

# IEEE Standard for Learning Technology—Data Model for Shareable Competency Definitions

IEEE Computer Society

Developed by the  
Learning Technology Standards Committee

IEEE Std 1484.20.3™-2022

# IEEE Standard for Learning Technology—Data Model for Shareable Competency Definitions

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

Approved 3 December 2022

**IEEE SA Standards Board**

**Abstract:** Defined in this standard are a data model for describing, referencing, and sharing competency definitions, and frameworks of competency definitions and rubrics in the context of online and distributed learning and in employment and work. This standard provides a way to formally represent the key characteristics of a competency definition, independently of its use in any particular context. It enables interoperability among learning systems that deal with competency information by providing a means for them to refer to common definitions with common meanings.

**Keywords:** competency, competency definition, competency framework, IEEE 1484.20.3, shareable competency definition

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## Introduction

This introduction is not part of IEEE Std 1484.20.3-2022, IEEE Standard for Learning Technology—Data Model for Shareable Competency Definitions.

This standard defines conceptual and logical data models for describing, referencing, and sharing competency definitions and frameworks of competency definitions regardless of the domain of use. It is intended to complement other standards that support interoperability of such data. This standard provides a way to formally represent the key characteristics of a competency definition, independently of its use in any particular context. To describe characteristics beyond the defined key characteristics, the standard provides a formal means for extension through use of shareable competency definition (SCD) application profile schemas. It supports interoperability among learning and human resource management systems that deal with competency information and coordination among technical standards by providing a means for them to refer to common definitions with common meanings.

Competency definitions supported by this standard include any assertion of what a person should know or be able to do regardless of how characterized or labeled including tasks, knowledge, skills, and abilities.

## Simplicity and extensibility

The standard is lightweight by design. It specifies a minimum set of core properties needed across SCD use cases. However, it is not limited by this simplicity as it also formally allows for the addition of properties from identified namespace schemas that have been identified in SCD application profiles that enrich resource description.

## Informed by the Credentialing Ecosystem Mapping Project

This standard was informed by an ad-hoc collaborative effort, the Credentialing Ecosystem Mapping Project, that developed and implemented a process to map the leading U.S.-based technical standards and de facto standards for competency definitions and frameworks data. The mapping included de jure and de facto standards that spanned education, training, workforce, and military domains. This process included mapping across entity and element types and definitions and developing conceptual models. For this exercise the group chose the Common Education Data Standards (CEDS.ed.gov) as the “spine” due to its breadth of data vocabulary. This process of pair-wise semantic mapping of properties across disparate schemas identified a range of mappings from exact matches to no matches and provided a clearer picture of commonly occurring properties and classes. Findings from this process were published in 2017 and updated in September 2018 (Goodell and Robson. “Analysis of Ecosystems Mapping for Competency Frameworks,” [https://docs.google.com/document/d/1U\\_mxdiuF0P5pOatVnPNQ\\_2LotvR9A9OPxXQRRTxm1IU](https://docs.google.com/document/d/1U_mxdiuF0P5pOatVnPNQ_2LotvR9A9OPxXQRRTxm1IU)). The findings identified the common classes and properties in describing competency definitions and competency frameworks across the standards domains mapped.

## Informed by and informing other standards

The following referenced documents informed the creation of this document:

- ASN Rubric Model, <http://standards.asn.desire2learn.com/rubric.html>.
- Element definitions from the Common Education Data Standards (CEDS).
- IEEE Std 1484.12.1™-2002, IEEE Standard for Learning Object Metadata.

- IETF RFC 3986:2005, Uniform Resource Identifier (URI): Generic Syntax.
- ISO 639–1, Codes for the representation of names of languages—Part 1: Alpha-2 code.
- 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, Information technology—Universal Multiple-Octet Coded Character Set (UCS).
- ISO/IEC 11404:1996, 2007, Information technology—Programming languages, their environments and system software interfaces—Language-independent datatypes.
- JSON-LD, a method for serializing the standard (<https://www.w3.org/TR/json-ld11/>).
- RDF, Resource Description Framework <https://www.w3.org/TR/2014/REC-rdf11-concepts-20140225/Overview.html>.
- W3C Recommendation (28 October 2004), XML Schema Part 2: Datatypes Second Edition.
- W3C RFD 3986, 3987.
- W3C, SKOS Simple Knowledge Organization System Namespace, <https://www.w3.org/2009/08/skos-reference/skos.html>.

In turn, the work in IEEE Std 1484.20.3-2022 has or may inform other standards including candidate changes and clarifications to CEDS.

This standard is intended to provide common data definitions with an approach to internationalization that serve to align with, rather than replace existing technical standards for competency definition data. It is intended to provide an internationalized standard data model.

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# IEEE Standard for Learning Technology—Data Model for Shareable Competency Definitions

## 1. Overview

### 1.1 Scope

This standard describes referencing and sharing competency definitions (and frameworks of competency definitions with related classes) as used in education and training systems at all levels. In this standard, a competency is defined for a skill, knowledge, ability, attitude, habit of practice, or learning.

### 1.2 Purpose

This standard provides a way to formally represent the core characteristics of a competency, whether it is highly contextualized, completely decontextualized, or anywhere in between. It enables interoperability among learning systems that deal with competency information by providing a means for them to refer to common definitions with common meanings. The standard provides a formal mechanism for profiling that extends the expressivity of the core characteristics using properties defined in other publicly available standards.

### 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>6,7</sup>

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*).

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<sup>6</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>7</sup>The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

## 1.4 Supporting resources

Resources that support implementation of this standard may be developed as part of an open source project under IEEE SA Open hosted in the following repository: <https://opensource.ieee.org/scd/>.

## 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). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IETF RFC 3986:2005, Uniform Resource Identifier (URI): Generic Syntax.

IETF RFC 3987:2005, Internationalized Resource Identifiers (IRIs).

## 3. Definitions, acronyms, and abbreviations

### 3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.<sup>8</sup>

**activity:** A pursuit in which a person or team uses effort.

**application profile (AP) schema:** A schema in which properties and classes from two or more existing namespace schemas are combined and further constrained to meet the needs of a particular entity or community of practice.

**behavior:** The way someone acts in response to a particular situation or stimulus.

**community of practice (CoP):** A group of practitioners connected by a common cause, role, or purpose, which operates using a common application profile schema.

**competence:** The level of ability required to perform a task or activity.

**competencies:** The plural of competency and describes the set of skills and behaviors required in the performance of a task or activity within a specific context.

**competency definition:** A resource that includes a statement that describes a competency and may include a specific context and reference definitions of potential levels of proficiency.

**competency framework:** A resource that identifies a collection of logically related competency definitions, competency associations, and contextualizing metadata.

**competency:** The set of skills and behaviors required in the performance of a task or activity within a specific context.

**context:** Describes the performance setting that might include, but not be limited to the job, role, occupational category, physical and psychological environment, and required or expected tools, information, and incentives.

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<sup>8</sup>*IEEE Standards Dictionary Online* 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.

**contextualization:** The application of contextualizing attributes in the text of the competency statement and/or through definition of relationships between instances of CompetencyDefinition, CompetencyFramework, and other resources.

**namespace schema:** A schema in which properties and classes are identified and defined.

**performance:** An observable or measurable act.

**range:** The class (type) of the resource referenced by a property.

**resource association:** A resource that defines a relationship between two resources.

**resource:** A resource is anything that can be identified by uniform resource indicator (URI); used herein in property definition tables to identify the range of a property that is left unspecified by this standard.

**rubric criterion level:** A resource that identifies a degree of competence.

**rubric criterion:** A resource that identifies a single criterion by which one aspect of an entity's competence may be evaluated.

**rubric:** A resource that identifies a set of criteria or indicators that assist in determining whether an entity possesses a given competence or a level of competence in a task or work product.

**shareable competency definition (SCD):** A CompetencyDefinition that may be used in a different context using its original uniform resource indicator (URI) and CompetencyStatement.

**skill:** The ability to effectively use cognitive and physical abilities to perform a task or activity.

### 3.2 Acronyms and abbreviations

IRI	international resource identifier
JSON	JavaScript object notation
JSON-LD	JavaScript object notation for linked data
SCD	shareable competency definition
SKOS	simple knowledge organization system
URI	uniform resource identifier
XML	extensible markup language

## 4. Shareable competency definition (SCD) conceptual model

The SCD conceptual model is designed to support shareable competency descriptions using a CompetencyDefinition class. The shareability of content in a CompetencyDefinition varies based on the amount of contextualization present. The amount of contextualization to include is a design decision. The consequence of highly contextualized instances of CompetencyDefinition increases the number of incompatible contexts and decreases shareability. In many contexts, the result may be a tightly woven graph crossing multiple conceptual spaces that is coherent and explorable via querying and navigation. Contextualization is a function of both the richness of the expression of the competency statement and the relationships defined to contextualizing internal and external resources.

It is expected that machines, enabled with artificial intelligence, will increasingly exhibit human-like behaviors and capabilities. However, this standard has neither been designed to define nor exclude competencies, behaviors, or capabilities of machines.

This standard requires the use of a URI (IETF RFC 3986:2005) or IRI (IETF RFC 3987:2005) to identify classes, properties, and resources to support linked data and semantic artifacts such as knowledge graphs. For example, a learning resource may be tagged as “teaches” the competence defined in using the SCD and an assessment resource may be tagged as “assesses” the same competence. The learning resource may also be used in different places. For example, a competency about patient privacy may be linked from a medical school course and separately from a law school course.

The SDC conceptual model shown in Figure 1 defines CompetencyFramework and CompetencyDefinition classes and a ResourceAssociation class that may be used to define relationships between instances of CompetencyDefinition, CompetencyFramework, and from those two classes to resources outside the model. In addition, instances of CompetencyFramework and CompetencyDefinition may reference instances of the Rubric, RubricCriterion, and RubricCriterionLevel classes defining assessment criteria and levels applicable to framework and competency.

Instances of CompetencyFramework include metadata about a set of logically related instances of CompetencyDefinition. Relationships between CompetencyDefinition instances may be expressed using an instance of ResourceAssociation or by direct reference using a URI or IRI. The primary association types are specified in Table 5 and may be extended as specified in Clause 6.

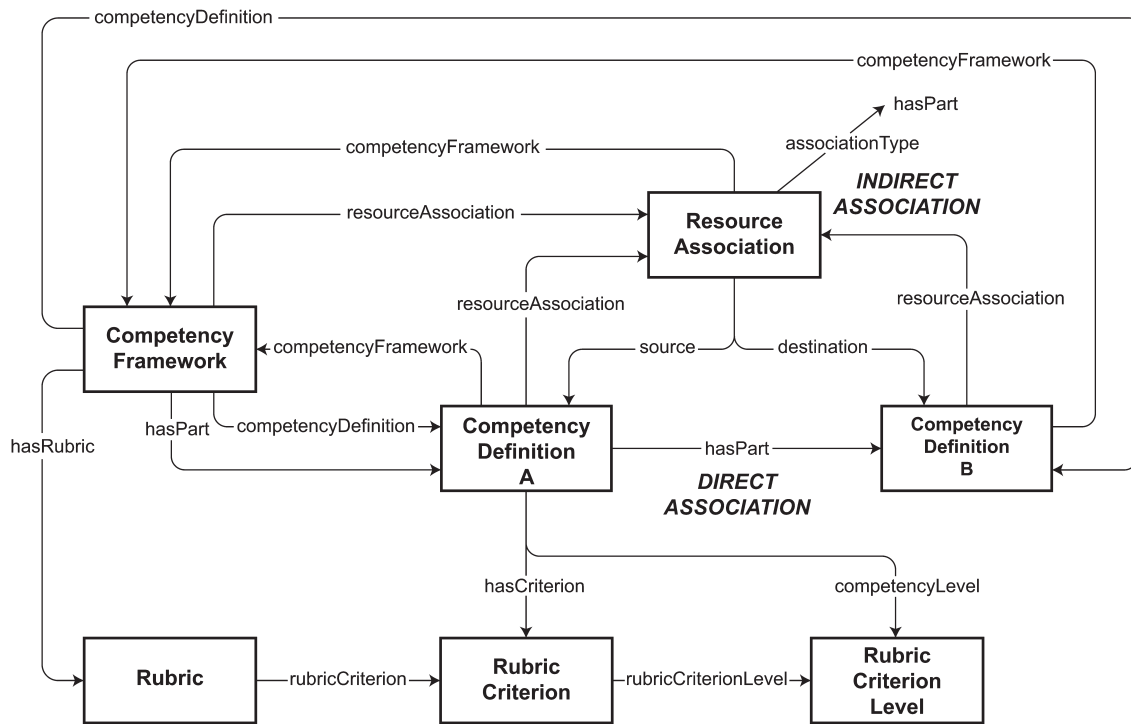
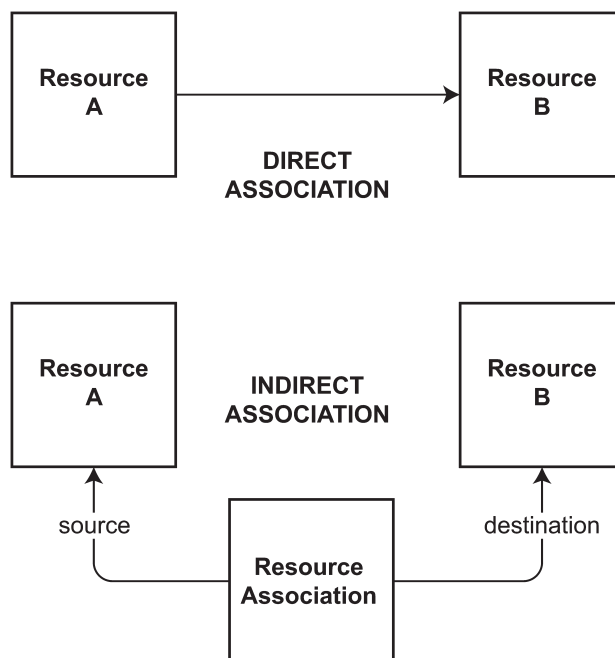


Figure 1—Shareable competency definition conceptual model

The CompetencyDefinition class has a typeLabel and type properties for identifying the specific type of a CompetencyDefinition instance such as skill, knowledge, ability, attitude, disposition, habit of mind or practice, behavior, learning outcome, or task. It does not define separate classes for such notions.

There are two models supported by this standard for expressing the relationship between two entities—a direct association model and an indirect association model (see Figure 2).



**Figure 2—Association models**

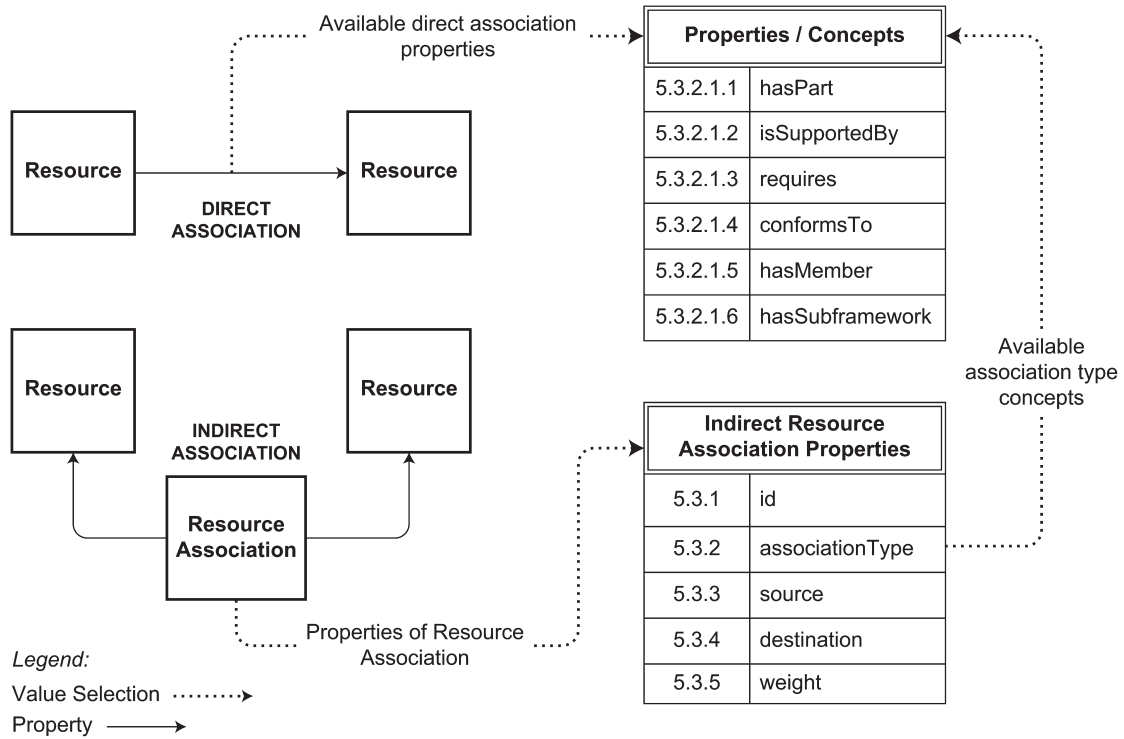
In the “direct” model, any relationship between Resource A and Resource B is established using a “property” within Resource A. This means that the relationship is always carried with Resource A into contexts where Resource A is shared while the semantics are managed by the “author” of Resource A. In the “indirect” model, the relationship is modeled by using a bridging or intermediate instance of ResourceAssociation which defines the relationship but exists as a resource identified with its own URI or IRI. Therefore, in contexts of a CompetencyDefinition shared by third parties, those parties may create and manage ResourceAssociation instances independently while referencing (sharing) CompetencyDefinition instances developed by others.

If the relationship is expressed as a direct relationship, then that relationship is always true for the related CompetencyDefinition in the context of the graph in which the relationship is defined. In such a case, the direct relationship is a property that contextualizes CompetencyDefinition itself. If the relationship is expressed indirectly as a ResourceAssociation instance, then that relationship might *not* always be true for related CompetencyDefinition instances. For example, where a ResourceAssociation is created in Graph A relating two CompetencyDefinition instances in Graph A, that relationship is true. However, if a ResourceAssociation is created in Graph B by a third party and used to assert a relationship between two CompetencyDefinition instances in Graph A, the truth of that assertion is unknown in the context of Graph A while true in the context of Graph B. In this case, indirect relationships may be expressed for separate contexts while allowing the CompetencyDefinition to apply. This fact makes the use of the ResourceAssociation indirect mechanism particularly attractive where CompetencyDefinition shareability is the goal since it does not embed context-creating relationships directly in the CompetencyDefinition.

The direct and indirect models can coexist and are not mutually exclusive. There are use cases that would predispose the use of one or the other or both. In the end, the use case of the implementer, and/or any rules imposed by that implementer will dictate how relationships are modeled.



Direct and indirect associations differ in form; however, both may express the same array of relationships between two resources. Figure 3 illustrates how both forms of relationship reference the same set of terms defined as both classes and concepts in Table 5.



**Figure 3—Direct and indirect associations**

## 5. SCD logical data model

The classes (types) in Table 1 are defined above in Figure 1.

**Table 1—SCD classes**

Ref	Class (type)	Definition
5.1	<b>CompetencyDefinition</b>	A resource that states a capability or behavior that an actor may learn or be able to do within a given context with references to potential levels of competence, a mastery threshold, and other contextualizing metadata. See NOTE 1.
5.2	<b>CompetencyFramework</b>	A resource that identifies a collection of logically related Competency Definitions, Competency Associations, and contextualizing metadata.
5.3	<b>ResourceAssociation</b>	A resource that defines a relationship between two resources. See NOTE 2.
5.4	<b>Rubric</b>	A resource that defines a set of criteria or indicators that assist in determining whether an actor possesses a given competence or level of proficiency in a task or work product. See NOTE 3.

*Table continues*

**Table 1—SCD classes (continued)**

Ref	Class (type)	Definition
5.5	<b>RubricCriterion</b>	A resource that defines a single criterion by which one aspect of an actor’s competence may be evaluated. See NOTE 4.
5.6	<b>RubricCriterionLevel</b>	A resource that defines a degree or level of competence.
NOTE 1—Actor may include persons, teams, and organizations.		
NOTE 2—The ResourceAssociation is used to relate one CompetencyDefinition to another CompetencyDefinition or to any other resource within or without a CompetencyFramework including resources such as controlled vocabulary terms (concepts), jobs, and assessment instruments.		
NOTE 3—A Rubric may have one or more instances of RubricCriterion.		
NOTE 4—Points to number of instances of RubricCriterionLevel.		

In 5.1 through 5.6, tables defining the properties of the model’s classes use UML cardinality notation for values in the “Cardinality” column.<sup>9</sup>

For Ordinality (whether a property is required or not) use the following:

- “M” to represent “Mandatory (shall be included),”
- “O” to represent “Optional (may be included),” and
- “R” to represent “Recommended” (should be included)

The definitions in tables in 5.1 through 5.6 are normative.

All properties in this data model are intrinsically unordered. The order of the properties in the class definition tables and the values in a list of values are not significant. In this document the convention is to list mandatory (M) properties first in alphabetical order in boldface, followed by recommended (R) and optional (O) properties in alphabetical order and not boldfaced.

All classes and properties in the SCD data model shall be identified by URI or IRI.

## 5.1 CompetencyDefinition

The properties of CompetencyDefinition are defined in 5.1.1 through 5.1.13 as shown in Table 2.

The competencyStatement (5.1.1) and id (5.1.2) properties are mandatory and shall be included in CompetencyDefinition instances. Depending on the implementation, an instance of CompetencyDefinition may include some or all the other properties in the SCD namespace schema as well as properties defined elsewhere using the extension mechanism described in Clause 6.

**Table 2—Properties in CompetencyDefinition class**

Ref	Property	Definition	Range	Ord.	Card.
5.1.1	<b>competencyStatement</b>	<b>Human readable expression that describes a competency.</b> See NOTE 3 and NOTE 4.	<b>rdf:langString</b>	<b>M</b>	<b>1</b>

*Table continues*

<sup>9</sup>UML Cardinality Notation: <https://tdan.com/uml-as-a-data-modeling-notation-part-1/8457>.

**Table 2—Properties in CompetencyDefinition class (continued)**

Ref	Property	Definition	Range	Ord.	Card.
5.1.2	id	<b>Globally unique identifier that allows a system to retrieve or reference this resource.</b>	URI (RFC 3986:2005) or IRI (RFC 3987:2005)	M	1
5.1.3	competencyLevel	Resource identifying a level of competence or grade that is achieved in the referenced Rubric by this CompetencyDefinition.	RubricCriterionLevel	O	1
5.1.4	description	Narrative in plain language that describes and may contextualize this resource. See NOTE 4.	rdf:langString	O	0..1
5.1.5	hasCompetencyFramework	CompetencyFramework to which this resource belongs. See NOTE 5.	URI (RFC 3986:2005) or IRI (RFC 3987:2005)	O	0..*
5.1.6	hasCriterion	Resource identifying a specific criterion in a Rubric.	RubricCriterion	O	1
5.1.7	name	Name of this resource. See NOTE 6 and NOTE 4.	rdf:langString	O	0..1
5.1.8	referenceCode	Human-decipherable identifier that uses a set of semantically cohesive categories or facets that are meaningfully combined, such as “Math.G.C.A.2.” interpreted as subject=Mathematics, category=Geometry, strand=Circles, sub-strand=Arcs and an instance number.	rdfs:Literal	O	0..*
5.1.9	resourceAssociation	ResourceAssociation used within this resource. See NOTE 7.	rdfs:Resource	O	0..*

*Table continues*

**Table 2—Properties in CompetencyDefinition class (continued)**

Ref	Property	Definition	Range	Ord.	Card.
5.1.10	type	Type, class, or category of the competency. See NOTE 8 and NOTE 9.	skos:Concept	O	0..*
5.1.11	typeLabel	Human readable label for type, class, or category of this CompetencyDefinition. See NOTE 10 and NOTE 4.	rdf:langString	O	0..*

NOTE 1—5.1.12 The controlled vocabulary terms in [Table 5](#) can be used in expressing either direct associations (i.e., as properties) or indirect associations using the ResourceAssociation (i.e., as concepts).

NOTE 2—5.1.13 Additional properties defined outside the SCD namespace schema may be used in an SCD application profile namespace schema as stated in [Clause 6](#) to extend the expressivity of the CompetencyDefinition class.

NOTE 3—This property is an unstructured, literal text of the CompetencyDefinition.

NOTE 4—The data value may be expressed in multiple languages with no more than one instance per language.

NOTE 5—In the case where a competency definition says it belongs to a framework yet the framework does not include that competency definition, the inclusion cannot be assumed to be accurate.

NOTE 6—This property is a text representing a short name or label for the CompetencyDefinition in a competency framework.

NOTE 7—When resourceAssociation is used within a CompetencyDefinition it specifies a relationship between the CompetencyDefinition and another resource.

NOTE 8—The referenced resource is a type defining a: (1) level in a hierarchical framework (e.g., “subject,” “strand,” “standard,” “benchmark,” “indicator,” “task”); (2) functional class (e.g., “condition,” “context,” “criteria,” “outcome”); or (3) a category (e.g., “knowledge,” “skill,” “ability,” “behavior,” “habit of mind or practice”).

NOTE 9—The preference is for the types to be defined as concepts (skos:Concept) in a machine-actionable concept scheme (skos:ConceptScheme).

NOTE 10—The label indicates a: (1) level in a hierarchical framework (e.g., “subject,” “strand,” “standard,” “benchmark,” “indicator,” “task”); (2) its functional class (e.g., “condition,” “context,” “criteria,” “outcome”); or (3) category (e.g., “knowledge,” “skill,” “ability,” “behavior,” “habit of mind or practice”).

## 5.2 CompetencyFramework

The properties of CompetencyFramework are defined in 5.2.1 through 5.2.9 as shown in [Table 3](#).

The id (5.2.1) and name (5.2.2) properties are mandatory and shall be included in CompetencyFramework instances. Depending on the implementation, an instance of CompetencyFramework may include some or all the other properties.

**Table 3—Properties of the CompetencyFramework class**

Ref	Property	Definition	Range	Ord.	Card.
5.2.1	id	Identifier that allows a system to retrieve or reference this resource.	URI (RFC 3986:2005) or IRI (RFC 3987:2005)	M	1
5.2.2	name	Name of this resource. See NOTE 3.	rdf:langString	M	1

*Table continues*

**Table 3—Properties of the CompetencyFramework class (continued)**

Ref	Property	Definition	Range	Ord.	Card.
5.2.3	description	Narrative that contextualizes this resource. See NOTE 3.	rdf:langString	O	0..1
5.2.4	hasCompetencyDefinition	CompetencyDefinition within this CompetencyFramework.	CompetencyDefinition	O	0..*
5.2.5	hasRubric	Rubric required by this resource.	Rubric	O	0..*
5.2.6	originalFramework	Original competency framework which this resource is based on or derived from.	rdfs:Resource	O	0..1
5.2.7	resourceAssociation	ResourceAssociation used within this resource. See NOTE 4.	ResourceAssociation	O	0..*

NOTE 1—5.2.8 The controlled vocabulary terms in [Table 5](#) can be used in expressing either direct associations (i.e., as properties) or indirect associations using the **ResourceAssociation** (i.e., as concepts).

NOTE 2—5.2.9 Additional properties defined outside the SCD namespace schema may be used in an SCD application profile namespace schema as stated in [Clause 6](#) to extend the expressivity of the **CompetencyFramework** class.

NOTE 3—The data value may be expressed in multiple languages with no more than one instance per language.

NOTE 4—When resourceAssociation is used within a CompetencyFramework, the ResourceAssociation instances within the framework are authoritative.

### 5.3 ResourceAssociation

The properties of ResourceAssociation are defined in 5.3.1 through 5.3.8 as shown in [Table 4](#).

The id (5.3.3), associationType (5.3.1), destination (5.3.2), and source (5.3.4) properties are mandatory and shall be included in ResourceAssociation instances. Depending on the implementation, an instance of ResourceAssociation may include the weight property.

Instances of the ResourceAssociation class may be used to associate one CompetencyDefinition instance with another CompetencyDefinition instance. It may also be used to associate a CompetencyDefinition with other classes. Other relationships are also allowed through the addition of properties using the SCD extension mechanism (see [Clause 6](#)). For example, the occupationalCategory property as defined by Schema.org might be used to indicate one or more occupations that use a competency definition or framework.

**Table 4—Properties of the ResourceAssociation class**

Ref	Property	Definition	Range	Ord.	Card.
5.3.1	associationType	Type of the association between two resources.	skos:Concept	M	1
5.3.2	destination	Destination node in a ResourceAssociation.	rdfs:Resource	M	1
5.3.3	id	Identifier that allows a system to retrieve or reference the resource.	URI (RFC 3986:2005) or IRI (RFC 3987:2005)	M	1
5.3.4	source	Origin node in a ResourceAssociation.	rdfs:Resource	M	1

*Table continues*

**Table 4—Properties of the ResourceAssociation class (continued)**

Ref	Property	Definition	Range	Ord.	Card.
5.3.5	hasCompetencyFramework	CompetencyFramework to which this resource belongs.	CompetencyFramework	0	0..*
5.3.6	weight	An asserted measurement of the weight, degree, percent, or strength of a recommendation, requirement, or comparison. See NOTE 3.	rdfs:Literal (xsd:decimal)	0	0..1

NOTE 1—5.3.7 The controlled vocabulary terms in Table 5 can be used in expressing either direct associations (i.e., as properties) or indirect associations using the **ResourceAssociation** (i.e., as concepts).

NOTE 2—5.3.8 Additional properties defined outside the SCD namespace schema may be used in an SCD application profile namespace schema as stated in Clause 6 to extend the expressivity of the **ResourceAssociation** class.

NOTE 3—Relative significance this connection has for the destination node in a learning map.

### 5.3.1 Controlled vocabulary for ResourceAssociation Type

The controlled vocabulary terms in the following Table 5 may be used in expressing either direct associations (i.e., as properties) or indirect associations using the **ResourceAssociation** (i.e., as concepts).

**Table 5—ResourceAssociation type concepts/properties**

Concept/Property	Definition
<b>conformsTo</b>	Destination is an established standard to which the origin resource conforms.
<b>hasMember</b>	Destination resource is a member of the origin resource. See NOTE 1.
<b>hasPart</b>	Destination resource is a part of the resource defined in the source. See NOTE 2.
<b>hasSubframework</b>	Origin framework has a subframework identified as the destination. See NOTE 3.
<b>isSupportedBy</b>	Destination resource supports the ability to do or learn the source competency.
<b>requires</b>	Attainment of the destination resource is essential to the ability to do or learn the origin resource.

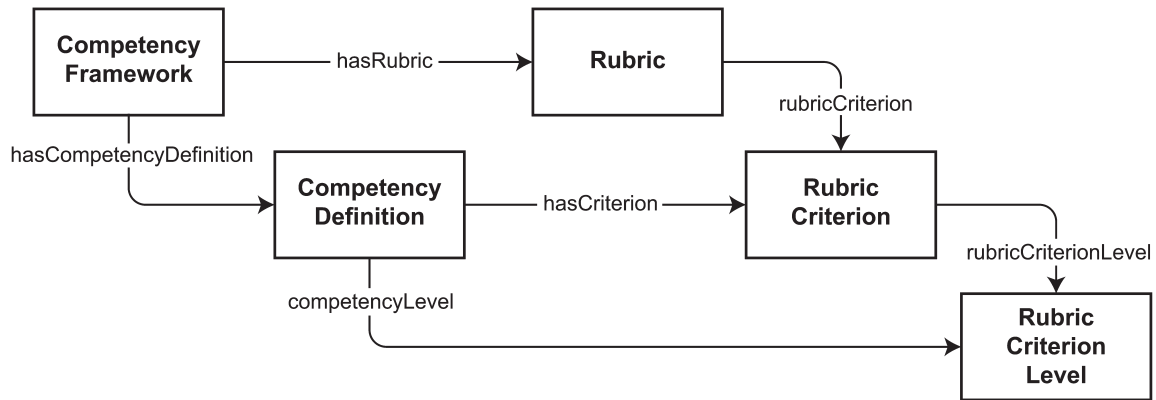
NOTE 1—This may imply that the member belongs to the source but does not necessarily define it. This list of all the members does not necessarily imply the whole of the source.

NOTE 2—This may be used for example to declare that a “task” is part of a “job” OR a “skill” is part of a “task” OR a Measure of Effectiveness is part of a “skill” definition. This may imply that all the child instances define the parent.

NOTE 3—The **hasSubframework** property shall not be used unless both **source** and **destination** are instances of **CompetencyFramework**.

## 5.4 Rubric

Normative description: Instances of CompetencyDefinition may point to instances of Rubric with information about levels of competence associated with a CompetencyDefinition. Figure 5 shows entity relationships for instances of Rubric defined in this standard.



**Figure 4—Competency definition with rubric criterion level**

A rubric is typically an evaluation tool or set of guidelines used to identify and promote the consistent application of learning or performance expectations in the classroom and the workplace and to measure their attainment against a consistent set of criteria. In addition to defining expected levels of achievement, rubrics are also used as scoring instruments to determine grades or the degree to which performance standards have been demonstrated or achieved by students and workers.

Rubrics usually contain evaluative criteria and quality definitions for those criteria at particular levels of achievement.

Rubrics are most frequently presented in a human readable table format very similar to spreadsheets with rows representing criteria and columns representing levels and the benchmarking of the criteria at those levels. Like CompetencyDefinition, CompetencyFramework, and ResourceAssociation, the SCD domain model requires that instances of Rubric, RubricCriterion, and RubricCriterionLevel shall be identified by URI or IRI to facilitate unambiguous global identification and to support linked data.

A CompetencyFramework instance may have zero or more instances of Rubric associated with it based on its content. An instance of CompetencyDefinition may be aligned to instances of either or both RubricCriterion and RubricCriterionLevel.

Figure 5 is a non-normative example of an analytic rubric and not intended to be an example of well-defined rubric content. The example assumes all criterion have the same four levels. However, the model in this standard supports any number of RubricCriterionLevel instances for each RubricCriterion. Each of the light grey-shaded/italicized cells in the example represents a RubricCriterionLevel instance with properties such as name, description, and score.

Rubric	
<b>Rubric: Name</b>	“Project Rubric (analytic)”
<b>Rubric: Description</b>	“This rubric is used to evaluate a learner’s performance on the project and the quality of the resulting work.”
<b>Rubric: Method</b>	“manual”

RubricCriterion		RubricCriterionLevel			
Rubric Criterion: Name / Description	Rubric Criterion: Weight	4 Points	3 Points	2 Points	1 Point
<b>Has a plan for investigation</b> The student turns in a written plan for investigation.	1	<i>The plan is thorough (4)</i>	<i>The plan is missing a few details (3)</i>	<i>The plan is missing significant details (2)</i>	<i>The plan is limited (1)</i>
<b>Use of materials</b> The student manages materials responsibly.	.5	<i>Manages all materials responsibly (4)</i>	<i>Uses the materials responsibly most of the time (3)</i>	<i>Mishandles some of the materials (2)</i>	<i>Does not use materials properly (1)</i>
<b>Collects the data</b> The student collects and accurately records a sufficient number of data points.	1.5	<i>Data quality and collection methods exceeds the requirements for the investigation (4)</i>	<i>Data quality and collection methods are sufficient for the investigation (3)</i>	<i>Major portions of data are missing or of low quality (2)</i>	<i>The data collection lacks a sufficient number of data points for the investigation (1)</i>

**Figure 5—Example of typical rubric presented as a human readable table mapped to classes and properties in this standard**

The properties of Rubric are defined in 5.4.1 through 5.4.8 as shown in Table 6. The id (5.4.1) property is mandatory and shall be included in Rubric instances.

**Table 6—Properties of the rubric class**

Ref	Property	Definition	Range	Ord.	Card.
5.4.1	id	Identifier that allows a system to retrieve or reference the resource.	URI (RFC 3986:2005) or IRI (RFC 3987:2005)	M	1
5.4.2	description	Short narrative that describes the resource. See NOTE 4.	rdf:langString	R	0..1

Table continues



**Table 6—Properties of the rubric class (continued)**

Ref	Property	Definition	Range	Ord.	Card.
5.4.3	method	Whether a rubric is designed for manual or automated evaluation of a proficiency level.	skos:Concept	O	0..1
5.4.4	name	Name of the resource. See NOTE 4.	rdf:langString	R	0..1
5.4.5	rubricCriterion	RubricCriterion instance.	RubricCriterion	O	0..*

NOTE 1—5.4.6 The controlled vocabulary terms in [table 5](#) can be used in expressing either direct associations (i.e., as properties) or indirect associations using the **ResourceAssociation** (i.e., as concepts).

NOTE 2—5.4.7 Additional properties defined outside the SCD namespace schema may be used in an SCD application profile namespace schema as stated in [Clause 6](#) to extend the expressivity of the **Rubric** class.

NOTE 3—5.4.8 A typical holistic rubric would require one **RubricCriterion** with more than one **RubricCriterionLevel**. A typical analytic rubric would require more than one **RubricCriterion** with each having more than one **RubricCriterionLevel**.

NOTE 4—The data value may be expressed in multiple languages with no more than one instance per language.

The following concept scheme in [Table 7](#) defines two concepts that form the value space for the 5.4.3 method property in [Table 6](#). The concepts describe whether the rubric is designed for manual or automated proficiency level evaluation. The SCD data model requires that concepts and the concept schemes shall be identified by URI or IRI to facilitate unambiguous global identification and to support linked data.

**Table 7—Concept scheme for the method property**

Concept	Definition	Domain	Range
automated	Automated method of evaluation.	skos:ConceptScheme	skos:Concept
manual	Manual method of evaluation.	skos:ConceptScheme	skos:Concept

## 5.5 RubricCriterion

Normative description: The properties of rubricCriterion are defined in 5.5.1 through 5.5.9 as shown in [Table 8](#). The id (5.5.1) and name (5.5.2) properties are mandatory and shall be included in RubricCriterion instances.

**Table 8—Properties of the RubricCriterion class**

Ref	Property	Definition	Range	Ord.	Card.
5.5.1	id	Identifier that allows a system to retrieve or reference this resource.	URI (RFC 3986:2005) or IRI (RFC 3987:2005)	M	1
5.5.2	name	Name of this resource. See NOTE 3.	rdfs:Literal rdf:langString	M	0..1
5.5.3	category	Textual label for the category by which rubricCriterion may be grouped. See NOTE 3.	rdfs:Literal rdf:langString	O	0..1

*Table continues*

**Table 8—Properties of the RubricCriterion class (continued)**

Ref	Property	Definition	Range	Ord.	Card.
5.5.4	description	Narrative in plain language that contextualizes the resource. See NOTE 3.	rdfs:Literal rdf:langString	O	0..1
5.5.5	position	Numeric value representing this resource's ordinal position in an array of resources.	rdfs:Literal (xsd:integer)	O	0..1
5.5.6	rubricCriterionLevel	RubricCriterionLevel resource.	URI (RFC 3986:2005) or IRI (RFC 3987:2005)	O	0..*
5.5.7	weight	An asserted measurement of the weight, degree, percent, or strength of a recommendation, requirement, or comparison. See NOTE 4.	rdfs:Literal (xsd:decimal)	O	0..1
<p>NOTE 1—5.5.8 The controlled vocabulary terms in Table 5 can be used in expressing either direct associations (i.e., as properties) or indirect associations using the <b>ResourceAssociation</b> (i.e., as concepts).</p> <p>NOTE 2—5.5.9 Additional properties defined outside the SCD namespace schema may be used in an SCD application profile namespace schema as stated in Clause 6 to extend the expressivity of the <b>RubricCriterion</b> class.</p> <p>NOTE 3—The data value may be expressed in multiple languages with no more than one instance per language.</p> <p>NOTE 4—Numeric weight assigned to this rubricCriterion, used for scored rubrics.</p>					

## 5.6 RubricCriterionLevel

The components of RubricCriterionLevel are defined in 5.7.1 through 5.7.8 as shown in Table 9. The id (5.6.1) and name (5.6.2) properties are mandatory and shall be included in RubricCriterionLevel instances.

**Table 9—Properties of the RubricCriterionLevel class**

Ref	Property	Definition	Range	Ord.	Card.
5.6.1	id	Identifier that allows a system to retrieve or reference the resource.	URI (RFC 3986:2005) or IRI (RFC 3987:2005)	M	1
5.6.2	name	Name of the resource. See NOTE 3.	rdf:langString	M	0..1
5.6.3	description	Text describing one or more benchmarks that must be met to achieve a degree of achievement on a product, process, or performance task. See NOTE 4.	rdfs:Literal rdf:langString	O	0..1

*Table continues*

**Table 9—Properties of the RubricCriterionLevel class (continued)**

Ref	Property	Definition	Range	Ord.	Card.
5.6.4	feedback	Predefined feedback text to be relayed to the person or organization being evaluated. This may include guidance and suggestions for improvement or development. See NOTE 4.	rdfs:Literal rdf:langString	O	0..1
5.6.5	position	Numeric value representing this resource’s ordinal position in an array of resources.	rdfs:Literal (xsd:integer)	O	0..1
5.6.6	score	Points awarded for achieving this level.	rdfs:Literal (xsd:decimal)	O	0..1
NOTE 1—5.6.7 The controlled vocabulary terms in Table 5 can be used in expressing either direct associations (i.e., as properties) or indirect associations using the <b>ResourceAssociation</b> (i.e., as concepts).					
NOTE 2—5.6.8 Additional properties defined outside the SCD namespace schema may be used in an SCD application profile namespace schema as stated in Clause 6 to extend the expressivity of the <b>RubricCriterionLevel</b> class.					
NOTE 3—The name property of a level corresponds to quality labels, often presented as row labels in tabular holistic rubrics or cell values in analytic rubrics.					
NOTE 4—The data value may be expressed in multiple languages with no more than one instance per language.					

## 6. SCD extensibility

The SCD namespace schema defined in this document has been deliberately designed as a lightweight expression that addresses common characteristics of competency definitions and competency frameworks. As a result, the SCD namespace schema used by itself in competency definition and framework descriptions might not provide the varied levels of rich description required by specific applications or communities of practice (CoPs). To enable higher levels of expressivity, this document provides a formal extension mechanism for achieving general interoperability across common characteristics while supporting higher levels of expressivity by providing systems unfamiliar with any given extension with the means to machine-retrieve the definitions and semantics of any unfamiliar properties and classes. Extensions in this specification are achieved through creation and publication of SCD application profile schemas.

### 6.1 Extension of the SCD namespace schema using SCD application profile schemas

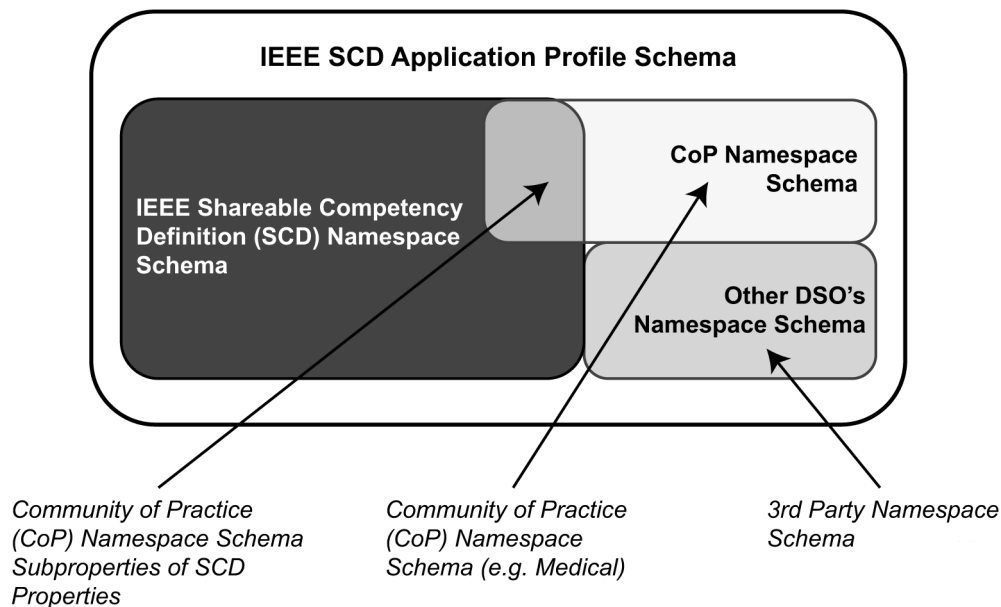
In this document, an SCD application profile schema is defined as a schema in which properties and classes (terms) from two or more existing namespace schemas are combined and further constrained to meet the needs of a particular entity or CoP. An SCD application profile schema *should not define new properties or classes* but instead reuse well defined terms from publicly available namespace schemas or any other publicly identified schema where the needed terms are identified by URI and those URI are machine-resolve to term definitions and semantics. In all cases, the meaning of an extension term in an SCD application profile schema is defined by the entity that controls that term’s URI or IRI.

An organization or CoP may coin a new property or class in a public-facing namespace schema of its own for reuse in an SDC application profile schema where no existing property or class can be found that meets the need.

Therefore, to fulfill a need not met by the SCD namespace schema, an entity or CoP may create an SCD application profile schema that:

- a) Extends the SCD namespace schema by reusing existing properties or classes that fulfill the need from any public-facing namespace schemas that identify their properties and classes using URIs that resolve to the terms' meaning and semantics;
- b) Creates new properties or classes in a public-facing namespace schema that refine (narrow) the semantics of an existing SCD namespace property to increase the profile's granularity and precision (e.g., using the hasChild property from CTDL-ASN namespace schema and declaring it in the SCD application profile schema to be a subproperty of the broader SCD hasPart namespace property); and
- c) Defines constraints on terms such as cardinality, optionality, datatypes, and permissible value spaces (concept schemes).

Figure 6 illustrates the components of an SCD application profile schema.



**Figure 6—IEEE SCD application profile model**

The CoP AP schema illustrated in Figure 6 has selected the IEEE SCD as its base schema. The CoP has also created a separate Namespace Schema of its own to define the terms it needs to add to the base schema that it is not able to find elsewhere for reuse. Included in that CoP Namespace Schema are some CoP-defined subproperties for a few SCD terms that are more specific than the broader SCD terms they refine. Also illustrated in the diagram is the addition of terms from other publicly defined namespaces such as ASN and CTDL-ASN.

It is important to remember that such a CoPAP schema reuses and refines terms, for example refining “date” as “date published,” from other namespace schemas, it does not redefine them.

Reusing terms defined in other namespace schemas as opposed to recreating terms with the same semantics promotes overall interoperability in a data ecosystem. If changes need to be made to a property being considered from another’s namespace schema for it to be useful, the property should not be reused; instead, a derivative property should be defined in a namespace schema and referenced in an SCD application profile schema.

There are public schemas from which to borrow properties and classes that range from general schemas for the description of entities to specialized schemas in the same descriptive space as this SCD standard. Table 10 contains a *limited set* of widely used public *namespace schemas* that name their properties and classes by URI that resolve to machine descriptions of the properties and classes they identify.

**Table 10—Limited set of widely used public namespace schemas**

Prefix	URI
asn	Namespace: <a href="https://purl.org/ASN/schema/core/">https://purl.org/ASN/schema/core/</a>
case	Namespace: (see <a href="https://www.imsglobal.org/activity/case">https://www.imsglobal.org/activity/case</a> ) Context File (version 1.0): <a href="https://purl.imsglobal.org/spec/case/v1p0/context/imscasev1p0_context_v1p0.jsonld">https://purl.imsglobal.org/spec/case/v1p0/context/imscasev1p0_context_v1p0.jsonld</a>
dct	Namespace: <a href="https://purl.org/dc/terms/">https://purl.org/dc/terms/</a>
ceterms	Namespace: <a href="https://purl.org/ctdl/terms/">https://purl.org/ctdl/terms/</a> Context File: <a href="http://credreg.net/ctdl/schema/context/json">http://credreg.net/ctdl/schema/context/json</a>
sdo	Namespace: <a href="http://schema.org">http://schema.org</a> Context File: <a href="http://schema.org">http://schema.org</a>
skos	Namespace: <a href="http://www.w3.org/2004/02/skos/core#">http://www.w3.org/2004/02/skos/core#</a>
NOTE—For additional schema namespaces meeting particular needs, search and explore “Linked Open Vocabularies” ( <a href="https://lov.linkeddata.es/dataset/lov/vocabs/">https://lov.linkeddata.es/dataset/lov/vocabs/</a> ).	

Applications consuming data conforming to an SCD application profile schema may either ignore properties in that application profile that are not included in the SCD namespace schema or include such properties based on their machine-derived semantics.

## 7. Internationalization

All SCD properties with literal values intended for reading by humans provide the means to language tag those values. It is good practice to provide language tags for all human readable text even in a monolingual CompetencyFramework since individual CompetencyDefinition instances may be shared across instances of CompetencyFramework that are multilingual in whole or in part. The Range column in the SCD class tables 2-4, 6, and 8-9 identifies the range of properties with human readable values using `rdfs:Literal/rdf:langString`.

This standard provides two options for internationalized multilingual versions of shareable competency definitions. One of the following methods should be used to manage competency definitions translated into different languages:

- a) Translated definitions may be expressed in a separate CompetencyFramework. This is recommended for competencies that might be localized as well as translated to take account of local customs, practices, or contexts. In this case, the information should be managed as a separate derivative framework but may link to or reference the source definitions.
- b) Translated definitions may be expressed in the same CompetencyFramework along with the original language definitions. CompetencyDefinition instances include text properties that use the `rdf:langString` type, which supports multiple language translations of the same statement to be stored together within a single instance of CompetencyDefinition. For example, a CompetencyDefinition

statement may be expressed in English and Spanish (here serialized in JSON-LD using a language map in an unshown `@context`).






```
"competencyStatement": {  
  "en-GB": "a description",  
  "es": "una descripción"  
}
```



# RAISING THE WORLD'S STANDARDS

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