml:lang="en">How to select an ideal vacation</langstring>
  </title>
```

```
  <catalogentry>
    <catalog>Travel and tourism</catalog>
    <entry>
      <langstring xml:lang="en">12345</langstring>
    </entry>
  </catalogentry>

  <language>en</language>

  <description>
    <langstring xml:lang="en">
      Dreaming of the perfect vacation? This learning object will help you select
the ideal setting!
    </langstring>
  </description>

  <keyword>
    <langstring xml:lang="en">travel</langstring>
    <langstring xml:lang="fr">help</langstring>
  </keyword>
  <keyword>
    <langstring xml:lang="en">tourism</langstring>
  </keyword>
</general>

<lifecycle>
  <version>
    <langstring xml:lang="x-none">1.0</langstring>
  </version>

  <contribute>
    <role>
      <source>
        <langstring xml:lang="x-none">LOMv1.0</langstring>
      </source>
      <value>
        <langstring xml:lang="x-none">content provider</langstring>
      </value>
    </role>
    <centity>
      <vcard>
BEGIN: vcard
FN: Tourism Terry
EMAIL: tterry@cleo.org
END: vcard
      </vcard>
    </centity>
  </contribute>
</lifecycle>

<technical>
  <format>application/msword</format>
  <size>210000</size>
</technical>

<educational>
```

```
  <intendedenduserrole>
    <source>
      <langstring xml:lang="x-none">LOMv1.0</langstring>
    </source>
    <value>
      <langstring xml:lang="x-none">learner</langstring>
    </value>
  </intendedenduserrole>

  <learningresourcetype>
     <source>
       <langstring xml:lang="x-none">
http://www.cleolab.org/vocab/learningResourceType</langstring>
     </source>
     <value>
       <langstring xml:lang="x-none">example</langstring>
     </value>
  </learningresourcetype>

  <typicallearningtime>
    <datetime>12345</datetime>
  </typicallearningtime>
  <cleomd:typicalLearningTimeRange minimumLearningTime="PT30M"
maximumLearningTime="PT2H"/>
  <cleomd:cognitiveDomain>
    <cleomd:sourceURI>http://cleolab.org/vocab/cognitiveDomain
    </cleomd:sourceURI>
    <cleomd:vocToken>Analysis</cleomd:vocToken>
  </cleomd:cognitiveDomain>
  <cleomd:cognitiveStrategy>
    <cleomd:sourceURI>http://cleolab.org/vocab/cognitiveStrategy
    </cleomd:sourceURI>
    <cleomd:vocToken>concept</cleomd:vocToken>
  </cleomd:cognitiveStrategy>
</educational>

<classification>
  <purpose>
    <source>
      <langstring xml:lang="x-none">
http://www.cleolab.org/vocab/businessPurpose</langstring>
    </source>
    <value>
      <langstring xml:lang="x-none">experimental</langstring>
    </value>
    <description>
      <langstring xml:lang="en">How-To Article</langstring>
    </description>

</purpose>
</classification>
</lom>
```

4.3.2 XML instance using CLEO standard and company specific extensions

This example exhibits the CLEO standard schema extensions and displays how a company can further extend the IMS schema for it's own requirements:

```
<?xml version="1.0" encoding="UTF-8" ?>
<!--  sample xml instance using CLEO and Cisco schema extensions to IMS schema -->
<lom xmlns="http://www.imsglobal.org/xsd/imsmd_rootv1p2p1"
     xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
     xmlns:cleomd="http://cleolab.org/xsd/cleo_md_experimental_v002"
     xmlns:cisco_elearn="http://www.cisco.com/elearning/xsd/ciscomd_v001"
     xsi:schemaLocation= "http://www.cisco.com/elearning/xsd/ciscomd_v001
ciscomd_v001.xsd
     http://www.imsglobal.org/xsd/imsmd_rootv1p2p1 imsmd_rootv1p2p1.xsd
     http://cleolab.org/xsd/cleo_md_experimental20020531
cleo_md_experimental_v002.xsd">

<general>
     <title>How to Win With Catalyst 4000</title>
     <catalogentry>
          <catalog>Cisco LCMS</catalog>
          <entry>
                  <langstring xml:lang="x-none">14553</langstring>
          </entry>
     </catalogentry>
     <language>en</language>
     <description>
          <langstring xml:lang="en">How to sell the Catalyst caching application:
what are the services offered, what are the challenges.</langstring>
     </description>
     <keyword>
          <langstring xml:lang="en">Catalyst</langstring>
     </keyword>

     <aggregationlevel>
          <source>
               <langstring xml:lang="x-none"> LOMv1.0</langstring>
          </source>
          <value>
               <langstring xml:lang="x-none">3</langstring>
          </value>
     </aggregationlevel>
</general>
<lifecycle>
     <version>
          <langstring xml:lang="x-none">1.0</langstring>
     </version>

     <contribute>
          <role>
               <source>
                    <langstring xml:lang="x-none">LOMv1.0</langstring>
               </source>
               <value>
                    <langstring xml:lang="x-none">content provider</langstring>
               </value>
          </role>
          <centity>
               <vcard>
BEGIN: vcard
FN: Linda Svendol
EMAIL: lsvendol@cisco.com
CISCOMAILERID: sven
END: vcard
               </vcard>
```

```
          </centity>
     </contribute>
     <contribute>
          <role>
               <source>
                    <langstring xml:lang="x-none">LOMv1.0</langstring>
               </source>
               <value>
                    <langstring xml:lang="x-none">validator</langstring>
               </value>
          </role>
          <centity>
               <vcard>
BEGIN: vcard
ORG: FELC web team
CISCOMAILERID: felc-team
END: vcard
               </vcard>
          </centity>
     </contribute>
</lifecycle>

<technical>
     <format>application/msword</format>
     <size>210000</size>
     <cisco_elearn:location type="URI">
http:wwwin.cisco.com/webtraining/711_42/index.htm</location>
</technical>

<educational>
     <intendedenduserrole>
          <source>
                 <langstring xml:lang="x-none">LOMv1.0</langstring>
          </source>
          <value>
                 <langstring xml:lang="x-none">learner</langstring>
           </value>
      </intendedenduserrole>

      <learningresourcetype>
            <source>
                  <langstring xml:lang="x-none">
http://www.cleolab.org/vocab/learningResourceType</langstring>
            </source>
            <value>
                  <langstring xml:lang="x-none">example</langstring>
            </value>
      </learningresourcetype>

      <cleomd:cognitiveDomain>
            <cleomd:sourceURI>
                  http://cleolab.org/vocab/cognitiveDomain
            </cleomd:sourceURI>
      <cleomd:vocToken>analysis</cleomd:vocToken>
      </cleomd:cognitiveDomain>

      <cleomd:cognitiveStrategy>
            <cleomd:sourceURI>
                  http://cleolab.org/vocab/cognitiveStrategy
            </cleomd:sourceURI>
            <cleomd:vocToken>concept</cleomd:vocToken>
      </cleomd:cognitiveStrategy>
            <cleomd:typicalLearningTimeRange minimumLearningTime="PT10M"
                  maximumLearningTime="PT20M"/>
```

```
</educational>

<classification>
<!-- classification instance that does not require any extension -->
      <purpose>
            <source>
                  <langstring xml:lang="x-none">LOMv1.0</langstring>
            </source>
            <value>
                  <langstring xml:lang="x-none">educational objective</langstring>
            </value>
      </purpose>
      <description>
            <langstring xml:lang="en">Learn to effectively sell Avvid
technology.</langstring>
      </description>
</classification>

<classification>
<!-- classification instance requiring reference to organizational specific source-
->
     <purpose>
           <source>
                  <langstring xml:lang="x-none">LOMv1.0</langstring>
           </source>
           <value>
                  <langstring xml:lang="x-none">discipline</langstring>
           </value>
     </purpose>
     <taxonpath>
           <source>
                 <langstring xml:lang="en">CiscoLearningCategory</langstring>
           </source>
           <taxon>
                 <id>5420</id>
                 <entry><langstring xml:lang="en">Career
Certification</langstring></entry>
                 <taxon>
                       <id>5400</id>
                       <entry><langstring xml:lang="en">Communications and
Services</langstring></entry>
                       <taxon>
                              <id>5421</id>
                              <entry><langstring xml:lang="en">CCIE Wireless
Specialty</langstring></entry>
                       </taxon>
                 </taxon>
           </taxon>
     </taxonpath>
</classification>

<cisco_elearn:competency>
      <cisco_elearn:skill>
           <taxonpath>
                 <source>
                        <langstring xml:lang="en">CiscoSkills</langstring>
                 </source>
                 <taxon>
                       <id>93727</id>
                       <entry>><langstring xml:lang="en">Troubleshooting
Avvid</langstring></entry>
                 </taxon>
           </taxonpath>
      </cisco_elearn:skill>
```

```
      <cisco_elearn:proficiencylevel>
           <taxonpath>
                 <source><langstring
xml:lang="en">CiscoProficiencyLevels</langstring></ source>
                 <taxon>
                       <id>938</id>
                       <entry><langstring
xml:lang="en">Expert</langstring></entry>
                 </taxon>
           </taxonpath>
      </cisco_elearn:proficiencylevel>
</cisco_elearn:competency>

</lom>
```

Appendix A: Glossary

ADL	Advanced Distributed Learning
AICC	Aviation Industry CBT Committee
API	Application Programming Interface
ANSI	American National Standards Institute
CBT	Computer Based Training
CLEO	Customized Learning Experience Online
CMI	Computer Managed Instruction
CPI	Content Packaging Interchange
DTD	Document Type Definition
IEEE	Institute of Electronic & Electrical Engineering
IMS	IMS Global Learning Consortium, Inc.
ISO	International Standards Organization
JTC	Joint Technical Committee
LOM	Learning Object Metadata
LTSC	Learning Technology Standards Committee
RIO	Reusable Information Object (Level 3 in Aggregation Level vocabulary)
RLO	Reusable Learning Object (Level 5 in Aggregation Level vocabulary)
SCORM ™	Sharable Content Object Reference Model
URI	?_ Reference?
W3C	World Wide Web Consortium
XML	eXtensible Mark-up Language
XSD	XML schema
XSLT	XML style sheet determining content presentation

Appendix B: LOM with CLEO Extensions

The table below represents the information model for the IEEE Learning Object Metadata standard version 1.0. Areas where CLEO has extensions or vocabulary substitutions are shown in **red**.

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
1	**General**	**This category groups the general information that describes this learning object as a whole.**	1	unspecified	-	-	-
1.1	**Identifier**	**A globally unique label that identifies this learning object.**	smallest permitted maximum: 10 items	unspecified	-	-	-
1.1.1	**Catalog**	**The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.**	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	**"ISBN", "ARIADNE", "URI"**
1.1.2	**Entry**	**The value of the identifier within the identification or cataloging scheme that designates or identifies this learning object. A namespace specific string.**	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	**"2-7342-0318", "LEAO875", "http://www.ieee.org/documents/1234"**
1.2	**Title**	**Name given to this learning object.**	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	**("en", "The life and works of Leonardo da Vinci")**
1.3	**Language**	**The primary human language or languages used within this learning object to communicate to the intended user. NOTE 1:--An indexation or cataloging tool may provide a useful default. NOTE 2:--If the learning object had no lingual content (as in the case of a picture of the Mona Lisa, for example), then the appropriate value for this data element would be "none". NOTE 3:--This data element concerns the language of the learning object. Data element 3.4:Meta-Metadata.Language concerns the language of the metadata instance.**	smallest permitted maximum: 10 items	unordered	LanguageID = Langcode ["-"Subcode]* with Langcode a language code as defined by the code set ISO 639:1988 and Subcode (which can occur an arbitrary number of times) a country code from the code set ISO 3166-1: 1997.NOTE 4:--This value space is also defined by RFC1766:1995 and is harmonized with that of the xml:lang attribute. NOTE 5:--ISO 639:1988 also includes "ancient" languages, like Greek and Latin.	CharacterString (smallest permitted maximum: 100 char)	**"en", "en-GB", "de", "fr-CA", "it" "grc" (ancient greek, until 1453) "en-US-philadelphia" "eng-GB-cockney" "map-PG-buin" (Austronesian - Papua New Guinea – buin) "gem-US-pennsylvania"**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
					The language code should be given in lower case and the country code (if any) in upper case. However, the values are case insensitive. "none" shall also be an acceptable value.		
1.4	**Description**	**A textual description of the content of this learning object.** **NOTE:--This description need not be in language and terms appropriate for the users of the learning object being described. The description should be in language and terms appropriate for those that decide whether or not the learning object being**	smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 2000 char)	**("en", "In this video clip, the life and works of Leonardo da Vinci are briefly presented. The focus is on his artistic production, most notably the Mona Lisa.")**
1.5	**Keyword**	**A keyword or phrase describing the topic of this learning object. This data element should not be used for characteristics that can be described by other data elements.**	smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 1000 char)	**("en", "Mona Lisa")**
1.6	**Coverage**	**The time, culture, geography or region to which this learning object applies.** **The extent or scope of the content of the learning object. Coverage will typically include spatial location (a place name or geographic coordinates), temporal period (a period label, date, or date range) or jurisdiction (such as a named administrative entity). Recommended best practice is to select a value from a controlled vocabulary (for example, the Thesaurus of Geographic Names [TGN]) and that, where appropriate, named places or time periods be used in preference to numeric identifiers such as sets of coordinates or date ranges.** **NOTE 1:--This is the definition from the Dublin Core Metadata Element Set 4 .**	smallest permitted maximum: 10 items	unordered	-	LangString (smallest permitted maximum: 1000 char)	**("en", "16th century France")** **NOTE 2:--A learning object could be about farming in 16th century France: in that case, its subject can be described with 1.5:General.Keyword=("en","farming") and its 1.6:General.Coverage can be ("en","16th century France").**
1.7	**Structure**	**Underlying organizational structure of this learning object.**	1	unspecified	atomic: an object that is indivisible (in this context). collection: a set of objects with no specified relationship	Vocabulary (State)	**NOTE:--A learning object with Structure="atomic" will typically have 1.8:General.AggregationLevel=1. A learning object with Structure="collection", "linear",**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
					between them. networked: a set of objects with relationships that are unspecified. hierarchical: a set of objects whose relationships can be represented by a tree structure. linear: a set of objects that are fully ordered. Example: A set of objects that are connected by "previous" and "next" relationships.		**"hierarchical" or "networked" will typically have 1.8:General.AggregationLevel=2, 3 or 4.**
1.8	**Aggregation Level**	The functional granularity of this learning object.	1	unspecified	1: the smallest level of aggregation, e.g., raw media data or fragments. 2: a collection of level 1 learning objects, e.g., a lesson. 3: a collection of level 2 learning objects, e.g., a course. 4: the largest level of granularity, e.g., a set of courses that lead to a certificate. NOTE 1:--Level 4 objects can contain level 3 objects, or can recursively contain other level 4 objects.	Vocabulary (Enumerated)	**If the learning object is a digital picture of the Mona Lisa, 1.7:General.Structure=Atomic and 1.8:General.AggregationLevel=1.** **If the learning object is a lesson with the digital picture of the Mona Lisa, 1.7:General.Structure=Collection or Networked (since there are two descriptions of the same type of Structure) and 1.8:General.AggregationLevel=2.** **If the learning object is a course on the Mona Lisa, 1.7:General.Structure=Linear if the documents are intended to be viewed linearly and 1.8:General.AggregationLevel=3.** **If the learning object is a collection of lessons on the Mona Lisa from different sources, 1.7:General.Structure=Collection and 1.8:General:AggregationLevel=3.** **Lastly if the learning object is a set of courses with a full history, description, interpretation, etc. of the Mona Lisa, 1.7:General.Structure=Linear or Hierarchical and 1.8:General.AggregationLevel=4.** **NOTE 2:--A learning object with AggregationLevel=1 will typically have**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
							1.7:General.Structure="atomic". A learning object with AggregationLevel=2, 3 or 4 will typically have 1.7:General.Structure= "collection", "linear", "hierarchical" or "networked".
1.8.1	**Aggregation Sub Level**	Additional levels of detail	1	unspecified	"a": Source content "b": Finalized source content; intended for use only within a containing context "c": A meaningful visual image and any interaction associated with that image. The contents of a single CRT presentation that appears at a single point in time during a lesson. Equates to list of Learning Resource Types.: "d": Smallest sequence-able unit of aggregation. Satisfies an enabling objective. "e": Step (can be recursive) e.g. assessment, tutorial parts within a lesson. "g": Undifferentiated Block "h": Segment of LOM 1.8: General.Aggregation Level "3", e.g. assessment, tutorial (can be recursive). A block where you have assigned a specific purpose. "i": Particular path through a course "k": Collection of LOM 1.8: General.Aggregation Level "3" selected from a curriculum. Particular path through a curriculum "m": Collection of	Vocabulary (State)	

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
					learning resources for a field of study "n": Library (super-collection) Data type -- CLEO Vocabulary (State) Note: The CLEO Vocabulary model is the same as the LOM Base Schema Vocabulary model defined in 1484.12.1-2002 Clause 10. Importing a LOM binding is unnecessary since the LOM vocabulary model's elements are redeclared within a CLEO namespace.		
1.8.1.1	**Other Terms**	A collection of semantically equivalent values from different user environments that map to a CLEO sub-level vocabulary term	1	unspecified			
1.8.1.1.1	**Term**	A single clarifying term mapped from a specific context	smallest permitted maximum: 10 items	unordered	Repertoire of ISO/IEC 10646-1:2000	Open Vocabulary (declare) Note: The Open Vocabulary model is the same as the LOM Base Schema Vocabulary model defined in 1484.12.1-2002 Clause 10 except that no values are declared at this time. It is an "open" model: values may be declared when adding the CLEO Sub Level extension to a LOM 1.8:General.Aggregation Level element. Importing a LOM binding is	

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
						unnecessary since the LOM vocabulary model's elements are redeclared within a CLEO namespace.	
2	**Life Cycle**	**This category describes the history and current state of this learning object and those entities that have affected this learning object during its evolution.**	1	unspecified	-	-	-
2.1	**Version**	**The edition of this learning object.**	1	unspecified	-	LangString (smallest permitted maximum: 50 char)	**("en", "1.2.alpha"), ("nl", "voorlopige versie")**
2.2	**Status**	**The completion status or condition of this learning object.**	1	unspecified	draft final revised unavailable NOTE:--When the status is "unavailable" it means that the learning object itself is not available.	Vocabulary (State)	-
2.3	**Contribute**	**Those entities (i.e., people, organizations) that have contributed to the state of this learning object during its life cycle (e.g., creation, edits, publication).** **NOTE 1:--This data element is different from 3.3:Meta-Metadata.Contribute.** **NOTE 2:--Contributions should be considered in a very broad sense here, as all actions that affect the state of the learning object.**	smallest permitted maximum: 30 items	ordered	-	-	-
2.3.1	**Role**	**Kind of contribution. NOTE 1:--Minimally, the Author(s) of the learning object should be described.**	1	unspecified	author publisher unknown initiator terminator validator editor graphical designer technical implementer content provider technical validator educational validator script writer instructional designer subject matter expert	Vocabulary (State)	-

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
					NOTE 2:--"terminator" is the entity that made the learning object unavailable.		
2.3.2	**Entity**	**The identification of and information about entities (i.e., people, organizations) contributing to this learning object. The entities shall be ordered as most relevant first.**	smallest permitted maximum: 40 items	ordered	vCard, as defined by IMC vCard 3.0 (RFC 2425, RFC 2426).	CharacterString (smallest permitted maximum: 1000 char)	**"BEGIN:VCARD\nFN:Joe Friday\nTEL:+1-919-555-7878\nTITLE:Area Administrator\, Assistant\n EMAIL\;TYPE=INTERN\nET:jfriday @host.com\nEND:VCARD\n"**
2.3.3	**Date**	**The date of the contribution.**	1	unspecified	-	DateTime	**"2001-08-23"**
3	**Meta-Metadata**	**This category describes this metadata record itself (rather than the learning object that this record describes). This category describes how the metadata instance can be identified, who created this metadata instance, how, when, and with what references. NOTE:--This is not the information that describes the learning object itself.**	1	unspecified	-	-	**-**
3.1	**Identifier**	**A globally unique label that identifies this metadata record.**	smallest permitted maximum: 10 items	unspecified	-	-	**-**
3.1.1	**Catalog**	**The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.**	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	**"Ariadne", "URI"**
3.1.2	**Entry**	**The value of the identifier within the identification or cataloging scheme that designates or identifies this metadata record. A namespace specific string.**	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	**"KUL532", "http://www.ieee.org/descriptions/ 1234"**
3.2	**Contribute**	**Those entities (i.e., people or organizations) that have affected the state of this metadata instance during its life cycle (e.g., creation, validation). NOTE:--This data element is concerned with contributions to the metadata. Data element 2.3:Lifecycle.Contribute is concerned with contributions to the learning object.**	smallest permitted maximum: 10 items	ordered	-	-	**-**
3.2.1	**Role**	**Kind of contribution. Exactly one instance of this data element with value "creator" should exist.**	1	unspecified	creator validator	Vocabulary (State)	**-**
3.2.2	**Entity**	**The identification of and information about entities (i.e., people, organizations) contributing to this metadata**	smallest permitted maximum: 10	ordered	vCard, as defined by IMC vCard 3.0 (RFC 2425, RFC 2426).	CharacterString (smallest permitted maximum: 1000	**"BEGIN:VCARD\nFN:Joe Friday\nTEL:+1-919-555-7878\nTITLE:Area Administrator\, Assistant\n**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
		instance. The entities shall be ordered as most relevant first.	items			maximum: 1000 char)	**EMAIL\;TYPE=INTERN\nET:jfriday @host.com\nEND:VCARD\n"**
3.2.3	**Date**	**The date of the contribution.**	1	unspecified	-	DateTime	**"2001-08-23"**
3.3	**Metadata Schema**	**The name and version of the authoritative specification used to create this metadata instance.** **NOTE:--This data element may be user selectable or system generated.** **If multiple values are provided, then the metadata instance shall conform to multiple metadata schemas.**	smallest permitted maximum: 10 items	unordered	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 30 char)	**"LOMv1.0"**
3.4	**Language**	**Language of this metadata instance. This is the default language for all LangString values in this metadata instance. If a value for this data element is not present in a metadata instance, then there is no default language for LangString values. NOTE 1:--This data element concerns the language of the metadata instance. Data element 1.3:General.Language concerns the language of the learning object.**	1	unspecified	see 1.3:General.Language For this data element, "none" shall not be an acceptable value. NOTE 2:--"none" is unacceptable, because the metadata instance is in one or more human languages. "none" is acceptable for 1.3:General.Language, as the learning object itself may be in no particular human language. For example, a picture of the Mona Lisa has "none" for 1.3:General.Language. If its description (i.e., metadata instance) is in Swedish, then 3.4:Meta-Metadata. Language has value "sv".	CharacterString (smallest permitted maximum: 100 char)	**"en"**
4	**Technical**	**This category describes the technical requirements and characteristics of this learning object.**	1	unspecified	-	-	**-**
4.1	**Format**	**Technical datatype(s) of (all the components of) this learning object.** **This data element shall be used to identify the software needed to access the learning object.**	smallest permitted maximum: 40 items	unordered	MIME types based on IANA registration (see RFC2048:1996) or "non-digital"	CharacterString (smallest permitted maximum: 500 char)	**"video/mpeg", "application/x-toolbook", "text/html"**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
4.2	**Size**	**The size of the digital learning object in bytes (octets). The size is represented as a decimal value (radix 10). Consequently, only the digits "0" through "9" should be used. The unit is bytes, not Mbytes, GB, etc. This data element shall refer to the actual size of this learning object. If the learning object is compressed, then this data element shall refer to the uncompressed size.**	1	unspecified	ISO/IEC 646:1991, but only the digits "0".. "9"	CharacterString (smallest permitted maximum: 30 char)	**"4200"**
4.3	**Location**	**A string that is used to access this learning object. It may be a location (e.g., Universal Resource Locator), or a method that resolves to a location (e.g., Universal Resource Identifier). The first element of this list shall be the preferable location. NOTE:--This is where the learning object described by this metadata instance is physically located.**	smallest permitted maximum: 10 items	ordered	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	**"http://host/id"**
4.4	**Requirement**	**The technical capabilities necessary for using this learning object. If there are multiple requirements, then all are required, i.e., the logical connector is AND.**	smallest permitted maximum: 40 items	unordered	-	-	**-**
4.4.1	**OrComposite**	**Grouping of multiple requirements. The composite requirement is satisfied when one of the component requirements is satisfied, i.e., the logical connector is OR.**	smallest permitted maximum: 40 items	unordered	-	-	**-**
4.4.1.1	**Type**	**The technology required to use this learning object, e.g., hardware, software, network, etc.**	1	unspecified	operating system browser	Vocabulary (State)	**-**
4.4.1.2	**Name**	**Name of the required technology to use this learning object. NOTE 1:--The value for this data element may be derived from 4.1:Technical.Format automatically, e.g., "video/mpeg" implies "multi-os". NOTE 2:--This vocabulary includes most values in common use at the time that this Standard was approved.**	1	unspecified	if Type="operating system", then:pc-dos ms-windows macos unix multi-os none if Type="browser" then : any netscape communicator ms-internet explorer opera amaya	Vocabulary (State)	**-**
4.4.1.3	**Minimum Version**	**Lowest possible version of the required technology to use this learning object.**	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 30 char)	**"4.2"**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
4.4.1.4	**Maximum Version**	**Highest possible version of the required technology to use this learning object.**	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 30 char)	**"6.2"**
4.5	**Installation Remarks**	**Description of how to install this learning object.**	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	**("en", "Unzip the zip file and launch index.html in your web browser.")**
4.6	**Other Platform Requirements**	**Information about other software and hardware requirements.** **NOTE:--This element is intended for descriptions of requirements that cannot be expressed by data element 4.4:Technical.Requirement.**	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	**("en","sound card"), ("en","runtime X")**
4.7	**Duration**	**Time a continuous learning object takes when played at intended speed. NOTE:--This data element is especially useful for sounds, movies or animations.**	1	unspecified	-	Duration	**"PT1H30M", "PT1M45S"**
5	**Educational**	**This category describes the key educational or pedagogic characteristics of this learning object.** **NOTE:--This is the pedagogical information essential to those involved in achieving a quality learning experience. The audience for this metadata includes teachers, managers, authors, and learners.**	smallest permitted maximum: 100 items	unspecified	-	-	**-**
5.1	**Interactivity Type**	**Predominant mode of learning supported by this learning object. "Active" learning (e.g., learning by doing) is supported by content that directly induces productive action by the learner. An active learning object prompts the learner for semantically meaningful input or for some other kind of productive action or decision, not necessarily performed within the learning object's framework. Active documents include simulations, questionnaires, and exercises. "Expositive" learning (e.g., passive learning) occurs when the learner's job mainly consists of absorbing the content exposed to him (generally through text, images or sound). An expositive**	1	unspecified	active expositive mixed	Vocabulary (State)	**active documents (with learner's action): simulation (manipulates, controls or enters data or parameters); questionnaire (chooses or writes answers); exercise (finds solution); problem statement (writes solution). expositive documents (with learner's action): hypertext document (reads, navigates); video (views, rewinds, starts, stops); graphical material (views); audio material (listens, rewinds, starts, stops). mixed document: hypermedia document with embedded simulation applet.**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
		learning object displays information but does not prompt the learner for any semantically meaningful input. Expositive documents include essays, video clips, all kinds of graphical material, and hypertext documents. When a learning object blends the active and expositive interactivity types, then its interactivity type is mixed. NOTE:--Activating links to navigate in hypertext documents is not considered to be a productive action.					
5.2	**Learning Resource Type**	**Specific kind of learning object.**	smallest permitted maximum: 10 items	ordered	(*alternative vocabulary*) **See Section 3.1.2**	**Vocabulary (State)**	-
5.3	**Interactivity Level**	**The degree of interactivity characterizing this learning object. Interactivity in this context refers to the degree to which the learner can influence the aspect or behavior of the learning object. NOTE 1:--Inherently, this scale is meaningful within the context of a community of practice.**	1	unspecified	very low low medium high very high	Vocabulary (Enumerated)	**NOTE 2:--Learning objects with 5.1:Educational.InteractivityType= "active" may have a high interactivity level (e.g., a simulation environment endowed with many controls) or a low interactivity level (e.g., a written set of instructions that solicit an activity). Learning objects with 5.1:Educational.InteractivityType= "expositive" may have a low interactivity level (e.g., a piece of linear, narrative text produced with a standard word processor) or a medium to high interactivity level (e.g., a sophisticated hyperdocument, with many internal links and views).**
5.4	**Semantic Density**	**The degree of conciseness of a learning object. The semantic density of a learning object may be estimated in terms of its size, span, or --in the case of self-timed resources such as audio or video-- duration. The semantic density of a learning object is independent of its difficulty. It is best illustrated with examples of expositive material, although it can be used with active resources as well. NOTE 1:--Inherently, this scale is meaningful within the context of a community of practice.**	1	unspecified	very low low medium high very high	Vocabulary (Enumerated)	**Active documents: user interface of a simulation low semantic density: a screen filled up with explanatory text, a picture of a combustion engine, and a single button labeled "Click here to continue"high semantic density: screen with short text, same picture, and three buttons labeled "Change compression ratio", "Change octane index", "Change ignition point advance" Expositive documents: medium difficulty text documentmedium semantic density: "The class of Marsupial animals comprises a number of relatively primitive mammals. They are endowed with a short placentation, after which they give**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
							birth to a larva. The larva thereafter takes refuge in the mother's marsupium, where it settles to finish its complete development." high semantic density: "Marsupials are primitive mammals, with short placentation followed by the birth of larva, which thereafter takes refuge in the marsupium to finish its development." easy video documentlow semantic density: The full recorded footage of a conversation between two experts on the differences between Asian and African elephants; 30 minutes duration. high semantic density: An expertly edited abstract of the same conversation; 5 minutes duration difficult mathematical notation medium semantic density: The text representation of the theorem: For any given set j, it is always possible to define another set y, which is a superset of j. very high semantic density: The symbolic representation (formula) of the theorem ("j $y: y É j)
5.5	**Intended End User Role**	**Principal user(s) for which this learning object was designed, most dominant first. NOTE 1:--A learner works with a learning object in order to learn something. An author creates or publishes a learning object. A manager manages the delivery of this learning object, e.g., a university or college. The document for a manager is typically a curriculum. NOTE 2:--In order to describe the intended end user role through the skills the user is intended to master, or the tasks he or she is intended to be able to accomplish, the category 9:Classification can be used.**	smallest permitted maximum: 10 items		teacher author learner manager	Vocabulary (State)	**An authoring tool that produces pedagogical material is a typical example of a learning object whose intended end user is an author**
5.6	**Context**	**The principal environment within which the learning and use of this learning object is intended to take place.** **NOTE:--Suggested good practice is to use one of the values of the value space and to use an additional instance of this data**	smallest permitted maximum: 10 items	unordered	school higher education training other	Vocabulary (State)	-

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
		element for further refinement, as in ("LOMv1.0","higher education") and ("http://www.ond.vlaanderen.be/onderwijsinvlaanderen/Default.htm", "kandidatuursonderwijs")					
5.7	Typical Age Range	Age of the typical intended user. This data element shall refer to developmental age, if that would be different from chronological age. NOTE 1:--The age of the learner is important for finding learning objects, especially for school age learners and their teachers. When applicable, the string should be formatted as minimum age-maximum age or minimum age-. (NOTE:--This is a compromise between adding three component elements (minimum age, maximum age, and description) and having just a free text field.) NOTE 2:--Alternative schemes for what this data element tries to cover (such as various reading age or reading level schemes, IQ's or developmental age measures) should be represented through the 9:Classification category.	smallest permitted maximum: 5 items	unordered	-	LangString (smallest permitted maximum: 1000 char)	"7-9", "0-5", "15", "18-", ("en","suitable for children over 7"), ("en","adults only")
5.8	Difficulty	How hard it is to work with or through this learning object for the typical intended target audience. NOTE:--The " typical target audience" can be characterized by data elements 5.6:Educational.Context and 5.7:Educational.TypicalAgeRange.	1	unspecified	very easy easy medium difficult very difficult	Vocabulary (Enumerated)	-
5.9	Typical Learning Time	Approximate or typical time it takes to work with or through this learning object for the typical intended target audience. NOTE:--The " typical target audience" can be characterized by data elements 5.6:Educational.Context and 5.7:Educational.TypicalAgeRange.	1	unspecified	-	Duration	"PT1H30M", "PT1M45S"
5.9.1	Typical Learning Time Range	Identifies the approximate or typical length of time range to work with or through this learning object for the typical intended target audience. Contains two attributes in sequence:	1	unspecified	-	Duration	

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
		• minimumlearningtime • maximumlearningtime					
5.10	Description	Comments on how this learning object is to be used.	smallest permitted maximum: 10 items	unspecified	-	LangString (smallest permitted maximum: 1000 char)	("en", "Teacher guidelines that come with a textbook.")
5.11	Language	The human language used by the typical intended user of this learning object.	smallest permitted maximum: 10 items	unordered	See 1.3:General. Language	CharacterString (smallest permitted maximum: 100 char)	"en", "en-GB", "de", "fr-CA", "it" NOTE:--As an example, for a learning object in French, intended for English-speaking students, the value of 1.3:General.Language will be French, and the value of 5.11:Educational.Language will be English.
5.12	Cognitive Domain	Identifies cognitive level based upon Bloom or Merrill definitions	1	unspecified	(*alternative vocabulary*) knowledge comprehension application analysis synthesis evaluation remember use find	Vocabulary (State)	
5.13	Cognitive Strategy	Provides an instructional method & guideline to meet a learning objective (LOM 9.1 - where is value for 9.1 objective) based on a Cognitive Domain (LOM 5.12). Suggests learning resources that increase skills and knowledge, engage the learner, change behavior, provide instructional feedback or other cognitive devices.	1	unordered	(*alternative vocabulary*) concept fact procedure process principle	Vocabulary (State)	At Cisco Systems a value of "Concept" results in an instructional guideline that includes a definition, example, non-example, interaction, practice with feedback and assessment.
6	Rights	This category describes the intellectual property rights and conditions of use for this learning object. NOTE:--The intent is to reuse results of ongoing work in the Intellectual Property Rights and e-commerce communities. This category currently provides the absolute minimum level of detail only.	1	unspecified	-	-	-
6.1	Cost	Whether use of this learning object requires payment.	1	unspecified	yes no	Vocabulary (State)	-
6.2	Copyright and Other Restrictions	Whether copyright or other restrictions apply to the use of this learning object.	1	unspecified	yes no	Vocabulary (State)	-

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
6.3	**Description**	**Comments on the conditions of use of this learning object.**	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	**("en", "Use of this learning object is only permitted after a donation has been made to Amnesty International.")**
7	**Relation**	**This category defines the relationship between this learning object and other learning objects, if any.** **To define multiple relationships, there may be multiple instances of this category. If there is more than one target learning object, then each target shall have a new relationship instance.**	smallest permitted maximum: 100 items	unordered	-	-	(May be used in tandem with the metadata record associated with content packaging when the relationship is persistent.)
7.1	**Kind**	**Nature of the relationship between this learning object and the target learning object, identified by 7.2:Relation.Resource.**	1	unspecified	**Based on Dublin Core:ispartof: is part of haspart: has part isversionof: is version of hasversion: has version isformatof: is format of hasformat: has format references: references isreferencedby: is referenced by isbasedon: is based on isbasisfor: is basis for requires: requires isrequiredby: is required by**	Vocabulary (State)	
7.2	**Resource**	**The target learning object that this relationship references.**	1	unspecified	-	-	**-**
7.2.1	**Identifier**	**A globally unique label that identifies the target learning object.**	smallest permitted maximum: 10 items	unspecified	-	-	**-**
7.2.1.1	**Catalog**	**The name or designator of the identification or cataloging scheme for this entry. A namespace scheme.**	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	**"ISBN", "ARIADNE", "URI"**
7.2.1.2	**Entry**	**The value of the identifier within the identification or cataloging scheme that designates or identifies the target learning object. A namespace specific string.**	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 1000 char)	**"2-7342-0318", "LEAO875", "http://www.ieee.org/"**
7.2.2	**Description**	**Description of the target learning object.**	smallest permitted maximum: 10 items	unspecified	-	LangString (smallest permitted maximum: 1000 char)	**("en","The QuickTime movie of the Mona Lisa on the web site of the Louvre museum.")**
8	**Annotation**	**This category provides comments**	smallest	unordered	-	-	**-**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
		on the educational use of this learning object, and information on when and by whom the comments were created. This category enables educators to share their assessments of learning objects, suggestions for use, etc.	permitted maximum: 30 items				
8.1	**Entity**	**Entity (i.e., people, organization) that created this annotation.**	1	unspecified	vCard, as defined by IMC vCard 3.0 (RFC 2425, RFC 2426).	CharacterString (smallest permitted maximum: 1000 char)	**"BEGIN:VCARD\nFN:Joe Friday\nTEL:+1-919-555-7878\nTITLE:Area Administrator\, Assistant\n EMAIL\;TYPE=INTERN\nET:jfriday @host.com\nEND:VCARD\n"**
8.2	**Date**	**Date that this annotation was created.**	1	unspecified	-	DateTime	**"2001-08-23"**
8.3	**Description**	**The content of this annotation.**	1	unspecified	-	LangString (smallest permitted maximum: 1000 char)	**("en", "I have used this video clip with my students. They really enjoy being able to zoom in on specific features of the painting. Make sure they have a broadband connection or the experience becomes too cumbersome to be educationally interesting.")**
9	**Classification**	**This category describes where this learning object falls within a particular classification system. To define multiple classifications, there may be multiple instances of this category.**	smallest permitted maximum: 40 items	unordered	-	-	**-**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
9.1	**Purpose**	**The purpose of classifying this learning object.**	1	unspecified	discipline idea prerequisite educational objective accessibility restrictions educational level skill level security level competency	Vocabulary (State)	-
					(alternative vocabulary) **discipline** **idea** **prerequisite** **educational objective** **accessibility restrictions** **educational level** **skill level** **security level** **competency** **business purpose**	Vocabulary (State)	Includes additional term for business purpose. **See Section 3.1.6.**
9.2	**Taxon Path**	**A taxonomic path in a specific classification system. Each succeeding level is a refinement in the definition of the preceding level.** **There may be different paths, in the same or different classifications, which describe the same characteristic.**	smallest permitted maximum: 15 items	unordered	-	-	-
9.2.1	**Source**	**The name of the classifica-tion system. This data element may use any recog-nized "official" taxonomy or any user-defined taxonomy. NOTE:--An indexation, cataloging or query tool may provide the top-level entries of a well-established classifi-cation, such as the Library of Congress Classification (LOC), Universal Decimal Classification (UDC), Dewey Decimal Classification (DDC), etc.**	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	LangString (smallest permitted maximum: 1000 char)	**("en","ACM"), ("en","MESH"), ("en","ARIADNE")**
9.2.2	**Taxon**	**A particular term within a taxonomy. A taxon is a node that has a defined label or term. A taxon may also have an alphanumeric designation or identifier for standardized reference. Either or both the label and the entry may be used to designate a particular taxon.**	smallest permitted maximum: 15 items	ordered	-	-	**{["12",("en","Physics")], ["23",("en","Acoustics")], ["34",("en","Instruments")], ["45",("en","Stethoscope")]}** **A 2nd taxon path for the same learning object could be: {["56",("en","Medicine")], ["67",("en","Diagnostics")],**

Nr	Name	Explanation	Size	Order	Value space	Datatype	Example
		An ordered list of taxons creates a taxonomic path, i.e., "taxonomic stairway": this is a path from a more general to more specific entry in a classification.					**["34",("en","Instruments")], ["45",("en","Stethoscope")]}**
9.2.2.1	**Id**	**The identifier of the taxon, such as a number or letter combination provided by the source of the taxonomy.**	1	unspecified	Repertoire of ISO/IEC 10646-1:2000	CharacterString (smallest permitted maximum: 100 char)	**"320", |"4.3.2", |"BF180"**
9.2.2.2	**Entry**	**The textual label of the taxon.**	1	unspecified	-	LangString (smallest permitted maximum: 500 char)	**("en", "Medical Sciences")**
9.3	**Description**	**Description of the learning object relative to the stated 9.1:Classification.Purpose of this specific classification, such as discipline, idea, skill level, educational objective, etc.**	1	unspecified	-	LangString (smallest permitted maximum: 2000 char)	**("en", "A medical instrument for listening called a stethoscope.")**
9.4	**Keyword**	**Keywords and phrases descriptive of the learning object relative to the stated 9.1:Classification.Purpose of this specific classification, such as accessibility, security level, etc., most relevant first.**	smallest permitted maximum: 40 items	ordered	-	LangString (smallest permitted maximum: 1000 char)	**("en", "diagnostic instrument")**

Appendix C: CLEO Use Scenario: Content Creation and Exchange Using Metadata

This use scenario is divided into two parts. Part one presents the shared CLEO vision of exchanging any object at any aggregation level between vendors. Part two presents examples of applied metadata at aggregation level 2d and level 2.

Part 1: Learning Object Exchange Use Scenario

Content Creators (Business/Educational/Non Profit/Government institutions) need the ability to exchange learning objects and their metadata between separate database-oriented authoring tools and systems.

- Content Creators create a basic course, complete with lessons that comprise content, multimedia, practice activities and assessments.
- These are saved in a database and have metadata tags identifying each as learning objects.
- From this base course, the learning objects can be handed to a training development ”Partner” or another Content Creator.
- The Partner can then use any authoring tool/database to modify those learning objects to fit their particular didactical needs or audience.
- Partners and Content Creators can also add new “resources” or “services” to the learning objects that improve the quality of the multimedia, content, practices or assessments.
- In some cases the Partner may develop source content from scratch using their authoring tool/database.
- If required the Partner will return those learning objects to the Content Creator for validation.
- After validation those learning objects are imported back into the Content Creator’s authoring tool/database.

In order for the objects to function correctly, each aggregation level must have the appropriate metadata. (See Appendix D.)

Primary Actor: Author working for the Partner or the Content Creators

Scope: The systems under discussion in this use case include: Authoring tools, Authoring systems and the interoperability among those systems.

Stakeholders and Interests:
Content Creator or Partner: create and modify learning objects according to contractual requirements or identified didactic needs.

Preconditions:
Both Content Creators and the Partners have systems capable of importing and exporting learning objects and their associated metadata. Partners also must have an authoring tool that allows them to modify or create learning objects.

Minimal guarantees:
The learning object will function when imported back to the Content Creator and all of the required LOM and CLEO metadata is valid.

Success Guarantees:
- The unit of learning does not fail during export from Partner's system or import into Content Creator's system.
- All conditions of the contract between the Partner and Content Creator have been fulfilled.
- LOM and CLEO controlled vocabularies are used

Trigger:
Author is contracted to edit an imported learning object or create new learning object

Main Success Scenario:
1. Author's system receives formatted learning objects from an external source.
2. Author opens the learning object in their authoring tool/system.
3. Author edits learning objects regardless of the tool used to create that learning object.
4. Author creates a new learning object
5. Author exports the edited and/or new learning objects to an external source.
6. Author's system formats the learning objects to the agreed upon model for exportation.

Extensions:
1a. Internal and External Systems must agree upon a structure in order to successfully receive the learning objects.
1b. Formatted learning objects consist of structure, content and associated LOM metadata.
1c. Failed reception initiates a system response to external source. Human intervention may be needed to solve failure.
1d. Format is determined by the Content Creator's established methodology.
2a. Opening can include any resource or service, but some of these are not "editable" or visible to the Author (i.e. - AVI, MOV, services, or locked).
2b. Opening does not necessarily allow authors to delete locked resources or services.
3a. Author is able to create new "resources" or "services" to enhance the learning object.
3b. It is possible that a resource or service is not "editable" or visible by the authoring tool/system (i.e. - AVI, MOV, services, or locked).
3c. New "resources" or "services" created must be tagged with the appropriate LOM metadata.
4a. Author builds new learning objects, including new resources and services using their own tool/system, but based on the format agreed upon in success scenario. (See 1d.)
6a. The system and/or Content Creator validates that metadata has been correctly applied. Verify that metadata errors were not introduced during the creation or editing process.
6b. The system and/or Content Creator validates that the original format was not changed or applied incorrectly, preventing import to the Content Creator.
6c. Validation checks are not required until the learning objects are exported. Ownership of validation is the responsibility of the Author's system, Author's tool and the Author.

Part 2: Applying Key CLEO/LOM Metadata Data to the Use Scenario

This part focuses on metadata the authoring community could apply at aggregation level 2d and level 2 in order to exchange learning objects between vendors.

Please note that levels 1b and 1c are implied as being children of these objects and the metadata values are not specified in these examples. Likewise, only the CLEO extensions to the LOM, and those that are critical to illustrate this use scenario have been included.

The four examples in Table 8 list ways level 2d objects may be tagged given four different Learning Objectives and Cognitive Strategies.

Table 8. Aggregation Level 2d Examples

	Example 1	Example 2	Example 3	Example 4
1.2 Title	What is a Router	Performance Statistics	Configuring a Default Gateway	Cross Selling a Certificate of Deposit
1.8 Aggregation Level	2	2	2	2
1.8.1 Aggregation Sub Level	d	d	d	d
5.13 Cognitive Strategy	concept	fact	procedure	principle
5.12 Cognitive Domain	analysis	remember	use	synthesis
5.2 Learning Resource Type (ordered list)	practice definition example non example analogy	content practice	demonstration step practice reference	principle statement guidelines scenario
5.1 Interactivity Type	active	expositive	mixed	mixed
5.3 Interactivity Level	medium	low	high	very high
5.4 Semantic Density	medium	high	low	low
5.6 Context	training	training	training	training
9.1 Classification	educational objective	educational objective	educational objective	educational objective
9.3 Description	Describe the unique characteristics of a Router that allow it to operate at Level 3 of the TCP/IP stack.	List the performance statistics of the P1930	Configure the default gateway on the 8500 series router using Ethernet.	Given a customer with a basic checking account and $10k in funds, correctly position a certificate of deposit in order to sell that feature.

In Example 1, the educational objective (9.3) indicates a "concept" cognitive strategy (5.13) is being applied at the "analysis" level (5.12). The primary learning resource type (5.2) is a "practice," which is supported by a "definition," "example," "non example," and an "analogy" (these are children at level 2). Interactivity type (5.1) is set to "active," however the author decided that compared to other types of interaction; its interactivity level (5.3) is "medium." Likewise, the semantic density (5.4) is set to "medium," as the concept is primarily active in nature, but requires expositive material through a narration. Finally, the context (5.6) is set to "training."

In reviewing examples 2 through 4 you should note the learning objectives for each, and the example values given based on those objectives. While the cognitive strategy list is the best option for that objective, the other values are more subjective based on the author's goal in creating this Level 3 object. For example, a "principle" based object could have a different interactivity level, semantic density, or learning resource type than those listed.

Keep in mind that these examples are all set to the CLEO aggregation level 2d as this is the most common level of reuse and exchange between companies in this use scenario.

At aggregation level 2, Cisco Systems calls the object a Lesson, which is a collection of level 2d objects. At level 2 a lesson is built upon a single educational objective (9.1). This objective is used to determine the cognitive strategy of the entire level 2 object. For example, a principle based objective such as "At the end of this Lesson you'll be able successfully explain to a customer the value of a Cisco Router over the competition's based on their need" would be tagged as a "principle." The level 2d objectives that are its children would contain objects with cognitive strategy values of Process, Concept and Fact (see Figure 1).

Figure 1. Cognitive Strategies between Aggregation Levels

Level Five Object (*Cisco's "Lesson" Level*)
Objective: At the end of this Lesson you'll be able successfully explain to a customer the value of a Cisco Router over the competition's based on their need
Cognitive Strategy: Principle

Level 3 Children (*Cisco's "Topic" level*)
Cognitive Strategies:
1. Process
2. Concept
3. Concept
4. Fact
5. Principle

Appendix D: CLEO LOM Profiles for "Publishing"

These profiles define the metadata recommended by CLEO to describe an object for publishing or final use. The profiles are different depending on the aggregation level

Profile "Publishing - Aggregation level 1b"

This profile defines CLEO recommendations for metadata at Aggregation Hierarchy Level 1b. Alternatively, this profile may be used to define metadata describing legacy or other type of binary objects at higher levels of aggregation (i.e. CD-ROM course).

Table 9. CLEO LOM Profile: Publishing – Aggregation Level 1b

Nr	Name	Profile Usage	Notes
1	General		
1.1	Identifier	Required	
1.1.1	Catalog	As needed	highest aggregation used
1.1.2	Entry	As needed	highest aggregation used
1.3	Language	Required	
1.7	Structure	Recommended	
1.8	Aggregation Level	Required	
2	Life Cycle	Recommended	
2.1	Version	Recommended	highest level exposed to learner via LMS
2.2	Status	Recommended	
3	Meta-Metadata		
3.3	Metadata Schema	Required	
3.4	Language	Required	
4	Technical		
4.1	Format	Required	
4.2	Size	Required	
4.3	Location	Required	At all aggregation levels accessible by the LMS In a package, the location is always relative to the metadata file itself; typically the value of location in that case is "."
4.4	Requirement		
4.4.1	OrComposite		
4.4.1.1	Type	As needed	
4.4.1.2	Name	As needed	
4.4.1.3	Minimum Version	As needed	
4.4.1.4	Maximum Version	As needed	
4.5	Installation Remarks	As needed	
4.6	Other Platform Requirements	As needed	
4.7	Duration	As needed	
6	Rights	As required by object owner	All as applicable
6.1	Cost	As required	All as applicable
6.2	Copyright and Other Restrictions	As required	All as applicable
6.3	Description	As required	All as applicable
7	Relation	As needed	Used for persistent relationship independent of

Nr	Name	Profile Usage	Notes
			content packaging or the context of use i.e. electronically delivered learning object based upon legacy instructor-led course
7.1	Kind	As needed	
7.2	Resource	As needed	
7.2.1	Identifier	As needed	
7.2.1.1	Catalog	As needed	
7.2.1.2	Entry	As needed	
7.2.2	Description	As needed	

Profile "Publishing - Aggregation level 1c"

This profile defines CLEO recommendations for metadata at Aggregation Hierarchy Level 1c.

Table 10. CLEO LOM Profile: Publishing – Aggregation Level 1c

Nr	Name	Profile Usage	Notes
1	General		
1.1	Identifier	Required	All
1.1.1	Catalog	As needed	highest aggregation used
1.1.2	Entry	As needed	highest aggregation used
1.2	Title	Required	2-12
1.3	Language	Required	All
1.5	Keyword	Recommended	2-5
1.7	Structure	Recommended	2-5
1.8	Aggregation Level	Required	All
2	Life Cycle	Recommended	All
2.1	Version	Recommended	highest level exposed to learner via LMS
2.2	Status	Recommended	
3	Meta-Metadata		
3.3	Metadata Schema	Required	
3.4	Language	Required	
5	Educational		
5.1	Interactivity Type	Recommended	2, 3
5.2	Learning Resource Type	Recommended	2, 3
5.3	Interactivity Level	Recommended	2, 3
5.4	Semantic Density	Optional	2, 3
5.8	Difficulty	Optional	2, 3
5.9	Typical Learning Time		
5.9.1	Typical Learning Time Range	Optional	2, 3
5.10	Description	Optional	smallest level accessed by LMS
5.11	Language	When needed	
5.12	Cognitive Domain	Required	2, 3
5.13	Cognitive Strategy	Optional	2-12
6	Rights	As required by object owner	
6.1	Cost	As required	All as applicable
6.2	Copyright and Other	As required	All as applicable

Nr	Name	Profile Usage	Notes
	Restrictions		
6.3	Description	As required	All as applicable
9.1	Purpose		At minimum, define "Educational Objective" if there is one associated with this object
9.2	Taxon Path		
9.2.1	Source		
9.2.2	Taxon		
9.2.2.1	Id		
9.2.2.2	Entry		
9.3	Description		
9.4	Keyword		

Profile "Publishing - Aggregation level 2d"

This profile defines CLEO recommendations for metadata at Aggregation Hierarchy Level 2d.

Table 11. CLEO LOM Profile: Publishing – Aggregation Level 2d

Nr	Name	Profile Usage	Notes
1	General		
1.1	Identifier	Required	All
1.1.1	Catalog	As needed	highest aggregation used
1.1.2	Entry	As needed	highest aggregation used
1.2	Title	Required	2-12
1.3	Language	Required	All
1.4	Description	Recommended	3-12
1.5	Keyword	Recommended	2-5
1.6	Coverage	Optional	3-12
1.7	Structure	Recommended	2-5
1.8	Aggregation Level	Required	All
2	Life Cycle	Recommended	All
2.1	Version	Recommended	highest level exposed to learner via LMS
2.2	Status	Recommended	
3	Meta-Metadata		
3.3	Metadata Schema	Required	
3.4	Language	Required	
5	Educational		
5.1	Interactivity Type	Recommended	2, 3
5.2	Learning Resource Type	Recommended	2, 3
5.3	Interactivity Level	Recommended	2, 3
5.4	Semantic Density	Optional	2, 3
5.5	Intended End User Role	Recommended	2, 3
5.7	Typical Age Range	Optional	
5.8	Difficulty	Optional	2, 3
5.9	Typical Learning Time		smallest level accessed by LMS
5.9.1	Typical Learning Time Range	Optional	
5.10	Description	Optional	2, 3
5.11	Language	When needed	2-12
5.12	Cognitive Domain	Required	2, 3

Nr	Name	Profile Usage	Notes
5.13	Cognitive Strategy	Optional	2-12
6	Rights	As required by object owner	
6.1	Cost	As required	All as applicable
6.2	Copyright and Other Restrictions	As required	All as applicable
6.3	Description	As required	All as applicable
9.1	Purpose		At minimum, define “Educational Objective” if there is one associated with this object
9.2	Taxon Path		
9.2.1	Source		
9.2.2	Taxon		
9.2.2.1	Id		
9.2.2.2	Entry		
9.3	Description		
9.4	Keyword		

Appendix E: CLEO Proposal for Future Work: Technical Metadata

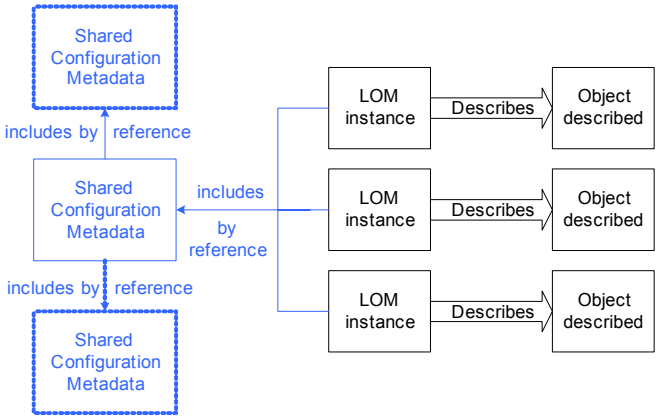
CLEO proposes to extend technical metadata in two ways:

- By defining a reusable configuration data model, based on LOM, that can be used by reference in metadata instances
- By extending specific elements or vocabularies already defined in LOM for technical metadata.

LOM 10.0, Configuration, Producing Configuration instances

The anticipated proliferation and reuse of learning objects suggests a need for a central location to maintain, update, or retrieve a learning object's metadata. Referencing a known location for metadata, rather than including it with each and every instance of a learning object would greatly streamline the size of payload when transferring data and learning object's between systems. This same concept can be extended to the technical requirements which can be cataloged as configuration instances. Many learning objects may share the same configuration instance(s). Hence, it makes good sense to create a cataloged instance of a configuration and refer that instance in metadata, rather than declaring the entire configuration or set of configurations for each metadata instance. This also enables a learning object creator or reuser to more easily manage any adjustments to configurations that may be necessary.

Figure 2. Shared Configurations



A configuration is expected to persist for the life of a version of a learning object. A configuration will encapsulate existing LOM base schema elements from LOM 4.4 Technical.Requirement, and extensions as shown in previous sections. A configuration may refer to the local delivery requirements of a learning object, or to the remote server-based configurations from which it is verified to work. This characteristic of a configuration is declared as part of its own 'metadata'.

Configurations must be written in XML. They may be stored remotely from an XML document instance that references them.

XLink may be used in a configuration reference to indicate to an importing system the nature of the relationship and any rules regarding the resolution and use of a link. However, given that XLink is relatively new to the XML world at this time and is unevenly supported across applications, XLink is not defined as a requirement for configuration references. Nevertheless, the Configuration model is designed to be used in an XLink environment when support for XLink becomes more prevalent.

Information Model for the Proposed "Configuration" Element Family

"Nr" begins at 10. This number is currently outside of the range of those used by the LOM Base Schema. Its use is purely for referential purposes in this document. It does not indicate the location of use of this proposed element family in a metadata record or the LOM information model.

"Size" may show a range (e.g., "0..2") to better guide those who use and bind this information model as to the multiplicity of an element.

The table below defines the information model for "Configuration" and its children.

Information Model for Proposed "Configuration" Element Family							
Nr	**Name**	**Explanation**	**Size**	**Order**	**Value space**	**Data type**	**Example**
10.	Configuration	A sub-category that describes a set of platform and presentation requirements. A Configuration element may contain nested instances of other Configuration elements by reference or by declaration. This sub-category need not be used if there is no meaningful configuration to be declared.	Smallest permitted maximum: 20	No	-		-
10.1	Identifier	A globally unique label that identifies a configuration.	0..1	N/A			
10.1.1	Catalog	The name or designator of the cataloging scheme for this entry. A namespace scheme.	1	N/A	Repertoire of ISO/IEC 10646-1:2000	Characterstring (smallest permitted maximum: 1000 char)	"URN" "URL" "IMS PLRID"
10.1.2	Entry	**The value of the identifier within the identification or cataloging scheme that designates or identifies this**	1	N/A	Repertoire of ISO/IEC 10646-1:2000	Characterstring (smallest permitted maximum: 1000 char)	"urn:x-ims-plrid-v0:DUNS:05-107-9929:cfgid:bpdl-shared"

Information Model for Proposed "Configuration" Element Family							
Nr	**Name**	**Explanation**	**Size**	**Order**	**Value space**	**Data type**	**Example**
		metadata record. A namespace specific string.					
10.2	Version	A value identifying a particular instance of this configuration	0..1	N/A		Characterstring (smallest permitted maximum: 100 char)	
10.3	Descriptor	A human readable name or short description given to a configuration instance.	0..1	N/A		LangString (smallest permitted maximum: 120 char)	
10.4	ScopeOfUse	The intended use of a configuration. 'Presentation needs' is a generic reference to delivering a learning object. Its use includes, but is not limited to, the display window or 'stage' required by a learning object for proper presentation. 'Stand-alone platform' is synonymous with a learning object not requiring a network connection to function properly. It could apply to a learning object that may have a disconnected mode or may require intermittent connection to a network to report learner history, or that is designed to never need a network connection (e.g., CD-ROM delivery). All other terms specify an instance of networking.	0..1	N/A	Presentation needs Client-side platform Peer-to-peer platform Server-side platform Stand-alone platform	Vocabulary	
10.5	Model	A container element to hold the metadata elements defining a configuration.	1				
10.5	Configuration Ref	A globally unique label that references a	Smallest permitted	N/A			

Information Model for Proposed "Configuration" Element Family							
Nr	**Name**	**Explanation**	**Size**	**Order**	**Value space**	**Data type**	**Example**
		configuration defined elsewhere that is to be included as part of this configuration instance. A referenced Configuration instance is always read-only. It cannot be changed by a referencing metadata instance. A referenced Configuration shall add to any other configuration data declared in the referencing Configuration instance.	maximum: 20 items				

Sample Use of Configuration for Proposed Technical.Requirement Extension

The proposed extensions to the base schema LOM Technical elements structure follow. LOM elements are shown in normal face. *Extensions* added to LOM base schema elements are shown in *italics*. Hierarchical relationship is depicted with one or more sets of subordination indicators (|--), where one set of characters is one level removed from the root element of the chain.

Note that the LOM super-category element "Technical" and its "Requirement" chain of elements is encapsulated within a proposed extension super-category "Configuration". This proposed category re-uses the LOM base schema "Identifier" family. However, since these LOM base schema elements are re-used outside of their stipulated contexts in the LOM, they are presented as part of the "Configuration" extension.

Configuration [*a new container element*]
|--*Identifier* [*a container element as specified in LOM*]
|--|--*Catalog* [*an element as specified in LOM*]
|--|--*Entry* [*an element as specified in LOM*]
|--*Version* [*a new element*]
|--*Descriptor* [*a new element*]
|--*ScopeOfUse* [*a new element*]
|--*Model* [*a new element*]
|--|--Technical
|--|--|--Requirement
|--|--|--|--OrComposite
|--|--|--|--|--Type [*extended by additional vocabularies*]
|--|--|--|--|--Name [*extended by additional vocabularies*]

|--|--|--|--|--|--|--*Dimensioned Value* [*a new container element*]
|--|--|--|--|--|--|--|--*Dimension* [*a new element*]
|--|--|--|--|--|--|--|--*Rate* [*a new element*]
|--|--|--|--|--|--|--|--*Multiplier* [*a new element*]
|--|--|--|--|--|--|--|--*Value* [*a new element*]
|--|--|--|--|--Minimum Version
|--|--|--|--|--MAXIMUM VERSION
|--*ConfigurationRef* [*a new container element modeled on LOM's* Identifier]

Note that the structure of the core LOM elements is preserved per the standard, and that extension occurs per the standard.

Extending LOM Elements 4.4.1.1, Type, and 4.4.1.2, Name, with Controlled Vocabularies

LOM's technical requirement element family only describes the browser and operating system requirements of a learning object. This small set of the technical characteristics of learning objects needs to be expanded upon to more fully depict:

- presentation requirements in terms of display window size, video and audio adapter capabilities,
- data communication capabilities,
- software environment for local and remote machines,
- hardware platforms on which delivery is assured,
- deployment capabilities (online only, online & off-line, stand-alone), and
- service requirements.

It is anticipated that this information may likely be invariant or of very low volatility in terms of values for a large number of learning objects. To this end, a mechanism for referencing a configuration instance (i.e., metadata fragment or catalog entry) of one or more requirements is proposed. Referencing a configuration declared in a single location instead of restating configuration requirements in each metadata instance will reduce the size of metadata files and optimize their use.

This data will meet the needs of content integrators, learner management and content repository vendors, and training organizations or their users to inform their selection and use of a given learning object.

The following LOM base schema chain of elements forms the basis for the proposed extension:

LOM Number	Element
4.	Technical
4.4	Requirement
4.4.1	OrComposite
4.4.1.1	Type
4.4.1.2	Name
4.4.1.3	Minimum Version
4.4.1.4	Maximum Version

Extensions to the above will be made by

- adding vocabularies to "Type" and "Name",
- adding a dimensioned value element family as a child of "Name", and
- encapsulating this set of LOM base schema elements and extensions into a new, optional "Configuration" super-category.

Each approach will be detailed in the following sections.

LOM 4.4.1.1, Type, Controlled Vocabulary

A list of technologies limited to browsers and operating systems is inadequate information for learning object integrators and users. An additional vocabulary of technology terms is proposed. Its location is to be determined.

Proposed Element for LOM 4.4.1.1, Type	Proposed Vocabulary
CLEO Technology v1.0	• Audio adapter • Bandwidth • Codec • Communication binding • Communication data model • Display window • Graphic adapter • Input device • Output device • Processor • Proxy server • Removable media • Storage • Streaming media server • Virtual machine • Web server

NOTE: A separate vocabulary for services (e.g., grading, mentoring, chat, etc.) may also need to be constructed and used in the context of Technical.Requirement.OrComposite.Type.

LOM 4.4.1.2, Name, Controlled Vocabulary

Several lists of terms refining those used in "Type" are proposed. Separate vocabularies are proposed to ensure ease of maintenance and expansion. Location of vocabularies is to be determined. Proposed source names contain the extended vocabulary terms specified for "Type". The proposed vocabularies follow.

Proposed Element for LOM 4.4.1.1, Type	Proposed Vocabulary
CLEO Audio Adapter	• Channels • Frequency • Sample Size • Multimedia PC Specification level

Proposed Element for LOM 4.4.1.1, Type	Proposed Vocabulary
CLEO Codec	AVI • Macromedia Flash • MPEG Layer 1 • MPEG Layer 2 • MPEG Layer 3 • MPEG Layer 4 • Quicktime • RealAudio
CLEO Communication Binding	• AGR-006 • AGR-010 • Cookie • Proprietary • SCORM
CLEO Communication Data Model	• CMI • Proprietary • SCORM
CLEO Display Window	• Coordinate, top left • Coordinate, bottom right • Height • Width
CLEO Graphic Adapter	• Color depth • Screen height • Screen width • Refresh rate • Frames • Polygons • Triangles
CLEO Input Device	• Infrared pointer • Keyboard • Mouse • Mouse with scroll wheel • Microphone • Touch screen • Light pen
CLEO Output Device	• Monitor • Speakers • Headphones • Text to speech synthesizer • (Other accessibility devices TBD)
CLEO Processor	• Mips • Pentium • Pentium II • Pentium III • Pentium IV • Power PC • Power PC 604 • Power PC G3 • Power PC G4 • UltraSPARC
CLEO Proxy server	• Microsoft Proxy Server Netscape Proxy Server

Proposed Element for LOM 4.4.1.1, Type	Proposed Vocabulary
	Netscape Iplanet Web Proxy Server • Realsystem Proxy
Microsoft ISA Server	Netscape Proxy Server Netscape Iplanet Web Proxy Server Realsystem Proxy
CLEO Removable media	Floppy disk drive CD-ROM drive • DVD-ROM drive
CLEO Storage	• Disk space • Random access memory
CLEO Streaming media service	• Java Media Framework • Microsoft Windows Media Services • QuickTime Streaming Server • RealSystem Server Plus Any streaming media service
CLEO Virtual Machine	• Macintosh Runtime for Java • Microsoft Java Virtual Machine • Sun Java Runtime Environment
CLEO Web server	• Apache • Microsoft IIS • Netscape Enterprise • Netscape Fast Track

LOM 4.4.1.2, Name, Extending LOM "Operating System" Vocabulary

The LOM Base Schema vocabulary for operating system does not completely capture or lacks specificity for describing the operating systems in which learning objects may be required to run, or have been certified/verified to run.

CLEO is examining the following extensions to the LOM Base Schema vocabulary:

4.4.1.2 Operating System Vocabulary	Current Vocabulary	CLEO Additional Proposed Vocabulary Elements
	• pc-dos • ms-windows • macos • unix • multi-os • none	BEOS HP-UX IBM AIX LINUX MAC OS X SERVER MS-WINDOWS NT SERVER MS-WINDOWS NT WORKSTATION SUN SOLARIS OTHER

LOM 4.4.1.2, Name, Adding Dimensioned Values to "Name"

The vocabulary terms extending "Name" (and, by relationship, its parent "Type") are often incomplete without an associated value. A new element family is proposed to describe such values rather than overload the use of "MaximumVersion" and "MinimumVersion" in the base LOM schema. The new element family describes a value dimensioned along lines appropriate to a given vocabulary term.

The information model for the dimensioned value extensions follows. "Nr" value is purely for convenience of reference in this proposal. Actual value would be determined by IEEE if this proposal becomes part of a revision to LOM. "Size" may show a range (e.g., "0..2") to better guide those who use and bind this information model as to the multiplicity of an element.

Nr	Name	Explanation	Size	Order	Value space	Data type
4.4.1.2.1	Dimensioned Value	A container element for attributes of a dimensioned value pertaining to a Named technology	Smallest permitted maximum: 10 items	N/A		
4.4.1.2.1.1	Dimension	A means to interpret the proper interpretation of a value	0..1	N/A	If 'Type' = 'Audio adapter', 'Bandwidth', 'Graphic adapter', 'Processor', or 'Storage': Bits Bytes Hertz Pixels Triangles Polygons Frames If 'Name' = 'Keyboard', 'Mouse', or 'Mouse with scroll wheel': Buttons Keys If 'Name' = 'Display Window': X-ordinate Y-ordinate Generic terms for any Technology instance: Make Model Version Service pack Optional Recommended	Vocabulary
4.4.1.2.1.2	Rate	A measure modifying a particular value	0..1	N/A	Per second Per minute Per hour	Vocabulary

Nr	Name	Explanation	Size	Order	Value space	Data type
					Per course Per learning object Per pixel	
4.4.1.2.1.3	Measure multiplier	Standard computing multipliers	0..1	N/A	If 'Unit of measure' = 'Bits', 'Bytes', 'Hertz' or 'Pixels': Giga Kilo Mega Tera If 'Rate' = 'Per second': Micro Milli Nano Pico	Vocabulary
4.4.1.2.1.4	Boundary type	A way to interpret the application of a dimensioned value	0..1	N/A	Maximum Minimum Optional Recommended X-ordinate Y-ordinate	Vocabulary
4.4.1.2.1.5	Value	A vocabulary token or value appropriate for the named technology	0..1	N/A	Any value following repertoire of ISO/IEC 10646-1, except for specific Characteristics as specified – If 'Name' = 'Channels', then: Mono Stereo	Characterstring (smallest permitted maximum: 100) or, Vocabulary as specified

Future Extensions General Guidelines for Extending the LOM XMLSchema

Everything in this section is speculative. It is only included within this document for discussion purposes and to clarify next stage of the specification project.

XML Example: Technical Element - Declaring Presentation Window Requirements (Tentative)

This example illustrates how a display window size and minimum graphic adapter requirements that give context to a display window's dimensions could be declared. The display window's fixed size requirements are 640x480. This is expressed as minimum size.

```
<lom:technical>
      <lom:requirement>
            <lom:orComposite>
                  <lom:type source="CLEO Technology v1.0">displayWindow</lom:type>
                  <lom:name source="CLEO Display Window">width</lom:name>
                        <cleomd:dimensionedValue>
```

```
                              <cleomd:value dimension="pixels"
boundaryType="minimum">640</cleomd:value>
                        </cleomd:dimensionedValue>
            </lom:orComposite>
            <lom:orComposite>
                  <lom:type source="CLEO Technology v1.0">displayWindow</lom:type>
                  <lom:name source="CLEO Display Window">height</lom:name>
                        <cleomd:dimensionedValue>
                              <cleomd:value dimension="pixels"
boundaryType="minimum">480</cleomd:value>
                        </cleomd:dimensionedValue>
            </lom:orComposite>
      </lom:requirement>
</lom:technical>
```

XML Example: Technical Element - Giving Screen Context to an Instructional Presentation (Tentative)

Specifying the size of the presentation window is only part of describing a desired instructional environment. An additional part that gives context for a presentation window is to describe the screen resolution in which a presentation window is properly displayed. Screen resolution typically consists of a three attributes: screen width, screen height, and the number of colors required by content. A minimum screen resolution of 800 X 600 pixels (picture elements) with 256 colors (expressed as color depth in bits per pixel) is specified in this example to ensure that a baseline presentation environment is available at launch.

```
<lom:technical>
      <lom:requirement>
            <lom:orComposite>
                  <lom:type source="CLEO Technology
v1.0">graphicAdapter</lom:type>
                  <lom:name source="CLEO Graphic Adapter">screen width</lom:name>
                        <cleomd:dimensionedValue>
                              <cleomd:value dimension="pixels"
boundaryType="minimum">800</cleomd:value>
                        </cleomd:dimensionedValue>
            </lom:orComposite>
            <lom:orComposite>
                  <lom:type source="CLEO Technology
v1.0">graphicAdapter</lom:type>
                  <lom:name source="CLEO Graphic Adapter">screen height</lom:name>
                        <cleomd:dimensionedValue>
                              <cleomd:value dimension="pixels"
boundaryType="minimum">600</cleomd:value>
                        </cleomd:dimensionedValue>
            </lom:orComposite>
            <lom:orComposite>
                  <lom:type source="CLEO Technology
v1.0">graphicAdapter</lom:type>
                  <lom:name source="CLEO Graphic Adapter">color depth</lom:name>
                        <cleomd:dimensionedValue>
                              <cleomd:value dimension="bits" rate="per pixel"
boundaryType="minimum">8</cleomd:value>
                        </cleomd:dimensionedValue>
```

```
            </lom:orComposite>
      </lom:requirement>
</lom:technical>
```

XML Example: Technical Element - Creating Configurations for Presentation Window and Screen Display Requirements (Tentative)

It is highly likely that the presentation window and screen display requirements will be specified by thousands of learning objects. We can define two configurations to eliminate the redundant replication of this information for the thousands of metadata records that will be generated to describe their respective learning object. In this example, we use a uniform resource locator (URL) to uniquely identify each configuration. The actual URL is fictitious and is used only to demonstrate the proposed approach.

```
<cleomd:configuration>
      <lom:identifier>
            <lom:catalog>URI</lom:catalog>

      <lom:entry>http://www.cleolab.org/catalog/configuration/present640x480.xml</
lom:entry>
      </lom:identifier>
      <cleomd:version>1.0</cleomd:version>
      <cleomd:descriptor>
            <lom:langstring xml:lang="en-US">640 pixel by 480 pixel presentation
window<lom:langstring>
      </cleomd:descriptor>
      <cleomd:scopeOfUse>presentation needs</cleomd:scopeOfUse>
      <cleomd:model>
<lom:technical>
      <lom:requirement>
            <lom:orComposite>
                  <lom:type source="CLEO Technology v1.0">displayWindow</lom:type>
                  <lom:name source="CLEO Display Window">width</lom:name>
                        <cleomd:dimensionedValue>
                              <cleomd:value dimension="pixels"
boundaryType="minimum">640</cleomd:value>
                        </cleomd:dimensionedValue>
            </lom:orComposite>
            <lom:orComposite>
                  <lom:type source="CLEO Technology v1.0">displayWindow</lom:type>
                  <lom:name source="CLEO Display Window">height</lom:name>
                        <cleomd:dimensionedValue>
                              <cleomd:value dimension="pixels"
boundaryType="minimum">480</cleomd:value>
                        </cleomd:dimensionedValue>
            </lom:orComposite>
      </lom:requirement>
</lom:technical>
      </cleomd:model>
</cleomd:configuration>

<cleomd:configuration>
      <lom:identifier>
            <lom:catalog>URI</lom:catalog>
```

```
      <lom:entry>http://www.cleolab.org/catalog/configuration/screen800x600.xml</l
om:entry>
      </lom:identifier>
      <cleomd:version>1.0</cleomd:version>
      <cleomd:descriptor>
            <lom:langstring xml:lang="en-US">800 pixel by 600 pixel screen with
256 colors minimum<lom:langstring>
      </cleomd:descriptor>
      <cleomd:scopeOfUse>presentation needs</cleomd:scopeOfUse>
      <cleomd:model>
</lom:technical>
      <lom:requirement>
            <lom:orComposite>
                  <lom:type source="CLEO Technology
v1.0">graphicAdapter</lom:type>
                  <lom:name source="CLEO Graphic Adapter">screen width</lom:name>
                        <cleomd:dimensionedValue>
                              <cleomd:value dimension="pixels"
boundaryType="minimum">800</cleomd:value>
                        </cleomd:dimensionedValue>
            </lom:orComposite>
            <lom:orComposite>
                  <lom:type source="CLEO Technology
v1.0">graphicAdapter</lom:type>
                  <lom:name source="CLEO Graphic Adapter">screen height</lom:name>
                        <cleomd:dimensionedValue>
                              <cleomd:value dimension="pixels"
boundaryType="minimum">600</cleomd:value>
                        </cleomd:dimensionedValue>
            </lom:orComposite>
            <lom:orComposite>
                  <lom:type source="CLEO Technology
v1.0">graphicAdapter</lom:type>
                  <lom:name source="CLEO Graphic Adapter">color depth</lom:name>
                        <cleomd:dimensionedValue>
                              <cleomd:value dimension="bits" rate="per pixel"
boundaryType="minimum">8</cleomd:value>
                        </cleomd:dimensionedValue>
            </lom:orComposite>
      </lom:requirement>
</lom:technical>
      </cleomd:model>
</cleomd:configuration>
```

XML Example: Technical Element - Referencing Configuration Instances (Tentative)

A casual inspection of the previous examples shows a fair amount of XML to declare something as simple as a presentation window size and minimum screen resolution for appropriate display of content. Imagine the retarding effect on workflow of having to declare this same code over and over for hundreds or thousands of instances of learning objects that share the same requirements. Imagine the scale of the negative impact on an importing system that reads the metadata for hundreds or thousands of learning objects that shares the same characteristics. Now, imagine the positive impact on workflow for creating and parsing metadata if a known configuration is identified and then reused by all learning objects!

The following example references the configurations for presentation window and screen resolution. The references substitute for the full metadata declarations in their corresponding configuration declarations. An importing system could look up the catalog entry and import the referenced metadata records, logging the unique identifier when it does so. Any subsequent metadata records containing an identical configuration reference need not be downloaded, as the importing system would already have the catalog entries in its database. It need only store an internal pointer (key) to the stored configuration information.

```
<cleomd:configuration>
      <cleomd:configurationRef>http://www.cleolab.org/catalog/configuration/presen
t640x480.xml</cleomd:configurationRef>
      <cleomd:configurationRef>http://www.cleolab.org/catalog/configuration/screen
800x600.xml</cleomd:configurationRef>
</cleomd:configuration>
```