



# IEEE Standard for Learning Technology—Extensible Markup Language (XML) Schema Definition Language Binding for Learning Object Metadata

IEEE Computer Society

Developed by the  
Learning Technology Standards Committee

**IEEE Std 1484.12.3™-2020**  
(Revision of IEEE Std 1484.12.3-2005)



# **IEEE Standard for Learning Technology—Extensible Markup Language (XML) Schema Definition Language Binding for Learning Object Metadata**

Developed by the

**Learning Technology Standards Committee**  
of the  
**IEEE Computer Society**

Approved 5 March 2020

**IEEE SA Standards Board**

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**Abstract:** This standard defines a World Wide Web Consortium (W3C) Extensible Markup Language (XML) Schema definition language binding of the learning object metadata (LOM) data model defined in IEEE Std 1484.12.1™-2002. The purpose of this standard is to allow the creation of LOM instances in XML, which allows for interoperability and the exchange of LOM XML instances between various systems. This standard uses the W3C XML Schema definition language to de-fine the syntax and semantics of the XML encodings.

**Keywords:** Extensible Markup Language (XML), IEEE 1484.12.1, IEEE 1483.12.3, learning object metadata (LOM), LOM XML instance, LOM XML Schema binding, metadata, W3C XML Schema definition language, XML Schema definition (XSD)

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## Introduction

This introduction is not part of IEEE Std 1484.12.3-2020, IEEE Standard for Learning Technology—Extensible Markup Language (XML) Schema Definition Language Binding for Learning Object Metadata.

This standard defines World Wide Web Consortium (W3C) Extensible Markup Language (XML) structure and constraints on the contents of XML 1.1 documents that can be used to represent learning object metadata (LOM) instances as defined in IEEE Std 1484.12.1-2002. This standard defines the structure and constraints of the XML 1.1 documents in W3C XML Schema definition language.

The purpose of this standard is to allow the creation of interoperable LOM instances in XML. This standard uses the W3C XML Schema definition language as the encoding, which allows for interoperability and the exchange of LOM XML instances between various systems.

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# IEEE Standard for Learning Technology—Extensible Markup Language (XML) Schema Definition Language Binding for Learning Object Metadata

## 1. Overview

The scope and purpose of this standard are discussed in 1.1 and 1.2.

### 1.1 Scope

This standard defines World Wide Web Consortium (W3C) Extensible Markup Language (XML) structure and constraints on the contents of XML 1.1 documents that can be used to represent learning object metadata (LOM) instances as defined in IEEE Std 1484.12.1™-2002.<sup>1</sup> This standard defines the structure and constraints of the XML 1.1 documents in W3C XML Schema definition language. An implementation that conforms to this standard shall conform to IEEE Std 1484.12.1-2002.

### 1.2 Purpose

The purpose of this standard is to allow the creation of interoperable LOM instances in XML. This standard uses the W3C XML Schema definition language as the encoding, which allows for interoperability and the exchange of LOM XML instances between various systems.

### 1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (shall equals is required to).<sup>2, 3</sup>

<sup>1</sup> ~~For~~ Information on references can be found in ~~see~~ Clause 2.

<sup>2</sup> The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.

<sup>3</sup> The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (should equals is recommended that).

The word *may* is used to indicate a course of action permissible within the limits of the standard (may equals is permitted to).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (can equals is able to).

## 2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained) **Standard**. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std 1484.12.1™-2002 (Reaff 2009), IEEE Standard for Learning Object Metadata.<sup>4,5 2</sup>

IETF RFC 2048:1996, Multipurpose Internet Mail Extensions (MIME) Part Four: Registration Procedures.<sup>6 3</sup>

IETF RFC 2426:1998, vCard MIME Directory Profile.

ISO 639-1, Code for the Representation of Names of Languages—Part 1: Alpha-2 code.<sup>7 4</sup>

<sup>4 2</sup>IEEE publications are available from the Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, Piscataway, NJ 08854, USA (<http://standards.ieee.org/>).

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ISO 639-2, Codes for the Representation of Names of Languages—Part 2: Alpha-3 code.

ISO 3166-1, Codes for the Representation of Names of Countries and Their Subdivisions—Part 1: Country Codes.

ISO/IEC 10646-1, Information Technology—Universal Multiple-Octet Coded Character Set—Part 1: Architecture and Basic Multilingual Plane.<sup>5</sup>

W3C Recommendation (28 October 2004), XML Schema Part 1: Structures, Second Edition.<sup>8 6</sup>

W3C Recommendation (28 October 2004), XML Schema Part 2: Datatypes, Second Edition. W3C Recommendation (4 February 2004), Namespaces in XML 1.1.

### 3. Definitions, acronyms, and abbreviations

~~Definitions and acronyms are defined in 3.1 and 3.2, respectively.~~

#### 3.1 Definitions

For the purposes of this [document](#) ~~Standard~~, the following terms and definitions apply. The ~~Authoritative Dictionary of IEEE Standards~~ [Dictionary Online Terms \[B1\]](#)<sup>7</sup> should be [consulted](#) ~~referenced~~ for terms not defined in this clause.<sup>9</sup>

<sup>5</sup>~~ISO/IEC publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO/IEC publications are also available in the United States from Global Engineering Documents, 15 Inverness Way East, Englewood, CO 80112, USA (<http://global.ihs.com/>). Electronic copies are available in the United States from the American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).~~

<sup>8 6</sup>W3C publications are available from the World Wide Web Consortium, 32 Vassar Street, Room 32-G515, Cambridge, MA 02139, USA (<http://www.w3.org/>).

<sup>7</sup>~~The numbers in brackets correspond to those of the bibliography in Annex A.~~

<sup>9</sup>[IEEE Standards Dictionary Online](http://dictionary.ieee.org) is available at: <http://dictionary.ieee.org>. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.

**aggregate element:** A LOM data element that contains other LOM data elements called subelements.  
*See also:* **subelement**.

**component Extensible Markup Language Schema definition (component XSD):** An Extensible Markup Language Schema definition that defines a constituent of a composite schema. *See also:* **composite Extensible Markup Language Schema definition**.

**composite Extensible Markup Language Schema definition (composite XSD):** An Extensible Markup Language Schema definition that is a structure made up of distinct component XML Schema definitions. *See also:* **component Extensible Markup Language Schema definition**.

**content model:** A framework that identifies the makeup (i.e., data types, multiplicity constraints, ordering) of a specific model.

**data type:** A property of distinct values that indicates the common features of those values and operations on those values.

**extended data element:** A data element that is not defined in the LOMv1.0 base schema. *See also:* **LOMv1.0 base schema**.

**extended vocabulary:** A value space that is not defined in the LOMv1.0 base schema for a LOM data element of type Vocabulary. *See also:* **LOMv1.0 base schema**.

**Extensible Markup Language Information Set (XML Infoset):** An abstract data set that provides a consistent set of definitions for use in other specifications that need to refer to the information in a well-formed XML document (W3C, XML Information Set). *See also:* **post-schema-validation infoset**.

**Extensible Markup Language Schema binding (XML Schema binding):** A textual representation of the behaviors, attributes, and value space of a data model element in W3C XML Schema definition language.

**learning object:** Any entity, digital or nondigital, that may be used for learning, education, or training. (IEEE [Std](#) 1484.12.1-2002)

**learning object metadata data element (LOM data element):** A data element for which the name, explanation, size, ordering, value space, and data type are defined in IEEE Std 1484.12.1-2002. *See also: LOMv1.0 base schema.*

**learning object metadata Extensible Markup Language instance (LOM XML instance):** A collection of metadata for a learning object that conforms to IEEE Std 1484.12.1-2002, that is represented in XML, and that adheres to the requirements and constraints of the XML Schema binding.

**LOMv1.0 base schema:** A structured collection of standard data items, including their data types, multiplicities, and container/component relationships, as defined in IEEE Std 1484.12.1-2002, Clause 6.

**mixed content:** An element type has mixed content when elements of that type may contain character data, optionally interspersed with child elements. (W3C, Extensible Markup Language [XML] 1.1)

**Multipurpose Internet Mail Extensions type (MIME type):** A standard way of classifying content types on the Internet.

**post-schema-validation infoset:** A transformed version of the XML infoset of a document produced by a conforming W3C XML Schema processor. W3C XML Schema defines the data elements added to the XML infoset of the original document during validation to produce the post-schema-validation infoset. *See also: Extensible Markup Language information set.*

**subelement:** A LOM data element that is contained within another LOM data element called an aggregate element. A subelement may contain other subelements; in which case, it is also an aggregate element. *See also: aggregate element.*

**token:** A character string. The value space of a token is the set of strings that do not contain the line feed (#xA) or tab (#x9) characters, that have no leading or trailing spaces (#x20), and that have no internal sequences of two or more spaces. The lexical space is the set of strings that does not contain the line feed (#xA) nor tab (#x9) characters, that have no leading or trailing spaces (#x20), and that have no internal sequences of two or more spaces. The base type is `normalizedString`. Tokens are case sensitive. (Adapted from W3C, XML Schema Part 2). *See also:* **token set**.

**token set:** A set of tokens in which each token is unique. *See also:* **token**.

**uniqueness constraint:** A restriction placed on a LOM data element that enforces that the LOM data element is unique within a LOM XML instance. If a LOM data element has a uniqueness constraint, it appears in a LOM XML instance zero or one time. *See also:* **learning object metadata data element**.

**value space:** The set of values for a given data type. (ISO/IEC 11404:1996)

NOTE—In IEEE Std 1484.12.1-2002, a value space is typically enumerated outright or defined by reference to another standard or specification.<sup>10 8</sup>

## 3.2 Acronyms and abbreviations

IANA Internet Assigned Numbers Authority

LOM Learning Object Metadata

MIME Multipurpose Internet Mail Extensions

PSVI post-schema-validation info set

SPM smallest permitted maximum

UTC coordinated universal time

W3C World Wide Web Consortium

<sup>10 8</sup> Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the [standard guide](#).

XML Extensible Markup Language

XSD XML Schema definition

## 4. Conformance

Conformance to this standard is discussed in 4.1 and 4.2. In 4.1 and 4.2, *strictly conforming LOM XML instance* and *conforming LOM XML instance* refer to the metadata represented in the LOM XML instance before any processing of the LOM XML instance.

In this standard, “shall” is to be interpreted as a requirement on an implementation; “shall not” is to be interpreted as a prohibition.

### 4.1 Strictly conforming LOM XML instances

A *strictly conforming* LOM XML instance

- Shall be a strictly conforming LOM instance as defined in IEEE Std 1484.12.1-2002
- Shall conform to the requirements of Clause 5
- Shall not include vocabulary values that are not defined in Clause 5
- Shall not include XML elements or attributes that are not defined in Clause 5
- Shall not include mixed content

### 4.2 Conforming LOM XML instances

A *conforming* LOM XML instance

- Shall be a conforming LOM instance as defined in IEEE Std 1484.12.1-2002
- Shall conform to the requirements of Clause 5
- May include vocabulary values that are not defined in Clause 5

- May include XML elements and attributes that are not defined in Clause 5 by using the extension mechanism described in 5.1.3
- May include mixed content

## 5. LOM XML Schema binding definition

The LOM XML Schema binding is defined in 5.1—5.5. The LOM data elements defined in the LOMv1.0 base schema are listed in 5.4. For each LOM data element, the corresponding XML element for the XML Schema binding is described.

### 5.1 General information

As defined in IEEE Std 1484.12.1-2002, all LOM data elements are optional. An XSD for the LOMv1.0 base schema shall not require any LOM data to be present in a LOM XML instance.

The LOMv1.0 base schema defines an aggregation relationship between data items. An XSD for LOM defines an aggregation relationship between subelements that maintains the relationship defined in the LOMv1.0 base schema. In a LOM XML instance, a subelement shall appear only within the aggregate element of the aggregation relationship. For example, in 5.4.3.1, the Identifier subelement appears by definition as a component of the Meta-Metadata element described in 5.4.3. The presence of the subelement automatically implies the presence of the aggregate element to which the subelement belongs.

The LOMv1.0 base schema does not define any sequencing of LOM data elements, except for their aggregation relationships. Therefore, an XML Schema binding of the LOMv1.0 base schema shall not define any sequence of the elements in a LOM XML instance, except for their aggregation relationships.

NOTE—XML names used in this standard are derived from LOM data element names by concatenating the LOM data element names and using *lowerCamelCase* capitalization.

### 5.1.1 Smallest permitted maximums

The W3C XML Schema definition language does not support the concept of SPMs as defined in IEEE Std 1484.12.1-2002. The W3C XML Schema definition language does provide a means for restricting maximum lengths (i.e., `maxLength` for character strings) and maximum numbers of occurrences (i.e., `maxOccurs` for aggregate elements); however, these restrictions are not compatible with the definition of SPM.

If a LOM XML instance contains more than the SPM number of occurrences of a LOM data element, then an application shall process at least the SPM number of occurrences of the LOM data element. If a LOM XML instance contains more than the SPM number of characters in a character string, then an application shall process at least the SPM number of characters in the character string. (SPMs for LOM data elements and character strings are defined in IEEE Std 1484.12.1-2002.)

NOTE—To encourage interoperability, creators of XSDs that intend to validate LOM XML instances against IEEE Std 1484.12.1-2002 should not use `maxOccurs` or `maxLength` restrictions or should set the restricted limits to unbounded.

### 5.1.2 LOM XML instance conformance constraints

Constraints on the validity of a *conforming* or *strictly conforming* LOM XML instance with respect to IEEE Std 1484.12.1-2002 are defined throughout 5.4 and 5.5. All *conforming* and *strictly conforming* LOM XML instances shall satisfy these constraints.

NOTE—Some applications may use an XSD to validate a LOM XML instance. If an application uses an XSD to validate a LOM XML instance, the PSVI of a LOM XML instance is insufficient to determine the validity of the LOM XML instance with respect to IEEE Std 1484.12.1-2002. Use of an XSD to validate a LOM XML instance does not relieve an application from any requirements on enforcing the constraints that appear throughout 5.4 and 5.5.

### 5.1.3 Extension support

Extensions to the LOMv1.0 base schema are permitted by this standard. As defined in IEEE Std 1484.12.1-2002, extensions to the LOMv1.0 base schema shall retain the data types and value spaces of LOM data elements from the LOMv1.0 base schema and shall not define data types or value spaces for aggregate elements in the LOMv1.0 base schema.

This standard permits the following types of extensions for *conforming* but not for *strictly conforming* LOM XML instances:

- *LOMv1.0 base schema XML element extension*: LOMv1.0 base schema data elements may be extended. These extensions are new XML elements defined in a namespace other than the namespaces defined in 5.2. Extended data elements may be added to any LOM data element that is defined as an aggregate element. Extended data elements shall not be added to LOM data elements that are not aggregate elements (see 5.4 and 5.5).
- *LOMv1.0 base schema XML attribute extension*: LOM data elements may be extended by defining attributes for the LOM data elements. These extensions are XML attributes defined in a namespace other than the namespaces defined in 5.2. These attributes may be added to any LOM data element (see 5.4 and 5.5).
- *LOMv1.0 base schema vocabulary data type extension*: LOMv1.0 base schema vocabularies may be extended. These extensions are additional tokens for LOM data elements of type Vocabulary (see 5.4). If vocabularies are extended, the source of the additional vocabulary tokens should be identified and shall not be LOMv1.0.

## 5.2 LOM namespaces

All LOM data elements defined in 5.4 and 5.5 shall be defined in the namespace <http://ltsc.ieee.org/xsd/LOM>. This namespace is reserved by this standard and shall not be used to represent any other data element (see W3C Recommendation, Namespaces in XML 1.1.). This namespace shall not be used to define extensions to a LOM XML instance.

The following namespaces are reserved by this standard and shall not be used to represent any other data element. The namespaces are used in the XSDs provided with this standard (see Annex B).

- <http://ltsc.ieee.org/xsd/LOM/custom>
- <http://ltsc.ieee.org/xsd/LOM/unique>
- <http://ltsc.ieee.org/xsd/LOM/vocab>
- <http://ltsc.ieee.org/xsd/LOM/extend>

If an organization provides extensions to a LOM XML instance, the organization should define the namespace for these extensions.

### 5.3 Table format and organization

This standard uses tables to describe the requirements for a LOM XML instance. The tables express requirements for each LOM data element in the LOMv1.0 base schema. These requirements are as follows:

- *LOM data element*: The name of the LOM data element in the LOMv1.0 base schema.
- *XML name*: The name used in a LOM XML instance that conforms to this standard for the corresponding LOM data element. A dash ("-") in the tables in 5.5, which describe common LOM data types and LOM data elements, indicates that no XML name exists because the LOM name refers to a data type instead of a LOM data element.
- *Subelements*: A listing of subelements of the LOM data element. An entry of "None" indicates that the LOM data element does not have subelements. If present, the subelements listed shall be contained by their associated aggregate element, which [helps ensure](#) ~~ensures~~ that the aggregation relationships of the LOMv1.0 base schema components are enforced. The order of appearance of subelements shall not be significant.

- *Min*: If a LOM data element is not the top-level LOM element, the requirement on the minimum number of times the LOM data element may appear in a LOM XML instance in the context of the LOM data element's aggregate element. For the LOM element, the requirement on the minimum number of times the LOM data element may appear in a LOM XML instance.
- *Max*: If a LOM data element is not the top-level LOM element, the requirement on the maximum number of times the LOM data element may appear in a LOM XML instance in the context of the LOM data element's aggregate element. For the LOM element, the requirement on the maximum number of times the LOM element may appear in a LOM XML instance. An infinity symbol ("∞") indicates that the maximum number of times is unbounded. Values in parenthesis are SPMs.
- *Order*: Indicates whether the order of the values is significant. This standard uses three designators for the order: "Ordered," "Unordered," and "Unspecified." "Ordered" indicates that the ordering of the values is significant. "Unordered" indicates that the ordering of the values is not significant. For a LOM data element that has a multiplicity of zero or one, the concept of order has no meaning, which is indicated by "Unspecified."

NOTE : The significance of the order of a list of ordered values is determined by the implementation.

- *LOM data type*: Indicates whether the LOM data type is defined as LangString, DateTime, Duration, Vocabulary, or CharacterString, or is unspecified. If the LOM data element is an aggregate element, it has no data type and, therefore, is described as "Unspecified." If the data type is Vocabulary, the permissible values from the LOMv1.0 base schema are listed.

Each table that describes an aggregate element includes the direct-descendant subelements of that aggregate element. For example, Table 1 in 5.4 describes the LOM data element and includes the LOM data element's direct-descendant subelements, such as General and Life Cycle. However, the table does not include the subelements of the General element, such as Identifier and Title. If a subelement is also an aggregate element, a separate table describes the subelement with its direct-descendant subelements. If information beyond that provided by IEEE Std 1484.12.1-2002 is needed to define subelements in a LOM XML instance, that information is provided in subclauses of the aggregate element description.

With the exception of the order for Description, Educational, Identifier, and Intended End User Role<sup>7</sup> (in the case of any discrepancy in the tables in 5.4 and 5.5 and IEEE Std 1484.12.1-2002)<sup>7</sup>, the values from IEEE Std 1484.12.1-2002 shall be used.

Although the Max column may indicate that a subelement may appear in an aggregate element an unbounded maximum number of times, an application that processes a LOM XML instance shall process at least the SPM number of subelements (see 5.1.1).

## 5.4 LOM

Table 1 describes the LOM element and its direct-descendant subelements.

**Table 1—The LOM element**

| LOM data element | XML name       | Subelements                                                                                                              | Min | Max        | Order       | LOM data type |
|------------------|----------------|--------------------------------------------------------------------------------------------------------------------------|-----|------------|-------------|---------------|
| LOM              | lom            | General<br>Life Cycle<br>Meta-Metadata<br>Technical<br>Educational<br>Rights<br>Relation<br>Annotation<br>Classification | 1   | 1          | Unspecified | Unspecified   |
| General          | general        | See 5.4.1                                                                                                                | 0   | 1          | Unspecified | Unspecified   |
| Life Cycle       | lifeCycle      | See 5.4.2                                                                                                                | 0   | 1          | Unspecified | Unspecified   |
| Meta-Metadata    | metaMetadata   | See 5.4.3                                                                                                                | 0   | 1          | Unspecified | Unspecified   |
| Technical        | technical      | See 5.4.4                                                                                                                | 0   | 1          | Unspecified | Unspecified   |
| Educational      | educational    | See 5.4.5                                                                                                                | 0   | ∞<br>(100) | Unordered   | Unspecified   |
| Rights           | rights         | See 5.4.6                                                                                                                | 0   | 1          | Unspecified | Unspecified   |
| Relation         | relation       | See 5.4.7                                                                                                                | 0   | ∞<br>(100) | Unordered   | Unspecified   |
| Annotation       | annotation     | See 5.4.8                                                                                                                | 0   | ∞<br>(30)  | Unordered   | Unspecified   |
| Classification   | classification | See 5.4.9                                                                                                                | 0   | ∞<br>(40)  | Unordered   | Unspecified   |

The LOM XML instance shall include a namespace declaration that declares the LOM namespace for the LOM element and its components. The LOM namespace shall be "http://ltsc.ieee.org/xsd/LOM" as defined in 5.2.

The namespace declaration used is in conformance with "W3C Recommendation, Namespaces in XML 1.1." Examples are shown in Figure 1 and Figure 2, respectively.

```
<lom xmlns="http://ltsc.ieee.org/xsd/LOM">
  . . .
</lom>
```

**Figure 1—An example default namespace declaration**