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Commons Ontology Library

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Preface

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1 Scope

1.1 Introduction

The Commons Ontology Library is designed to provide a useful set of modeling constructs that are reusable in different modeling and data deployment environments with minimal commitments. It is intended to be extensible such that new ontologies and potentially other models (for example, UML models corresponding to the ontologies) can be added as cross-domain requirements present themselves. These requirements may come from other OMG standards efforts or potentially from external users of the library, for example, the Industrial Ontology Foundry (IOF) manufacturing community, EDM Council projects with the Pistoia Alliance IDMP pharmaceutical community, and others.

1.2 Criteria for Inclusion

Ontologies and other models will be identified primarily by drawing on other work, although care must be taken to ensure that intellectual property and other legal rights are addressed and that standardization is desired by the user community. Oversight for curation of the library will be managed by the Commons task force (RTF) via the normal OMG process. The minimum criteria identified to date for inclusion include: (1) the need for the same set of concepts with the same semantics across multiple specifications and/or domain areas, such as manufacturing, finance and/or retail, (2) a clear set of use cases, competency questions, and test cases that can help limit the scope for a given ontology and provide the basis for regression testing, (4) reusability in their own right with minimal dependencies on other ontologies with the possible exception of other Commons ontologies, and (4) that the ontologies meet minimal requirements for metadata, logical consistency, and serialization (*e.g.*, RDF/XML and Turtle serialized OWL, for OWL ontologies).

1.3 Overview

The Commons Ontology Library of ontologies specified herein covers:

(1) Annotations

- a reusable set of declarations for commonly used annotation properties from the Dublin Core Metadata Initiative (DCMI) Terms[1] and the Simple Knowledge Organization System (SKOS)[2], so that these vocabularies can be reused without importing either, and
- additional annotation properties that provide metadata for documentation that is not explicitly available in either Dublin Core or SKOS.

(2) Collections:

- commonly used concepts for arrangements and schemes for organizing information and collections of things, such as structured collections that may be organized according to some scheme, and related very high level mereology relations to enable association of things with such collections and schemes.

(3) Roles and Compositions:

[1] See https://www.dublincore.org/specifications/dublin-core/dcmi-terms/

[2] See https://www.w3.org/2004/02/skos/

- the notion of a composition that can be used, for example to relate something, such as a product or recipe, to its ingredients or constituents, and/or to the roles such constituents play in the composition, and optionally to some context, such as a jurisdiction, in which the composition is relevant

- the concept of a role, supporting the representation of participants in compositions, situations, and relationships, as well as properties that link the role to something that plays that role, that links something to a role it has (*e.g.*, a role that is pertinent to a situation or composition), as well as inverses that enable role traversal in a graph

(4) Designations:

- Designators – commonly used concepts for naming, derived in part from the patterns defined in ISO 1087 for terminology work and ISO 11179-3, Metadata Registries. The top-level designators ontology includes several very high level semiotic relationships, including defines, describes, and denotes for associating designators with the concepts they reference.

- Contextual Designators – an extension to the designators ontology to incorporate applicable dates and times and facilitate the inclusion of other context that is commonly needed, derived in part from the patterns defined in ISO 11179-3, Metadata Registries.

- Codes and Code Sets – commonly used concepts for describing codes, including standardized codes such as ISO language, country, and other code sets, the North American Industry Classification System (NAICS) codes, and custom code sets that many organizations develop for various purposes, derived from the patterns specified in ISO 11179-3, Metadata Registries.

- Identifiers – commonly used concepts for describing identifiers and the identification schemes that define them, such as various national and international identifiers for legal entities, financial instruments, and the like, derived from the patterns specified in ISO 11179-3, Metadata Registries.

- Contextual Identifiers – an extension to the contextual designators and identifiers ontologies covering concepts for describing more complex identifiers, including those that apply for some period of time as well as those that are structured and include other codes or identifiers.

(5) Classifiers:

- abstract concepts for representation of classification schemes that enable the classification of arbitrary concepts into hierarchies (or partial orders) for use in other ontologies, derived in part from the patterns defined in ISO 1087-1 for terminology work and ISO 11179-3, Metadata Registries.

(6) Parties and Situations:

- the concepts of agent, agent role, party, party role, and situation, which is a state of affairs or reified relationship that holds for some period of time, including lattice relations between the concepts driven by property chains that can be used to access the lattice from any perspective in the resulting graph.

(7) Quantities and Units:

- Documents – a small documents ontology that can be mapped to others, such as FRBR, to support representation of references and reference documents required for documenting certain units, and

- Quantities and Units – an ontology defining scalar quantities and units, corresponding to the quantities and units library in SysML v2 covering the key concepts required for most domains, including but not limited to measurement scales, quantity kinds, dimensions, scalar quantities and scalar units.

(8) Time:

- Dates and Times – commonly used temporal concepts that cover those most frequently needed across domains, with a focus on terminology that is used in business applications. It is designed to be mappable to other date and time ontologies and specifications, such as the W3C Time Ontology in OWL[3], certain temporal elements in ISO Basic Formal Ontology[4], time concepts defined in schema.org, and the OMG Date Time Vocabulary (DTV) specification, without the corresponding overhead, or in some cases, issues. The concepts were originally derived from a number of date and time standards including ISO 8601:2004 Representation of Dates and Times.

- Mapping Dates and Times to OWL Time – an extension to the dates and times ontology to map it to the widely used W3C Time Ontology in OWL recommendation.

(9) Text Datatype:

- a custom datatype that combines language tagged and plain string values. This text datatype is useful in cases where it is not clear whether string values will be tagged or not, but where it is anticipated that multilingual strings might be appropriate.

Each of these ontologies is defined below.

1.4 Metadata

Annotations on concepts, properties, and individuals in this specification follow the general policies recommended by the OMG Architecture Board, including the use of (1) the Dublin Core Metadata Terms [Dublin Core], (2) the Simple Knowledge Organization System (SKOS) [SKOS], and (3) the annotation vocabulary included in the Commons Ontology Library. Every element in the ontologies defined in the Commons Ontology Library must have a label and definition, and in many cases, the source for the definitions, such as an ISO or other OMG standard, is referenced. Examples are also included as appropriate, along with other notes that may assist users in understanding and reusing the ontology.

[3] Available at https://www.w3.org/TR/owl-time/

[4] See https://basic-formal-ontology.org/bfo-2020.html

2 Conformance

The Commons Ontology Library specification provides two options for conformance points for implementers. These are as follows:

> (1) Specification-level conformance with the OWL ontologies, which means that the subject application formally imports the ontologies (*i.e.*, through `owl:imports` statements in another ontology or via loading the full set of ontologies for reference in a knowledge graph that supports OWL) with no resulting logical inconsistencies;
>
> (2) Linked Data-level conformance – which means that the subject application references one or more of the ontologies but does not formally import them.

For either conformance point, references to the elements defined in a given ontology must use, or provide a mapping to, the standard OMG URI for that element. Users may choose to use or extend any of the Commons Ontology Library ontologies as necessary, to add concepts and properties required between releases, or to add application-specific extensions needed to address their individual requirements. We encourage library implementers and users to submit any requirements for extension, including requests to add ontologies to the library, to the relevant task force as issues.

3 References

3.1 Normative References

Reference	*Description*
[BCP 47]	BCP 47: Tags for Identifying Languages, available at https://tools.ietf.org/search/bcp47
[DTV]	Date-Time Vocabulary (DTV™). Available at https://www.omg.org/spec/DTV/.
[Dublin Core]	DCMI Metadata Terms, Issued 2020-01-20 by the Dublin Core™ Metadata Initiative. Available at https://www.dublincore.org/specifications/dublin-core/dcmi-terms/.
[ISO 704]	ISO 704:2009 Terminology work – Principles and methods, Fourth edition, 2022-07
[ISO 1087]	ISO 1087:2019 Terminology work – Vocabulary – Theory and Application, Second edition, 2019-09
[ISO 8601-1]	ISO 8601-1:2019 Date and Time – Representations for information interchange – Part 1: Basic Rules
[ISO 11179-3]	ISO/IEC 11179-3:2013 Information technology – Metadata registries (MDR) – Registry metamodel and basic attributes, Third edition, 2013-02-15
[MOF]	Meta Object Facility (MOF™) Core. Available at http://www.omg.org/spec/MOF/
[MOF XMI]	MOF 2/XMI (XML Metadata Interchange) Mapping Specification. Available at http://www.omg.org/spec/XMI/
[ODM]	Ontology Definition Metamodel (ODM™). Available at http://www.omg.org/spec/ODM/
[OWL 2]	OWL 2 Web Ontology Language Quick Reference Guide (Second Edition), W3C Recommendation 11 December 2012. Available at http://www.w3.org/TR/2012/REC-owl2-quick-reference-20121211/.
[RDF Concepts]	RDF 1.1 Concepts and Abstract Syntax. Richard Cyganiak, David Wood and Markus Lanthaler, Editors. W3C Recommendation, 25 February 2014. Available at http://www.w3.org/TR/rdf11-concepts/
[RDF Schema]	RDF Schema 1.1. Dan Brickley and R.V. Guha, Editors. W3C Recommendation, 25 February 2014. Available at http:// www.w3.org/TR/rdf-schema/.
[SKOS]	SKOS Simple Knowledge Organization System Reference, W3C Recommendation 18 August 2009. Available at http://www.w3.org/TR/2009/REC-skos-reference-20090818/.
[SMOF]	MOF Support for Semantic Structures (SMOF™). Available at https://www.omg.org/spec/SMOF/.
[SysML]	OMG System Modeling Language (SysML®). Available at https://www.omg.org/spec/SysML/.
[UML]	Unified Modeling Language™ (UML®). Available at http://www.omg.org/spec/UML/
[Unicode]	*The Unicode Standard, Version 3*, The Unicode Consortium, Addison-Wesley, 2000. ISBN 0-201-61633-5, as updated from time to time by the publication of new

	versions. (See http:// www.unicode.org/unicode/standard/versions/ for the latest version and additional information on versions of the standard and of the Unicode Character Database).
[UTF-8]	RFC 3629: UTF-8, a transformation format of ISO 10646. F. Yergeau. IETF, November 2003, http://www.ietf.org/rfc/rfc3629.txt
[W3C Datatypes in RDF and OWL]	XML Schema Datatypes in RDF and OWL, W3C Working Group Note 14 March 2006, Available at http://www.w3.org/TR/2006/NOTE-swbp-xsch-datatypes-20060314/.
[W3C OWL Time]	W3C Time Ontology in OWL, available at https://www.w3.org/TR/owl-time/
[XML Schema Datatypes]	XML Schema Part 2: Datatypes Second Edition. W3C Recommendation 28 October 2004. Available at http://www.w3.org/TR/xmlschema-2/.

3.2 Non-Normative References

The following informative documents are referenced in this specification:

Reference	*Description*
[DL Handbook]	THE DESCRIPTION LOGIC HANDBOOK: Theory, implementation, and applications. Baader, McGuinness, Nardi, and Patel-Schneider, editors. Cambridge University Press, Cambridge, United Kingdom, 2003.
[OE]	Kendall, Elisa F. and Deborah L. McGuinness. *Ontology Engineering*: Synthesis Lectures on the Semantic Web: Theory and Technology. Morgan & Claypool Publishers. 2019. doi: 10.2200/S00834ED1V01Y201802WBE018

4 Terms and Definitions

For the purposes of this specification, the following terms and definitions apply.

Term	*Definition*
annotation	note or comment added to provide explanatory information or other metadata about some element in an ontology
arrangement	systematic plan, manner, or method for making, doing, achieving, or organizing something
aspect	characteristic or feature that can be used to dimensionalize, filter, or subset something
collection	grouping of things (may be zero) that have some shared significance
composition	distinct element resulting from bringing together other elements, possibly in specific roles, for a particular purpose
context	situation or frame of reference in which something applies, exists, happens, or is used and that helps to illustrate or explain it
designation	representation for someone or something by a sign that denotes it
mereology	theory of parthood relations: the relations of part to whole and the relations of part to part within a whole
ontology	An ontology specifies a rich description of the • Terminology, concepts, nomenclature • Relationships among and between concepts and individuals • Sentences distinguishing concepts, refining definitions and relationships (constraints, restrictions, regular expressions) relevant to a particular domain or area of interest. [OE]
role	named specific behavior of something participating in a particular context

5 Symbols

5.1 Symbols

See clause 6.5, Notation, for a description of the logic symbols used to describe the ontologies covered in this specification.

5.2 Abbreviations

The following abbreviations are used throughout this specification:

DL – Description Logics

FIBO – Financial Industry Business Ontology

IOF – Industrial Ontology Foundry

IRI – Internationalized (Uniform) Resource Identifier

ISO – International Organization for Standardization

LCC – Languages, Countries and Codes

MVF – Multiple Vocabulary Facility

OWL – Web Ontology Language

ODM – Ontology Definition Metamodel

RDF – Resource Description Framework

UML – Unified Modeling Language

URI – Uniform Resource Identifier

URL – Uniform Resource Locator

W3C – World Wide Web Consortium

XMI – XML Metadata Interchange

XML – eXtensible Markup Language

6 Additional Information

6.1 Changes to Other OMG Specifications

None.

6.2 Acknowledgments

The following organization submitted this specification:

- Thematix Partners LLC

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- agnos.ai U.K. Ltd
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- QuoteWell, Inc.
- Raytheon Technologies
- Rensselaer Polytechnic Institute
- Sparx Systems Pty Ltd
- U. S. National Institute of Standards and Technology (NIST)
- Wells Fargo Bank, N.A.
- Working Ontologist

6.3 Intellectual Property Rights

The Commons Ontology Library is available under the OMG's Copyright and Non-Assertion Covenant (see https://www.omg.org/cgi-bin/doc.cgi?ipr for details). The individual ontologies are also licensed for use under the MIT open-source license agreement, available at https://opensource.org/licenses/MIT.

6.4 Application of the Commons Ontologies

The ontologies included in the library are reused by the Multiple Vocabulary Facility (MVF) specification and an anticipated update of the Languages, Countries and Codes (LCC) specification. With respect to LCC, they replace a number of existing concepts that were needed for MVF but derived from LCC. The ontologies are also needed for finalization of the API4KP specification. They are also used by the Financial Industry Business Ontology (FIBO), by the emerging Retail Industry Ontology (RIO), and by the Robotics Service Ontology specification.

In addition to their use in OMG standards, initiatives such as the Industrial Ontology Foundry (IOF), sponsored by the U.S. National Institute of Standards and Technology and a joint effort of the Pistoia Alliance and EDM Council for ontologies to facilitate identification of medicinal products (IDMP) are considering or using them as well.

6.5 Notation

The diagrams included herein are ODM-compliant UML diagrams. In other words, they conform to the UML Profiles for RDF and OWL specified in the OMG's Ontology Definition Metamodel [ODM] Specification. This includes the set of UML stereotypes and graphical notation used in the diagrams provided.

The color scheme employed in these diagrams includes:

- Basic OWL Classes: white for classes defined within the current (local) ontology, amber for classes defined within an imported (referenced) ontology
- OWL Restriction Classes and other Class Expressions (unions, intersection, complements): green
- OWL Object Properties: blue
- OWL Data Properties: dark gray
- OWL Datatypes: pink
- OWL Individuals: light gray

These colors are provided for clarification purposes only, and are non-normative.

For the library there is an "about" file, which provides metadata about the library, described below in tabular form. The ontologies themselves are documented as ODM-compliant UML models, aside from the "about" file, annotation vocabulary, and mapping ontology. Every ontology is expressed in RDF/XML-serialized OWL and Turtle-serialized OWL [OWL 2].

The notation used to represent description logic expressions (*i.e.*, the expressions in the Parent columns in class tables containing ontology details) is consistent with the notation defined in the Description Logic Handbook [DL Handbook]. The notation used in this specification, representing a subset of OWL 2, is described in Table 6.1, below.

Table 6.1: Description Logic Expressions Notation

Construct	*Description*	*Notation*
Boolean Connectives and Enumeration		
intersection	The intersection of two classes consists of exactly those individuals which are instances of both classes.	C ∩ D
union	The union of two classes contains every individual which is contained in at least one of these classes.	C ∪ D
enumeration	An enumeration defines a class by enumerating all its instances.	oneOf (i_1, i_2, i_3, … i_n)
Property Restrictions		
universal quantification	Universal quantification is used to specify a class of individuals for which all related individuals must be instances of a given class (*i.e.*, allValuesFrom in OWL).	∀R.C, where R is the relation (property) and C is the class that constrains all values for related individuals
existential quantification	Existential quantification is used to specify a class as the set of all individuals that are connected via a particular property to at least one individual which is an instance of a certain class (*i.e.*, someValuesFrom in OWL).	∃R.C, where R is the relation (property) and C is the class that constrains some values of related individuals
individual value	Individual value restrictions are used to specify classes of individuals that are related to one particular individual (*i.e.*, hasValue in OWL).	∀R.I, where R is the relation (property) and I is the individual
exact cardinality	Cardinality (number) restrictions specify classes by restricting the cardinality on the sets of fillers for roles (relationships, or properties in OWL). Exact cardinality restrictions restrict the cardinality of possible fillers to exactly the number specified.	= n R (for unqualified restrictions) = n R.C (for qualified restrictions, i.e., including onClass or on DataRange)
maximum cardinality	Maximum cardinality restrictions restrict the cardinality of possible fillers to at most the number specified (inclusive).	≤ n R (for unqualified restrictions) ≤ n R.C (for qualified restrictions)
minimum cardinality	Minimum cardinality restrictions restrict the cardinality of possible fillers to at least the number specified (inclusive).	≥ n R (for unqualified restrictions) ≥ n R.C (for qualified restrictions)
Class Axioms		
equivalent classes	Two classes are considered equivalent if they contain exactly the same individuals.	≡ C

disjoint classes	Disjointness means that membership in one class specifically excludes membership in another.	¬ C
Property Axioms		
complex role inclusions	Role inclusions allow [object] properties to be chained together in a sequence that is a subproperty of a higher-level property.	R ○ R

Note that in the case of complex restrictions, where there are nested elements in parentheses, the “dot notation” used as a separator between a property and the role filler is replaced with the embedded parenthetical filler definition. A “role” from a description logic perspective is essentially a property in OWL, and the role “filler” is the class or individual that provides the value for that role in a given axiom (*i.e.*, in a restriction or other logic expression).

7 Architecture

7.1 “About” the Commons Ontologies

The “about” file for the Commons Ontology Library provides metadata describing the library. This file is designed to (1) describe the machine-readable content of the specification for users that download the entire library directly and imports it into tools that can interpret and display the files, (2) for potential use in tagging the specification document on the OMG site, and (3) to provide a single file that imports the ontologies for ease of use (similar to a “make file” for software), excluding the mapping to the W3C Time Ontology in OWL, which may or may not be desired.

7.2 Namespace Definitions

The namespaces and prefixes corresponding to external elements required for use in the Commons Ontology Library are provided in Table 7.1. Table 7.2 provides the namespace declarations required for use of the ontologies included in the library itself. The prefixes provided in Tables 7.1 and 7.2 are normative, and their use is required in any conformant application or extension.

Table 7.1: Prefix and Namespaces for referenced/external vocabularies

Namespace Prefix	Namespace
rdf	http://www.w3.org/1999/02/22-rdf-syntax-ns#
rdfs	http://www.w3.org/2000/01/rdf-schema#
owl	http://www.w3.org/2002/07/owl#
xsd	http://www.w3.org/2001/XMLSchema#
dct	http://purl.org/dc/terms/
skos	http://www.w3.org/2004/02/skos/core#
time	http://www.w3.org/2006/time#

The namespace approach taken for Commons Ontology Library is based on OMG guidelines and is constructed as follows:

- The standard protocol, authority, and top level specification part of any OMG specification namespace, which is `https://www.omg.org/spec/`
- The abbreviation for the specification: in this case `Commons`
- The ontology name

Note that the URI/IRI strategy for the ontologies included in the library takes a “slash” rather than “hash” approach, in order to accommodate server-side applications. Namespace prefixes are constructed as follows with the components separated by “-“:

- The abbreviation used for prefix purposes across the Commons Ontology Library: `cmns`
- An abbreviation for the ontology name

The namespaces and prefixes for the individual ontologies are summarized in Table 7.2. These are given in alphabetical order, rather than with any intent to show imports relationships. The table includes the namespace definitions for the "about" file that is part of the machine-readable deliverables for the specification, but that is not required for imports closure. Note that these are not versioned, although version IRIs are included in every OWL ontology and are documented in the metadata for each of them.

Table 7.2: Prefix and Namespaces for the Commons Ontology Library Ontologies

Namespace Prefix	Namespace
cmns-abt	https://www.omg.org/spec/Commons/AboutCommons/
cmns-av	https://www.omg.org/spec/Commons/AnnotationVocabulary/
cmns-cds	https://www.omg.org/spec/Commons/CodesAndCodeSets/
cmns-cls	https://www.omg.org/spec/Commons/Classifiers/
cmns-col	https://www.omg.org/spec/Commons/Collections/
cmns-cxtdsg	https://www.omg.org/spec/Commons/ContextualDesignators/
cmns-cxtid	https://www.omg.org/spec/Commons/ContextualIdentifiers/
cmns-doc	https://www.omg.org/spec/Commons/Documents/
cmns-dsg	https://www.omg.org/spec/Commons/Designators/
cmns-dt	https://www.omg.org/spec/Commons/DatesAndTimes/
cmns-id	https://www.omg.org/spec/Commons/Identifiers/
cmns-mdt	https://www.omg.org/spec/Commons/MappingDatesAndTimesToOWLTime/
cmns-pts	https://www.omg.org/spec/Commons/PartiesAndSituations/
cmns-qtu	https://www.omg.org/spec/Commons/QuantitiesAndUnits/
cmns-rlcmp	https://www.omg.org/spec/Commons/RolesAndCompositions/
cmns-txt	https://www.omg.org/spec/Commons/TextDatatype/

8 Commons Ontologies

8.1 Ontology: Annotation Vocabulary

The annotation vocabulary provides commonly used annotation properties for documentation to facilitate understanding. It declares a number of properties available in the Dublin Core Metadata Initiative (DCMI)'s Metadata Terms vocabulary [Dublin Core] as OWL annotation properties to facilitate their usage in tools that require such declarations. It also declares the annotations provided in the Simple Knowledge Organization System [SKOS] to enable reuse without requiring import of the SKOS vocabulary, which includes semantics that may not be desirable for some knowledge graph applications. Finally, the vocabulary defines additional annotation properties that are useful for documenting other ontologies and are used in a number of OMG specifications.

Given that this ontology contains no classes, we have opted not to present a UML diagram for it herein. The metadata for this ontology is provided in Table 8.1, below and definitions for the new annotation properties (*i.e.*, those that are local to this ontology rather than declarations for Dublin Core and SKOS annotations) are presented in Table 8.2.

Table 8.1: Annotation Vocabulary Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/AnnotationVocabulary/
rdfs:label	Annotation Vocabulary
dct:abstract	The Annotation Vocabulary provides commonly used annotation properties for documentation to facilitate understanding.
cmns-av:copyright	Copyright (c) 2022 EDM Council, Inc.
cmns-av:copyright	Copyright (c) 2022 Object Management Group, Inc.
dct:license	http://opensource.org/licenses/MIT
dct:references	http://purl.org/dc/terms/
dct:references	http://www.w3.org/2004/02/skos/core#
dct:title	Commons Annotation Vocabulary
owl:versionIRI	https://www.omg.org/spec/Commons/20221101/AnnotationVocabulary/
skos:note	Note that any of the annotation properties provided in Dublin Core can be used in addition to those declared herein. However, Dublin Core terms that are not explicitly defined herein must be declared explicitly as annotation properties in the ontologies that use them.

skos:note	The annotation properties defined below are derived from similar annotation vocabularies used in (1) the Object Management Group (OMG) specification metadata - see http://www.omg.org/techprocess/ab/SpecificationMetadata/, (2) annotations used in the Financial Industry Business Ontology (FIBO) - see https://spec.edmcouncil.org/fibo/ontology/FND/Utilities/AnnotationVocabulary/, and (3) other ontology efforts such as the NIST-sponsored Industrial Ontology Foundation (IOF).

Table 8.2: Annotation Vocabulary Details

Properties

Name	Annotations	Property Axioms
abbreviation (abbreviation)	Definition: designation formed by omitting parts from the full form of a term that denotes the same concept Note: Abbreviations can be created by removing individual words, or can be acronyms, initialisms, or clipped terms. Adapted from: ISO 1087 Terminology work and terminology science - Vocabulary, Second edition, 2019-09 Adapted from: ISO 31-0 Quantities and units - General principles Example: Chemical Symbols: H, O, Mg; Units of Measure: Km, Kg, G Explanatory note: The symbols for quantities are generally single letters of the Latin or Greek alphabet, sometimes with subscripts or other modifying signs. These letters, including those that are members of the Greek alphabet are not symbols for the purposes of this ontology, however, they are abbreviations. Expressions of chemical formulae may, however, include a combination of abbreviations and symbols, as needed to define a given quantity.	Parent Property: cmns-av:synonym
acronym (acronym)	Definition: abbreviation that is made up of the initial letters of the components of the full form of a term or proper name or from syllables of the full form Note: Acronyms are frequently pronounced syllabically. Adapted from: ISO 1087 Terminology work and terminology science - Vocabulary, Second edition, 2019-09 Example: Examples of acronyms are: laser, ISO, GATT, UNESCO, UNICEF	Parent Property: cmns-av:abbreviation
adaptedFrom (adapted from)	Definition: document or other source from which a given term (or its definition) was adapted (*i.e.*, is compatible with but not quoted); the range for this annotation can be a string, URI, or citation Usage note: This annotation should be used to indicate that a reference was used, for example, as input to the development of a definition or term but would not be considered infringing on a copyright.	Parent Property: dct:source

copyright (copyright)	Definition: exclusive legal right, given to an originator or an assignee to print, publish, perform, film, or record literary, artistic, or musical material, and to authorize others to do the same Usage note: This annotation is typically used to describe an artifact such as a controlled vocabulary, ontology, or other similar resource.	Parent Property: dct:rights
directSource (direct source)	Definition: quoted reference for the subject resource; the range for this annotation can be a string, URI, or bibliographic citation	Parent Property: dct:source
explanatoryNote (explanatory note)	Definition: note that provides additional explanatory material for a resource	Parent Property: skos:note
logicalDefinition (logical definition)	Definition: definition in the form of a formal expression, such as the mathematical or logic representation, for the resource	Parent Property: skos:definition
symbol (symbol)	Definition: abbreviation that is a design or mark, or other non-alpha-numeric character(s) conventionally used to represent something, such as a currency or mathematical sign or operator	Parent Property: cmns-av:abbreviation
synonym (synonym)	Definition: designation that can be substituted for the primary representation of something Adapted from: ISO 1087 Terminology work and terminology science - Vocabulary, Second edition, 2019-09	Parent Property: skos:altLabel
usageNote (usage note)	Definition: note that provides information about how a given resource is used or may be extended	Parent Property: skos:note

8.2 Ontology: Classifiers

This ontology defines abstract concepts for representation of classification schemes that enable the classification of arbitrary concepts into hierarchies (or partial orders) for use in many other ontologies. It is derived in part from patterns defined in ISO 1087 for terminology work and ISO 11179-3, Metadata Registries.

Metadata for the Classifiers ontology is given in Table 8.3.

Table 8.3: Classifiers Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/Classifiers/
rdfs:label	Commons Classifiers Ontology
dct:abstract	This ontology defines abstract concepts for representation of classification schemes that enable the classification of arbitrary concepts into hierarchies (or partial orders) for use in many other ontologies, derived in part from the patterns defined in ISO 1087-1 for terminology work and ISO 11179-3, Metadata Registries.

cmns-av:copyright	Copyright (c) 2014-2022 EDM Council, Inc.
cmns-av:copyright	Copyright (c) 2014-2022 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2022 Object Management Group, Inc.
dct:license	http://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20221101/Classifiers/
skos:note	The classifiers ontology conforms with the OWL 2 DL semantics, and is outside of OWL 2 RL due to the inclusion of a local some values constraint. The latter could be removed as needed to support OWL RL rule-based applications that cannot be extended to support it.
skos:note	This ontology was originally designed for use in the OMG Languages, Countries and Codes (LCC) specification as part of the broader CountryRepresentation ontology. The concepts have also been used in the Financial Industry Business Ontology (FIBO) for representing industry sectors, financial instrument classifiers (e.g., asset classes), lifecycle states, and so forth.

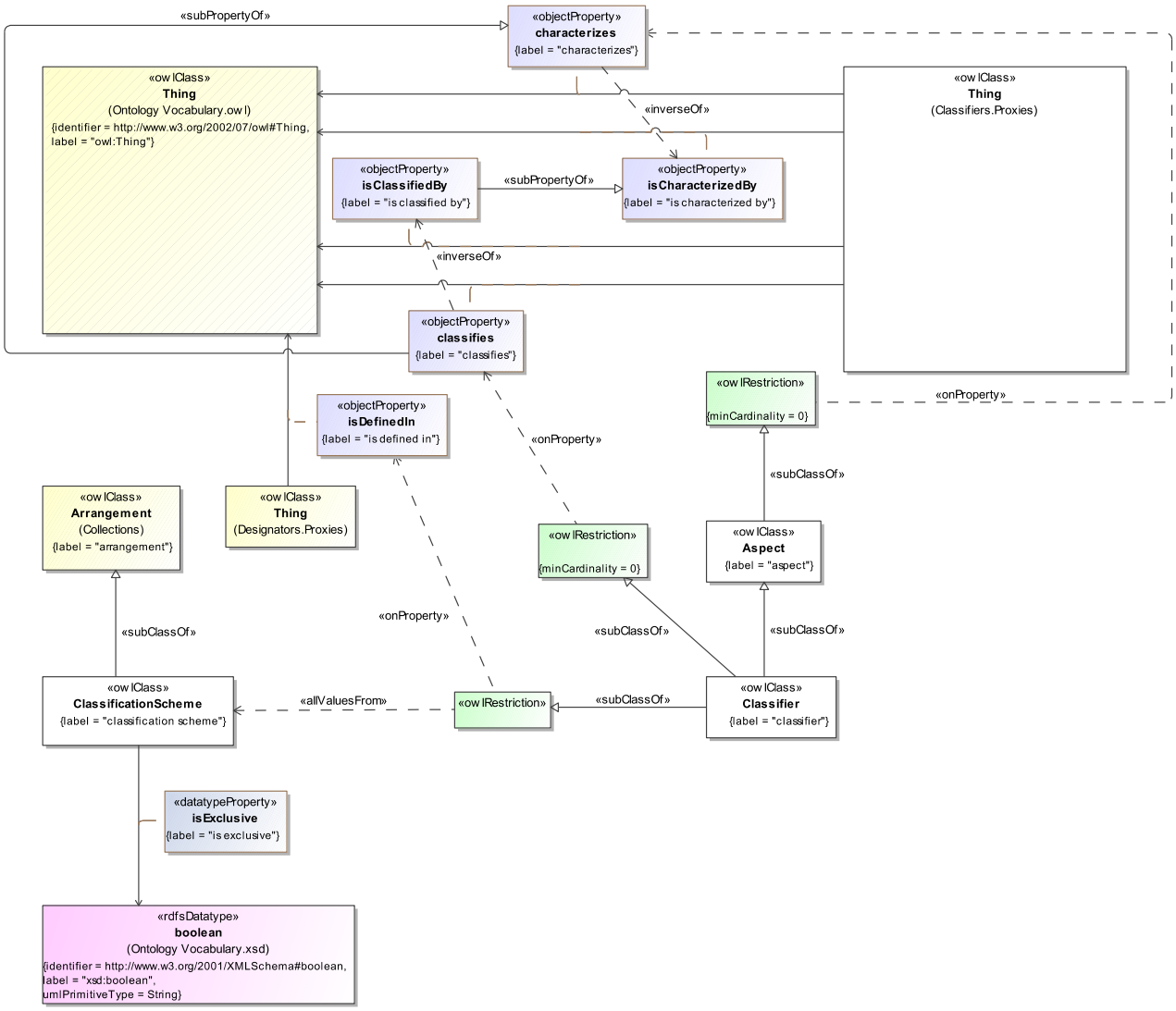

Figure 1: Overview of the Classifiers Ontology

An overview of the Classifiers ontology is given in Figure 1, above. The detailed annotations and axioms that comprise the Classifiers ontology are provided in Table 8.4, below.

Table 8.4:Classifiers Ontology Details

Classes

Name	Annotations	Class Expressions
Aspect (aspect)	Definition: characteristic or feature that can be used to dimensionalize, filter, or subset something Synonym: characteristic	Property Restriction: ≥ 0 characterizes
ClassificationScheme (classification scheme)	Definition: system for allocating classifiers to	Parent Class: cmns-col:Arrangement

	things Note: ISO 11179-3 defines a classification scheme as descriptive information for an arrangement or division of objects into groups based on criteria such as characteristics, which the objects have in common. A classification scheme may be a taxonomy, a network, an ontology, or any other terminological system. Such classification schemes are intended to permit the classification of arbitrary objects into hierarchies, or partial orders, as appropriate. The classification may also be just a list of controlled vocabulary of property words (or terms). The list might be taken from the 'leaf level' of a taxonomy. Source: ISO/IEC 11179-3 Information technology - Metadata registries (MDR) - Part 3: Registry metamodel and basic attributes, Third edition, 2013-02-15 See also: https://en.wikipedia.org/wiki/UTF-8	
Classifier (classifier)	Definition: standardized classification or delineation for something, per some scheme for such delineation, within a specified context Note: In ISO 1087, classifiers form categories of characteristics that serve as the criterion of subdivision when establishing concept systems. Example: The classifier 'color' embraces characteristics being red, blue, green, etc. The classifier 'material' embraces characteristics made of wood, metal, etc. Source: ISO/IEC 11179-3 Information technology - Metadata registries (MDR) - Part 3: Registry metamodel and basic attributes, Third edition, 2013-02-15	Parent Class: Aspect Property Restriction: ∀ isDefinedIn.ClassificationScheme Property Restriction: ≥ classifies.Thing

Properties

Name	Annotations	Property Axioms
characterizes (characterizes)	Definition: provides a discriminating feature or quality of	Parent Property: cmns-dsg:describes
classifies (classifies)	Definition: arranges in categories according to shared characteristics	Parent Property: cmns-cls:characterizes
isCharacterizedBy (is characterized by)	Definition: indicates a quality or feature of something, distinguishing it from something else	Parent Property: cmns-dsg:isDescribedBy Inverse: characterizes
isClassifiedBy (is classified by)	Definition: is systematically grouped based on characteristics by	Parent Property: cmns-cls:characterizes Inverse: classifies

isExclusive (is exclusive)	Definition: indicates that the classifiers in the scheme are all disjoint and that only one classifier may be used to classify something Usage note: This does not exclude classification by other classifiers from other schemes. It is simply a hint to users that whatever is classified by a classifier in this scheme should be classified by at most one of the classifiers in the scheme.	Domain: ClassificationScheme Range: xsd:boolean

8.3 Ontology: Codes and Code Sets

The Codes and Code Sets ontology defines commonly used concepts for describing codes, including standardized codes such as ISO language, country, and other code sets, the North American Industry Classification System (NAICS) codes, and custom code sets that many organizations develop for various purposes, derived from the patterns specified in ISO 11179-3, Metadata Registries.

Metadata for the Codes and Code Sets ontology is given in Table 8.5.

Table 8.5: Codes and Code Sets Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/CodesAndCodeSets/
rdfs:label	Commons Codes and Code Sets Ontology
dct:abstract	This ontology defines commonly used concepts for describing codes, including standardized codes such as ISO language, country, and other code sets, the North American Industry Classification System (NAICS) codes, and custom code sets that many organizations develop for various purposes, derived from the patterns specified in ISO 11179-3, Metadata Registries.
dct:contributor	Elisa Kendall, Thematix Partners LLC
dct:contributor	Pete Rivett, agnos.ai
cmns-av:copyright	Copyright (c) 2014-2022 EDM Council, Inc.
cmns-av:copyright	Copyright (c) 2014-2022 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2021-2022 agnos.ai U.K. Ltd
cmns-av:copyright	Copyright (c) 2022 Object Management Group, Inc.
dct:license	http://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20221101/CodesAndCodeSets/
skos:note	The codes and code sets ontology conforms with the OWL 2 DL semantics, and is outside of OWL 2 RL due to (1)

	imported axioms from the designations ontology, and (2) the inclusion of a local some values constraint. The latter could be removed as needed to support OWL RL rule-based applications that cannot be extended to support it.
skos:note	This ontology was originally designed for use in the OMG Languages, Countries and Codes (LCC) specification as part of the broader LanguageRepresentation ontology. The concepts have also been used in the Financial Industry Business Ontology (FIBO) for representing currency codes, market identifiers (MIC codes), codes for corporate actions, and so forth.
skos:changeNote	The https://www.omg.org/spec/Commons/20220501/CodesAndCodeSets.rdf version of this ontology was modified to make CodeSet a subclass of Arrangement (COMMONS-19) and to add a note to code set for clarity (COMMONS-26).

An overview of the Codes and Code Sets ontology is given in Figure 2.

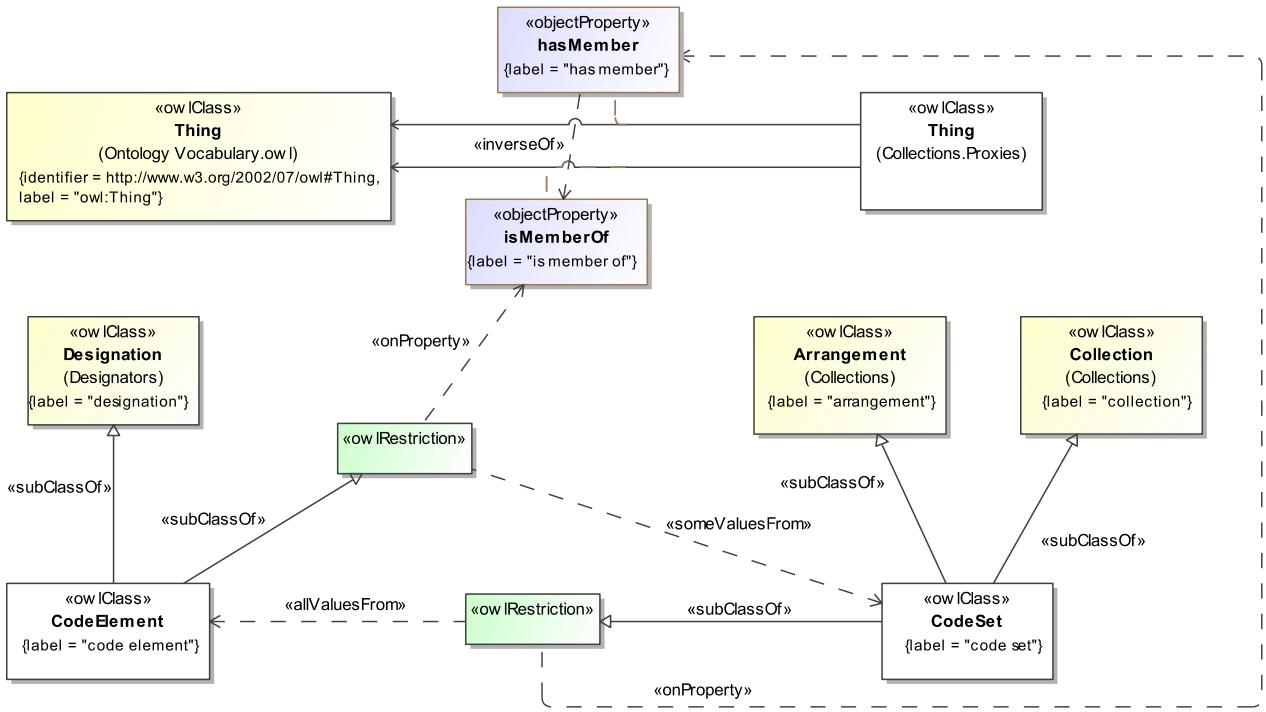

Figure 2: Overview of the Codes and Code Sets Ontology

The detailed annotations and axioms that comprise the Codes and Code Sets ontology are provided in Table 8.6, below.

Table 8.6: Codes and Code Sets Ontology Details

Classes

Name	Annotations	Class Expressions
CodeElement (code element)	Definition: sequence of characters denoting something for some purpose, within a specified context, according to some rule set Note: Note that codes may be included in multiple code lists, especially in cases where there are multiple versions of those code lists. ICD-9 and ICD-10 are examples of code sets that specify, in some cases, the same codes, but across different versions of those code sets. Example: An example of a code set that has multiple versions are the International Statistical Classification of Diseases and Related Health Problems (ICD) codes such as ICD-9, ICD-10, and so forth, that specify the same codes across multiple versions. Source: ISO/IEC 11179-3 Information technology - Metadata registries (MDR) - Part 3: Registry metamodel and basic attributes, Third edition, 2013-02-15	Parent Class: cmns-dsg:Designation Property Restriction: ∃ cmns-col:isMemberOf.CodeSet
CodeSet (code set)	Definition: system of alpha-numeric symbols, or combinations of symbols, that stand for specified values in some context Note: Note that a given code set will typically include a finite and known list of codes. Code sets may also be versioned. ICD-9 and ICD-10 are examples of code sets that specify, in some cases, the same codes, but across different versions of those code sets. Synonym: code system Source: ISO/IEC 11179-3 Information technology - Metadata registries (MDR) - Part 3: Registry metamodel and basic attributes, Third edition, 2013-02-15	Parent Class: cmns-col:Arrangement Parent Class: cmns-col:Collection Property Restriction: ∀ cmns-col:hasMember

8.4 Ontology: Collections

The collections ontology defines commonly used concepts for arrangements and schemes for organizing information and collections of things, such as structured collections that may be organized according to some scheme, and related very high level mereology relations to enable association of things with such collections and schemes.

Metadata for the Collections ontology is given in Table 8.7.

Table 8.7: Collections Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/Collections/
rdfs:label	Commons Collections Ontology
dct:abstract	The collections ontology defines commonly used concepts for arrangements and schemes for organizing information and collections of things, such as structured collections that may be organized according to some scheme, and related very high level mereology relations to enable association of things with such collections and schemes.
dct:contributor	Davide Sottara, Mayo Clinic
dct:contributor	Elisa Kendall, Thematix Partners LLC
dct:contributor	Pete Rivett, agnos.ai
cmns-av:copyright	Copyright (c) 2019-2022 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2021-2022 agnos.ai U.K. Ltd
cmns-av:copyright	Copyright (c) 2021-2022 EDM Council, Inc.
cmns-av:copyright	Copyright (c) 2021-2022 Mayo Clinic
cmns-av:copyright	Copyright (c) 2022 Object Management Group, Inc.
dct:license	http://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20221101/Collections/
skos:note	The collections ontology conforms with the OWL 2 DL semantics, and is outside of OWL 2 RL due to the inclusion of a min 0 cardinality constraint. This restriction may be removed as needed to support OWL RL rule-based applications that cannot be extended to support it.
skos:note	This ontology was originally designed for use in the OMG Languages, Countries and Codes (LCC) specification as part of the broader LanguageRepresentation ontology. The concepts have also been used in the Financial Industry Business Ontology (FIBO) for representing collections such as baskets, portfolios records, statistical universes and populations, etc., and schemes such as classification schemes and identification schemes.
skos:changeNote	The https://www.omg.org/spec/Commons/20220501/Collections.rdf version of this ontology was modified to better differentiate some of the properties that are subproperties of comprises to aid in user understanding, add new properties that allow for taxonomic parthood, and add a property allowing users to describe the intended method used with respect to arrangement (COMMONS-12).

A high-level view of the Collections ontology is provided in Figure 3.

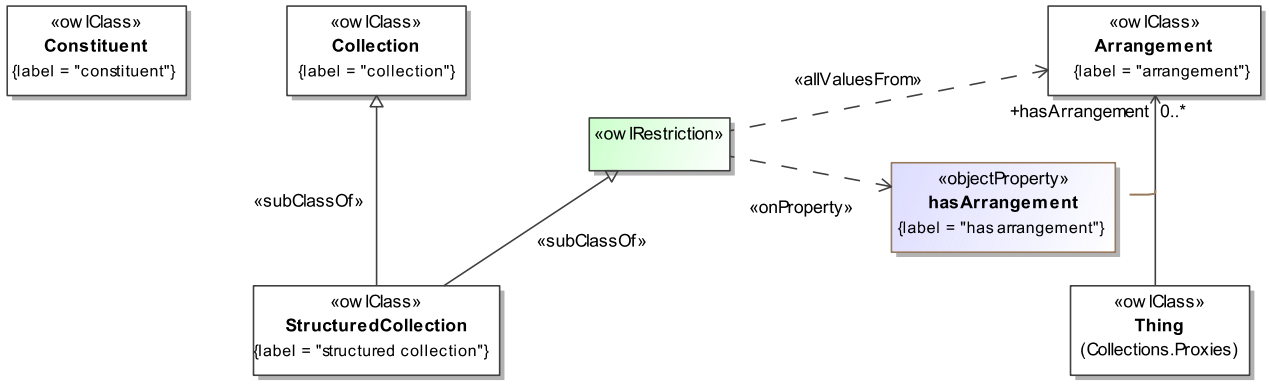

Figure 3: High-level Overview of the Collections Ontology

Figure 4, below, expands on the definition of Arrangement shown above.

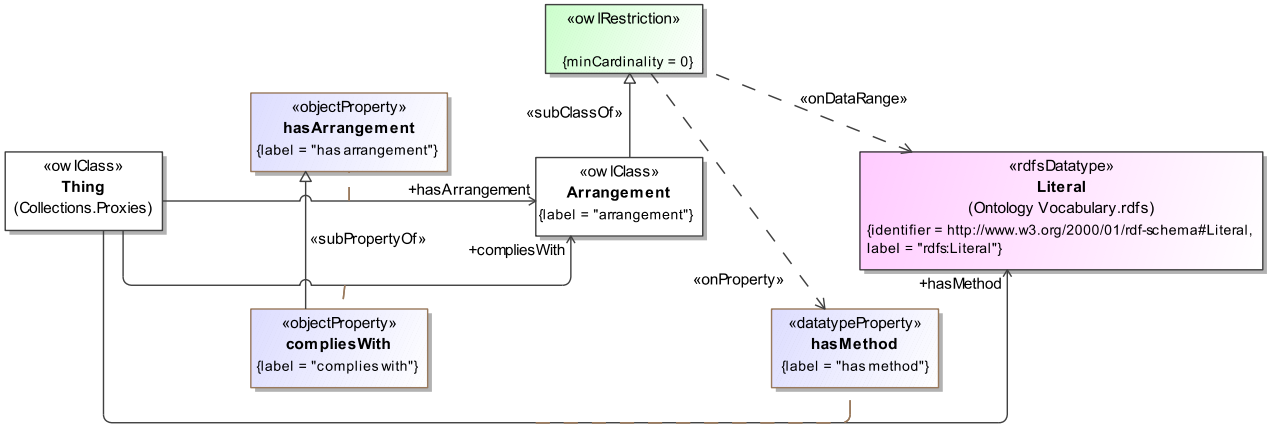

Figure 4: Expanded Arrangements Definitions

Additional mereology relationships defined in the Collections ontology are shown in Figure 5.

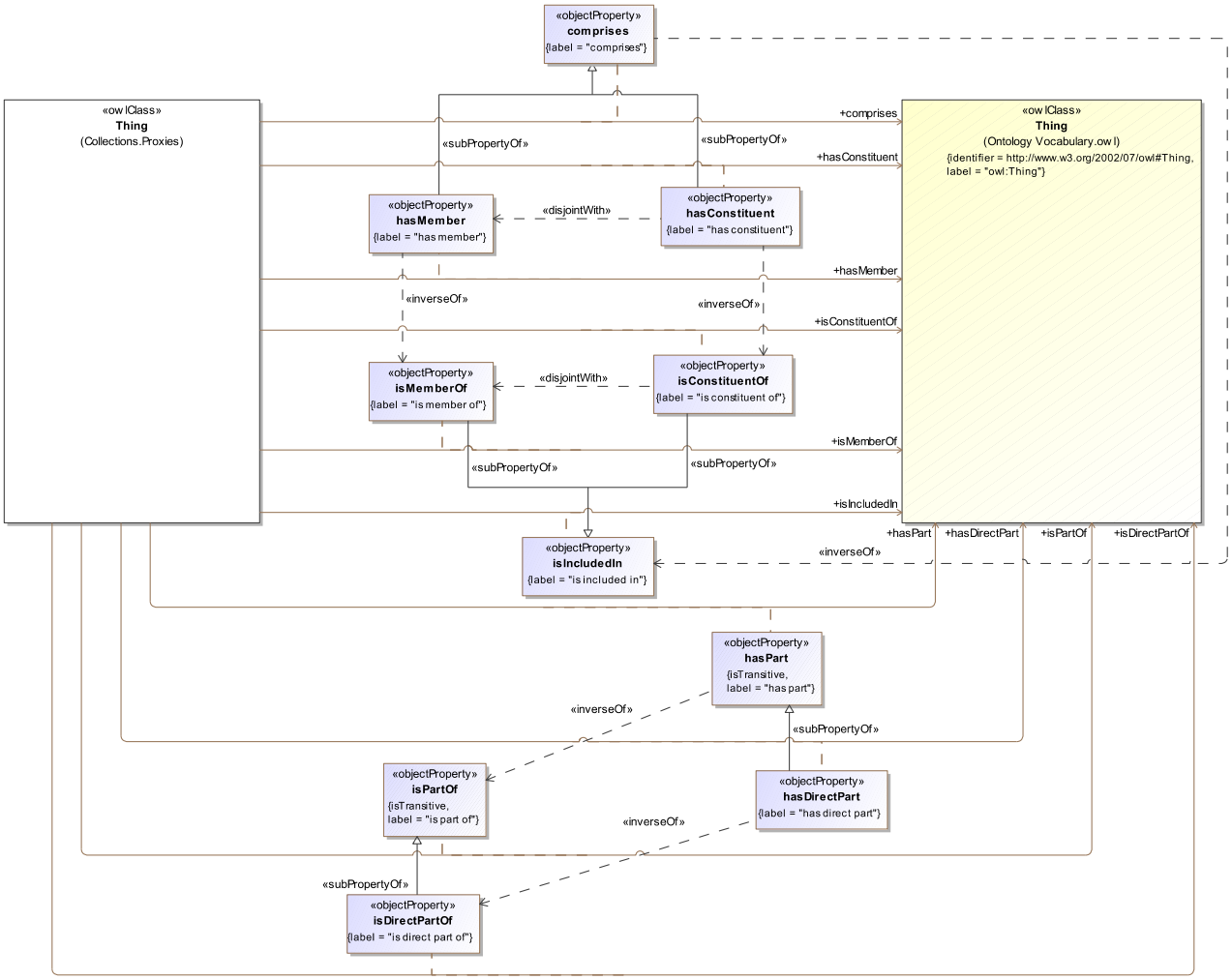

Figure 5: Mereological Relationships Defined in the Collections Ontology

The detailed annotations and axioms that comprise the Collections ontology are provided in Table 8.8, below.

Table 8.8: Collections Ontology Details

Classes

Name	Annotations	Class Expressions
Arrangement (arrangement)	Definition: systematic plan, manner, or method for making, doing, achieving, or organizing something Example: Examples include designs, schema, models, methodologies, alphabetical or numeric ordering, and the like.	Property Restriction: ≥ 0 hasMethod
Collection (collection)	Definition: grouping of things (may be zero) that have some shared significance	

	UsageNote: Users should use either comprises or hasPart, or one of their respective subproperties, to include things in a collection.	
Constituent (constituent)	Definition: component of a collection or combination of things Usage note: Users should use either isIncludedIn or isPartOf, or one of their respective subproperties, to include a constituent in a collection.	
StructuredCollection (structured collection)	Definition: collection that has a clearly defined structure or organization Example: Examples include collections organized thematically, alphabetically, by method used do develop them, according to time and/or version, or based on encoding schemes such as the Dewey Decimal System or Library of Congress Subject Headings. Usage note: Users should use the hasMethod property on arrangement to describe the methodology for structuring the collection.	Parent Class: cmns-col:Collection Property Restriction: ∀ hasArrangement.Arrangement

Properties

Name	Annotations	Property Axioms
compliesWith (complies with)	Definition: adheres to policies or rules specified in	Parent Property: hasArrangement Range: Arrangement
comprises (comprises)	Definition: includes, consists of, or contains, especially within a particular scope Note: Note that something can be comprised of something(s) that may or may not be understood as separable parts. In other words, comprises does not imply countability or uniqueness. Whole-part relations are transitive, whereas comprises is not defined to be transitive, so this property is useful in cases where cardinality constraints are needed. comprises and hasPart are not explicitly declared as disjoint to avoid reasoning issues, but should be considered as such.	
hasArrangement (has arrangement)	Definition: is structured or organized according to	Range: Arrangement
hasConstituent (has constituent)	Definition: consists of or contains Usage note: This property is disjoint with hasMember, and should be used in cases where the constituents of something are not considered discrete elements of whatever they are included in, such as a substance or composite.	Parent Property: comprises Property Axiom: ¬ hasMember
hasDirectPart (has direct part)	Definition: indicates an immediate 'child' part of something Usage note: This property is useful in cases where one is interested in the direct relationships between parts of things,	Parent Property: hasPart

	for example to build a tree view.	
hasMember (has member)	Definition: includes, as a discrete element Note: Note that the domain of hasMember should be some sort of collection, aggregate, or group. In the Financial Industry Business Ontology (FIBO), hasMember is used in the case of parties (people and organizations), whereas comprises can have anything in its range.	Parent Property: comprises
hasPart (has part)	Definition: indicates any portion of something, regardless of whether the portion itself is attached to the remainder or detached; cognitively salient or arbitrarily demarcated; self-connected or disconnected; homogeneous or gerrymandered; material or immaterial; extended or unextended; spatial or temporal Note: Note that 'has part' is not a subproperty of 'comprises' in order to enable transitivity for whole-part relationships without limiting the use of cardinality constraints on comprises and membership. Source: Stanford Encyclopedia of Philosophy at http://plato.stanford.edu/entries/mereology/	Type: owl:TransitiveProperty
isConstituentOf (is constituent of)	Definition: is a component of something else	Parent Property: isIncludedIn Inverse: hasConstituent Property Axiom: ¬ isMemberOf
isDirectPartOf (is direct part of)	Definition: indicates an immediate 'parent' of this part Usage note: This property is useful in cases where one is interested in the direct relationships between parts of things, for example to build a tree view.	Parent Property: isPartOf Inverse: hasDirectPart
isIncludedIn (is included in)	Definition: is contained in or an element of Note: Something that is included in something else may be an independently identifiable, discrete element or may be an indistinguishable element once it is combined with the target.	Inverse: comprises
isMemberOf (is member of)	Definition: is a discrete element of	Parent Property: isIncludedIn Inverse: hasMember
isPartOf (is part of)	Definition: relates something to another thing that it is some component or portion of, regardless of how that whole-part relationship is manifested Note: Note that 'is part of' is not a subproperty of 'is included in' in order to enable transitivity for whole-part relationships without limiting the use of cardinality constraints on inclusion and membership. Source: Stanford Encyclopedia of Philosophy at http://plato.stanford.edu/entries/mereology/	Type: owl:TransitiveProperty Inverse: hasPart
hasMethod (has method)	Definition: provides a text description of an approach or method used to accomplish something Example: This property can be used to describe an	Parent Property: hasTextValue

	arrangement or ordering applied to a collection.	

8.5 Ontology: Contextual Designators

The contextual designators ontology extends the designators ontology to incorporate applicable dates and times and facilitate the inclusion of other context that is commonly needed, derived in part from the patterns defined in ISO 11179-3, Metadata Registries.

Metadata for the Contextual Designators ontology is given in Table 8.9.

Table 8.9: Contextual Designators Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/ContextualDesignators/
rdfs:label	Commons Contextual Designators Ontology
dct:abstract	The contextual designators ontology extends the designators ontology to incorporate applicable dates and times and facilitate the inclusion of other context that is commonly needed, derived in part from the patterns defined in ISO 11179-3, Metadata Registries.
dct:contributor	Dean Allemang, Working Ontologist
dct:contributor	Elisa Kendall, Thematix Partners LLC
dct:contributor	Pete Rivett, agnos.ai
cmns-av:copyright	Copyright (c) 2020-2022 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2020-2022 Working Ontologist LLC
cmns-av:copyright	Copyright (c) 2022 agnos.ai U.K. Ltd
cmns-av:copyright	Copyright (c) 2022 Object Management Group, Inc.
dct:license	http://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20221101/ContextualDesignators/
skos:note	The contextual designators ontology conforms with the OWL 2 DL semantics, and is outside of OWL 2 RL due to (1) imported axioms from the designations and dates and times ontologies, and (2) the inclusion of local some values and min 0 cardinality constraints. The latter could be removed as needed to support OWL RL rule-based applications that cannot be extended to support it.
skos:changeNote	https://www.omg.org/spec/Commons/20220501/

	ContextualDesignators.rdf version of this ontology was modified to eliminate a double space in a note on ContextualName (COMMONS-6) and to require a ContextualName to have context (COMMONS-26).

An overview of the Contextual Designators ontology is given in Figure 6.

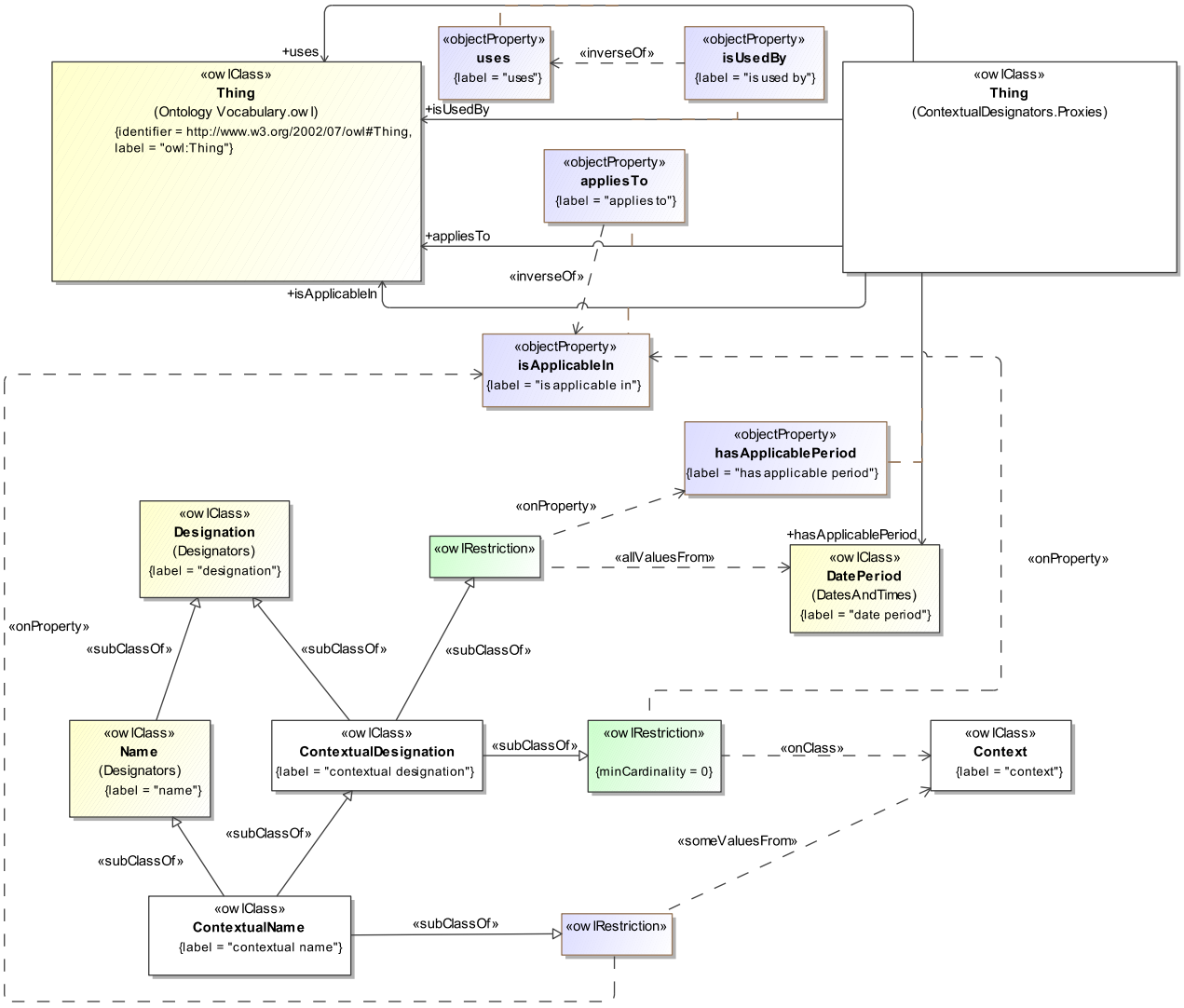

Figure 6: Overview of the Contextual Designations Ontology

The detailed annotations and axioms that comprise the Contextual Designators ontology are provided in Table 8.10, below.

Table 8.10: Contextual Designators Ontology Details

Classes

Name	Annotations	Class Expressions
Context (context)	Definition: situation or frame of reference in which something applies, exists, happens, or is used and that helps to illustrate or explain it Note: From a terminology perspective, context provides information, including but not limited to text, that illustrates a concept or the use of a designation for a given situation. Source: ISO 1087 Terminology work and terminology science - Vocabulary, Second edition, 2019-09, clause 3.6.5 Source: ISO/IEC 11179-3 Information technology - Metadata registries (MDR) - Part 3: Registry metamodel and basic attributes, Third edition, 2013-02-15	
ContextualDesignation (contextual designation)	Definition: designation that applies to something in some context Note: Contextual designators may be structured such that they include other designators, for example, composite identifiers that include a country code to distinguish national identifiers from one another, for example, in the case of some manufacturing, agricultural, or financial instrument identifiers. Note: Note that the use of the min 0 cardinality restriction in the definition of this class is provided as a reminder that contextual designators are expected, in most cases, to have some sort of context associated with them. There may be cases where the context is limited to a time period, though, and thus additional context may not be required, or where more direct relationships to provenance, governance, or other contextual information is available.	Parent Class: cmns-dsg:Designation Property Restriction: ∀ hasApplicablePeriod.cmns-dt:DatePeriod Property Restriction: ≥ 0 isApplicableIn.Context
ContextualName (contextual name)	Definition: designation by which someone, some place, or something is known in some context Note: Names for people may be considered to be personally identifying information (PII), especially when other details are also available. Specifying names as string values attached directly to an individual makes name reconciliation and management, including from a privacy perspective, more challenging. Note: Names of people, places, and organizations often change over time, and may be used in a particular context, such as a DBA name for a business or legal name for a person. Note: This class is designed to be extended to include provenance details regarding the source for a particular name as well as links to the	Parent Class: ContextualDesignation, cmns-dsg:Name Property Restriction: ∃ isApplicableIn.Context

	various contexts in which it is used.	

Properties

Name	Annotations	Property Axioms
appliesTo (applies to)	Definition: indicates something for which a context is material, germane, or relevant in some way	
hasApplicablePeriod (has applicable period)	Definition: indicates a date period during which something may be used, applies, is valid or is accurate or relevant	Parent Property: isApplicableIn, cmns-dt:hasDatePeriod Range: cmns-dt:DatePeriod
isApplicableIn (is applicable in)	Definition: indicates a context in which something is relevant	Inverse: appliesTo
isUsedBy (is used by)	Definition: is employed in the process of accomplishing something for	Inverse: uses
uses (uses)	Definition: employs as a means of accomplishing some task or achieving some result	

8.6 Ontology: Contextual Identifiers

The contextual identifiers ontology defines commonly used concepts for describing more complex identifiers, including those that apply for some period of time as well as those that are structured and include other codes or identifiers.

Metadata for the Contextual Identifiers ontology is given in Table 8.11.

Table 8.11: Contextual Identifiers Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/ContextualIdentifiers/
rdfs:label	Commons Contextual Identifiers Ontology
dct:abstract	The contextual identifiers ontology defines commonly used concepts for describing more complex identifiers, including those that apply for some period of time as well as those that are structured and include other codes or identifiers.
dct:contributor	Elisa Kendall, Thematix Partners LLC
dct:contributor	Evan Wallace, U.S. National Institute of Standards and Technology (NIST)
cmns-av:copyright	Copyright (c) 2022 Thematix Partners LLC

cmns-av:copyright	Copyright (c) 2022 Object Management Group, Inc.
dct:license	http://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20221101/ContextualIdentifiers/
skos:changeNote	https://www.omg.org/spec/Commons/20220501/ContextualIdentifiers.rdf version of this ontology was modified to add a ContextualIdentificationScheme and require a ContextualIdentifier to have context (COMMONS-26).

An overview of the Contextual Identifiers ontology is given in Figure 7.

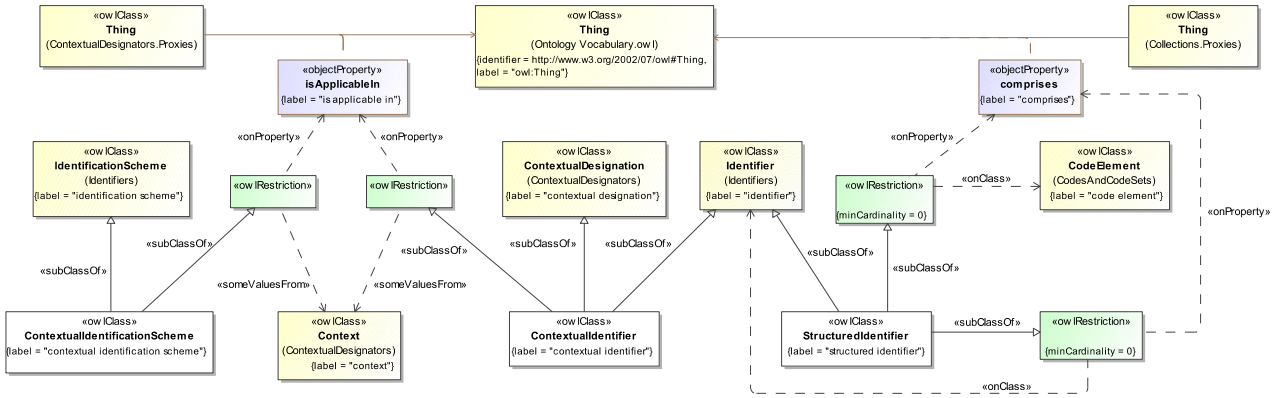

Figure 7: Overview of the Contextual Identifiers Ontology

The detailed annotations and axioms that comprise the Contextual Identifiers ontology are provided in Table 8.12, below.

Table 8.12: Contextual Identifiers Ontology Details

Classes

Name	Annotations	Class Expressions
ContextualIdentificationScheme (contextual identification scheme)	Definition: identification scheme that applies within one or more contexts	Parent Class: cmns-id;IdentificationScheme Property Restriction: ∃ isApplicableIn.Context
ContextualIdentifier (contextual identifier)	Definition: sequence of characters uniquely identifying that with which it is associated, within a specified context Note: The context within which an identifier is unique may be limited to a given data source, registry or jurisdiction, or may be designed to be globally unique such as a legal entity identifier	Parent Class: cmns-cxtdsg:ContextualDesignation, cmns-id:Identifier

	issued by a registrar authorized by the Global LEI Foundation. Such identifiers may have other features associated with them, such as the date they were originally issued, and information related to registration, validation, recency, and so forth.	
StructuredIdentifier (structured identifier)	Definition: sequence of characters uniquely identifying that with which it is associated, that includes other codes or identifiers, or that is constructed from other notions Note: Many structured identifiers can be validated using a regular expression, such as a social security number in the United States. Example: A vehicle identification number (VIN) includes a world-wide manufacturer identifier, a vehicle description (*i.e.*, make, model), check digits, the year, plant and a specific vehicle number. Example: An international security identification number (ISIN) includes a country code and the national security identification number (NSIN), as defined in ISO 6166.	Parent Class: cmns-id:Identifier Property Restriction: ≥ 0 cmns-col:comprises.cmns-cds:CodeElement Property Restriction: ≥ 0 cmns-col:comprises.cmns-id:Identifier

8.7 Ontology: Dates and Times

The dates and times ontology defines commonly used temporal concepts that cover those most frequently needed across domains, with a focus on terminology that is used in business applications. It is designed to be mappable to other date and time ontologies and specifications, such as the W3C Time Ontology in OWL[5], certain temporal elements in the Basic Formal Ontology (BFO 2020)[6], time concepts defined in schema.org, and the OMG's Date Time Vocabulary (DTV) specification[7], without the corresponding overhead or in some cases, issues. The concepts were originally derived from a number of date and time standards including ISO 8601:2004 Representation of Dates and Times. The ontology itself was derived from the Financial Industry Business Ontology (FIBO) Financial Dates ontology, with minor revisions to better reflect requirements for mapping to other ontologies.

Metadata for the Dates and Times ontology is given in Table 8.13.

Table 8.13: Dates and Times Ontology Metadata

Metadata Term	Value
`OntologyIRI`	`https://www.omg.org/spec/Commons/DatesAndTimes/`
`rdfs:label`	`Commons Dates and Times Ontology`
`dct:abstract`	`The dates and times ontology defines commonly used temporal concepts that cover those most frequently needed`

[5] See https://www.w3.org/TR/owl-time/

[6] See https://basic-formal-ontology.org/bfo-2020.html

[7] Available at https://www.omg.org/spec/DTV/

	across domains, with a focus on terminology that is used in business applications. It is designed to be mappable to other date and time ontologies and specifications, such as the W3C Time Ontology in OWL (available at https://www.w3.org/TR/owl-time/), certain temporal elements in BFO 2020 (see https://basic-formal-ontology.org/bfo-2020.html), time concepts defined in schema.org, and the Object Management Group's Date Time Vocabulary (DTV) specification (available at https://www.omg.org/spec/DTV/), without the corresponding overhead or in some cases, issues. The concepts were originally derived from a number of date and time standards including ISO 8601:2004 Representation of Dates and Times. The ontology itself was derived from the Financial Industry Business Ontology (FIBO) Financial Dates ontology, with minor revisions to better reflect requirements for mapping to other ontologies.
dct:contributor	Elisa Kendall, Thematix Partners LLC
dct:contributor	Mark Linehan, Thematix Partners LLC
dct:contributor	Pete Rivett, agnos.ai
cmns-av:copyright	Copyright (c) 2014-2023 EDM Council, Inc.
cmns-av:copyright	Copyright (c) 2014-2023 Object Management Group, Inc.
cmns-av:copyright	Copyright (c) 2014-2023 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2021-2023 agnos.ai U.K. Ltd
dct:license	http://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20230801/DatesAndTimes/
skos:note	The dates and times ontology conforms with the OWL 2 DL semantics, and is outside of OWL 2 RL due to the inclusion of exact cardinality constraints on explicit date, explicit duration and time of day. These constraints can be changed to maximum cardinality constraints if needed to support OWL RL rule-based applications that cannot be extended to support them.
skos:changeNote	The https://www.omg.org/spec/Commons/20221101/DatesAndTimes.rdf version of this ontology was revised to add properties supporting start and end time and related concepts (COMMONS-11-3).

The class hierarchy for the Dates and Times ontology is shown in Figure 8.

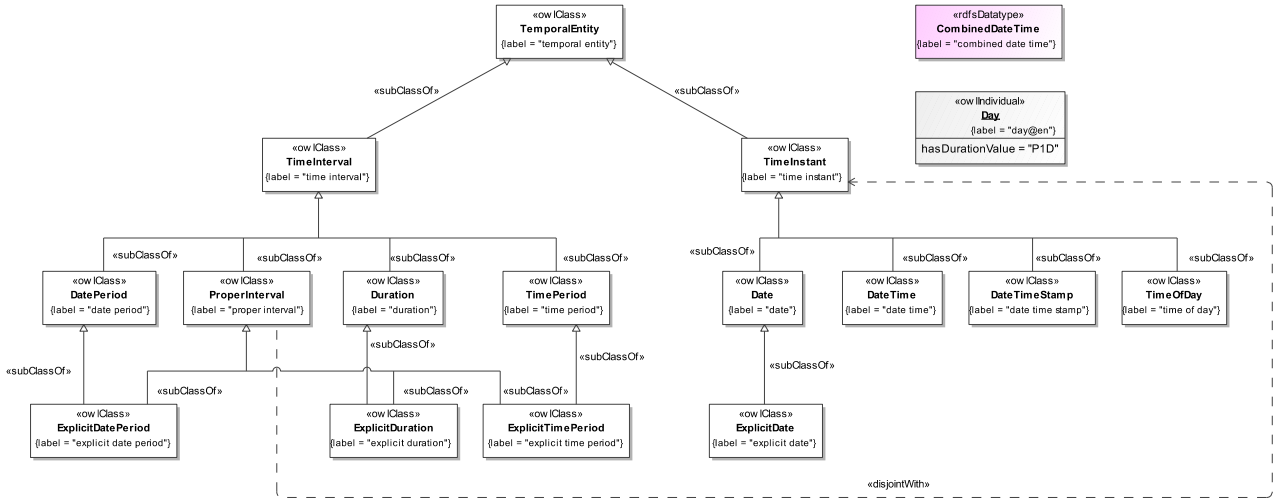

Figure 8: Class Hierarchy for the Dates and Times Ontology

The detailed annotations and axioms that comprise the Dates and Times ontology are provided in Table 8.14, below.

Table 8.14: Dates and Times Ontology Details

Classes

Name	Annotations	Class Expressions
Date (date)	Definition: calendar day on some calendar Note: A date may or may not have a value, and may be explicit or calculated. A date that has a value is one that is either explicitly set as a literal when it is created, or is some form of 'calculated date'. In an instance of date, the existence of the 'has date value' property both indicates that the date is known, and gives the value of the date. A date that does not have a value is likely one that is some form of 'calculated date', in which the actual date has not (yet) been established.	Parent Class: TimeInstant Property Restriction: ≤ 1 hasDateValue.xsd:string
DatePeriod (date period)	Definition: time span over one or more calendar days Note: A date period is defined by at least two of three properties: (1) a start date, (2) an end date, and (3) a duration. If more than one of these properties is missing, the date period may be invalid or unknown. Note: A date period is unknown if either the start date or the end date has no value. If a date period is unknown, then the duration should either be	Parent Class: TimeInterval Property Restriction: ≤ 1 hasEndDate.Date Property Restriction: ≤ 1 hasStartDate.Date Property Restriction: ≤ 1 hasDuration.Duration

	omitted or unknown (have no value).	
DateTime (date time)	Definition: time point including a date and a time, optionally including a time zone offset Note: 'has date time value' is omitted if the 'date time' is not (yet) known. The time zone is implicitly GMT.	Parent Class: TimeInstant Property Restriction: ≤ 1 hasDateTimeValue.xsd:dateTime
DateTimeStamp (date time stamp)	Definition: time point including a date and a time that requires a time zone offset Note: 'has date time stamp value' is omitted if the 'date time stamp' is not (yet) established.	Parent Class: TimeInstant Property Restriction: ≤ 1 hasDateTimeStampValue.xsd:dateTimeStamp
Duration (duration)	Definition: interval of time of some specific length Note: The 'has duration value' property is absent if the duration is not (yet) known.	Parent Class: TimeInterval Property Restriction: ≤ 1 hasDurationValue.xsd:string
ExplicitDate (explicit date)	Definition: date in which the 'has date value' property is required	Parent Class: Date Property Restriction: = 1 hasDateValue.xsd:string
ExplicitDatePeriod (explicit date period)	Definition: date period for which the start date, end date, and/or duration are required Note: As with 'date period', any one of {start date, end date, duration} may be omitted because the missing property can be inferred from the other two.	Parent Class: DatePeriod, ProperInterval Property Restriction: ≤ 1 hasEndDate.ExplicitDate Property Restriction: ≤ 1 hasStartDate.ExplicitDate Property Restriction: ≤ 1 hasDuration.ExplicitDuration
ExplicitDuration (explicit duration)	Definition: duration for which the 'has duration value' property must have a value Note: This class is used when a duration is guaranteed to be known when it is created.	Parent Class: Duration, ProperInterval Property Restriction: = 1 hasDurationValue.xsd:string
ExplicitTimePeriod (explicit time period)	Definition: time period for which the starting time, ending time, and/or duration are required Note: As with 'time period', any one of {start time, end time, duration} may be omitted because the missing property can be inferred from the other two.	Parent Class: ProperInterval, TimePeriod Property Restriction: ≤ 1 hasDuration.ExplicitDuration Property Restriction: ≤ 1 hasEndTime.TimeOfDay Property Restriction: ≤ 1 hasStartTime.TimeOfDay
ProperInterval (proper interval)	Definition: time interval with a non-zero extent or duration Note: Proper interval is included explicitly to enable mapping to the same term in the Time Ontology in OWL for use with the Allen intervals encoded therein. Source: https://www.w3.org/TR/owl-time/#time:ProperInterval	Parent Class: TimeInterval Class Axiom: ¬ TimeInstant

TemporalEntity (temporal entity)	Definition: time interval or instant See also: http://www.w3.org/2006/time#TemporalEntity	
TimeInstant (time instant)	Definition: temporal entity that is a member of a time scale, with no extent or duration Synonym: instant in time Synonym: time point Adapted from: https://www.omg.org/spec/DTV/ Adapted from: https://www.w3.org/TR/owl-time/#time:Instant Example: The Battle of Hastings was on '14 October 1066'. (This gives the Julian date of the battle at a granularity of 'day'. If desired, the battle could be given more precisely as a time period within that calendar day.) Note: For scales that have a granularity specified in days, a date is a time point; for scales down to the seconds, the equivalent of an xsd:dateTime or xsd:dateTimeStamp is a time point. Note: The duration of each time interval that is an instance of the time point is the granularity of the time scale of the time point.	Parent Class: TemporalEntity
TimeInterval (time interval)	Definition: segment of the time axis, a location in time, with an extent or duration Adapted from: https://www.omg.org/spec/DTV/ Adapted from: https://www.w3.org/TR/owl-time/#time:Interval Example: the day whose Gregorian calendar date is September 11, 2001 Example: the lifetime of Henry V Note: Every time interval has a beginning, an end, and a duration, even if not known. Every time interval is 'finite', a bounded segment of the time axis. The beginning or end of a time interval may be defined by reference to events that occur for a time interval that is not known. Note: Time intervals may be indefinite, meaning that their beginning is primordiality or their end is perpetuity, or both (eternity). This vocabulary assumes that indefinite time intervals exist and have some duration, but their duration is unknown.	Parent Class: TemporalEntity
TimeOfDay (time of day)	Definition: explicit time, according to a clock Note: The representation similar to xsd:dateTime, but should exclude the date component and time zone. The value of the has time value property roughly corresponds to xsd:time in XML schema datatypes, which is prohibited from use in OWL due to ambiguity in	Parent Class: TimeInstant Property Restriction: = 1 hasTimeValue.xsd:string

	its definition.	
TimePeriod (time period)	Definition: time span over some finite window Note: A time period is defined by at least two of three properties: (1) a start time, (2) an end time, and (3) a duration. If more than one of these properties is missing, the time period may be invalid or unknown. Note: A time period is unknown if either the starting or ending time has no value. If a time period is unknown, then the duration should either be omitted or unknown (have no value).	Parent Class: TimePeriod Property Restriction: ≤ 1 hasDuration.ExplicitDuration Property Restriction: ≤ 1 hasEndTime.TimeOfDay Property Restriction: ≤ 1 hasStartTime.TimeOfDay

Datatypes

Name	Annotations	Class Expressions
CombinedDateTime (combined date time)	Definition: datatype that maps to several base types for dates and times Note: Valid values must use the ISO 8601 representation for a date, or the corresponding XML Schema Datatypes representation for a date and time, or date and time including the time zone. Scope Note: There are many cases where the representation of a date may or may not include a time, and where the underlying data representation varies. This composite datatype should only be used in cases where a standard representation using one of the options in the union for date or date and time value specification does not work.	Equivalent Datatype: ∪ (xsd:string, xsd:dateTime, xsd:dateTimeStamp)

Individuals

Name	Annotations	Individual Axioms
Day (day)	Definition: explicit period of 24 hours	Type: ExplicitDuration hasDurationValue = 'P1D'

Properties

Name	Annotations	Property Axioms
hasDate (has date)	Definition: identifies a calendar day, month and year	Parent Property: hasTime Range: Date
hasDateOfIssuance (has date of issuance)	Definition: links something, such as an agreement, contract, license, or report, to the date it was made available	Type: FunctionalProperty Parent Property: hasStartDate

		Range: Date
hasDatePeriod (has date period)	Definition: identifies a specific window of time, including a start date, end date and/or duration	Parent Property: hasTime Range: DatePeriod
hasDateTime (has date time)	Definition: identifies a specific date and time of day, possibly excluding the time zone	Parent Property: hasTime Range: DateTime
hasDateTimeStamp (has date time stamp)	Definition: identifies a specific date and time of day, explicitly including the time zone	Parent Property: hasTime Range: DateTimeStamp
hasDateTimeStampValue (has date time stamp value)	Definition: specifies an actual literal (explicit) date and time, including the time zone	Range: xsd:dateTimeStamp
hasDateTimeValue (has date time value)	Definition: specifies an actual literal (explicit) date and time	Range: xsd:dateTime
hasDateValue (has date value)	Definition: specifies an actual literal (explicit) date captured in the format specified for xsd:date (i.e., ISO 8601 format), WITHOUT the time or timezone information; the semantics are identical to those of xsd:date Example: 2002-10-10 means October 10, 2002 Note: In the Finance domain, for consistency with FpML (reference FpML Coding Schemes 30 June 2014, Version 1.56, section 2.1.1), the year MUST be specified as 4 digits, and the month and day MUST be specified as 2 digits with a leading zero if needed. Times and timezones should NOT be specified.	Range: xsd:string
hasDuration (has duration)	Definition: specifies the time during which something continues Note: This duration may be omitted or unknown if either the start or end Date of the DatePeriod is an ExplicitDate.	Parent Property: hasTime Range: Duration
hasEnd (has end)	Definition: indicates the final or ending time point associated with something	Parent Property: hasTime Range: TimeInstant
hasDurationValue (has duration value)	Definition: specifies a literal (explicit) duration (amount of time) captured in the format specified for xsd:duration (*i.e.*, ISO 8601 format); the semantics are identical to those of xsd:duration Example: -P3D means negative 3 days duration. This is used with OffsetDates to specify 3 days before (prior) to some other Date. Example: P1Y means 1 year Example: P1Y2M3DT4H5M6S means 1 year, 2 months, 3 days, 4 hours, 5 minutes, 6 seconds Example: P2M means 2 months Example: P3D means 3 days Example: PT4H means 4 hours Example: PT5M means 5 minutes Example: PT6S means 6 seconds	Domain: Duration Range: xsd:string

	Note: Negative durations are used to indicate relative dates that are before (rather than after) some other Date.	
hasEndDate (has end date)	Definition: indicates the final or ending date associated with something	Parent Property: hasDate, hasTime Range: Date
hasEndTime (has end time)	Definition: indicates the final or ending time associated with something Usage note: Use the property 'hasTimeValue' as a property of the TimeOfDay to record the actual time, or use either the DateTime or DateTimeStamp class with the date zeroed out if the date is not relevant but with the time included.	Parent Property: hasEnd Range: TimeOfDay
hasExplicitDate (has explicit date)	Definition: indicates a stated date, as opposed to a calculated or unknown date, associated with something	Parent Property: hasDate Range: ExplicitDate
hasObservedDateTime (has observed date time)	Definition: indicates a date and time associated with an event, measurement, record, or observation	Range: CombinedDateTime
hasStart (has start)	Definition: indicates the initial time point associated with something	Parent Property: hasTime Range: TimeInstant
hasStartDate (has start date)	Definition: indicates the initial date associated with something	Parent Property: hasDate, hasTime Range: Date
hasStartTime (has start time)	Definition: indicates the initial or starting time associated with something Usage note: Use the property 'hasTimeValue' as a property of the TimeOfDay to record the actual time, or use either the DateTime or DateTimeStamp class with the date zeroed out if the date is not relevant but with the time included.	Parent Property: hasEnd Range: TimeOfDay
hasTime (has time)	Definition: specifies a general time that can be associated with any element Note: This property corresponds to the property of the same name in the W3C Time Ontology, and can be used to support mapping. See also: https://w3c.github.io/sdw/time/#time:hasTime	Range: TemporalEntity
hasTimePeriod (has time period)	Definition: identifies a specific window of time, including a starting time, ending time and/or duration	Parent Property: hasTime Range: TimePeriod
hasTimeValue (has time value)	Definition: specifies an explicit time, captured in the format specified for xsd:time (*i.e.*, ISO 8601 format), WITHOUT the date or timezone information	Range: xsd:string
precedes (precedes)	Definition: associates based on prior spatial or temporal proximity; occurs before in a logical order or sequence Source: ISO 1087 Terminology work and terminology science - Vocabulary, Second edition, 2019-09, clause 3.2.24	
succeeds (succeeds)	Definition: associates based on subsequent spatial or temporal	Inverse: precedes

	proximity; follows in a logical order or sequence Source: ISO 1087 Terminology work and terminology science - Vocabulary, Second edition, 2019-09, clause 3.2.24	

8.8 Ontology: Designators

The designators ontology defines commonly used concepts for naming, derived in part from the patterns defined in ISO 1087 for terminology work and ISO 11179-3, Metadata Registries. It includes several very high level semiotic relationships, including defines, describes, and denotes for associating designators with the concepts they reference.

Metadata for the Designators ontology is given in Table 8.15.

Table 8.15: Designators Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/Designators/
rdfs:label	Commons Designators Ontology
dct:abstract	The designators ontology defines commonly used concepts for naming, derived in part from the patterns defined in ISO 1087 for terminology work and ISO 11179-3, Metadata Registries. It includes several very high level semiotic relationships, including defines, describes, and denotes for associating designators with the concepts they reference.
dct:contributor	Davide Sottara, Mayo Clinic
dct:contributor	Dean Allemang, Working Ontologist
dct:contributor	Elisa Kendall, Thematix Partners LLC
dct:contributor	Pete Rivett, agnos.ai
cmns-av:copyright	Copyright (c) 2014-2022 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2021-2022 Mayo Clinic
cmns-av:copyright	Copyright (c) 2021-2022 Working Ontologist LLC
cmns-av:copyright	Copyright (c) 2021-2022 agnos.ai U.K. Ltd
cmns-av:copyright	Copyright (c) 2022 Object Management Group, Inc.
dct:license	http://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20221101/Designators/
skos:note	The designators ontology conforms with the OWL 2 DL semantics, and is outside of OWL 2 RL due to the inclusion

	of one minimum cardinality constraint (which is tyically ignored, but is important - see note on the Designator class) and two value restrictions. These constraints can be removed if required to support OWL RL rule-based applications that cannot be extended to support them.
skos:changeNote	The https://www.omg.org/spec/Commons/20220501/Designators.rdf version of this ontology was modified to eliminate a double space in the abstract and a note on Designation (COMMONS-6) and to clarify the definition of designation, denotes, and name, and better align them with ISO 704 / ISO 1087 (COMMONS-26).

An overview of the Designators ontology is given in Figure 9.

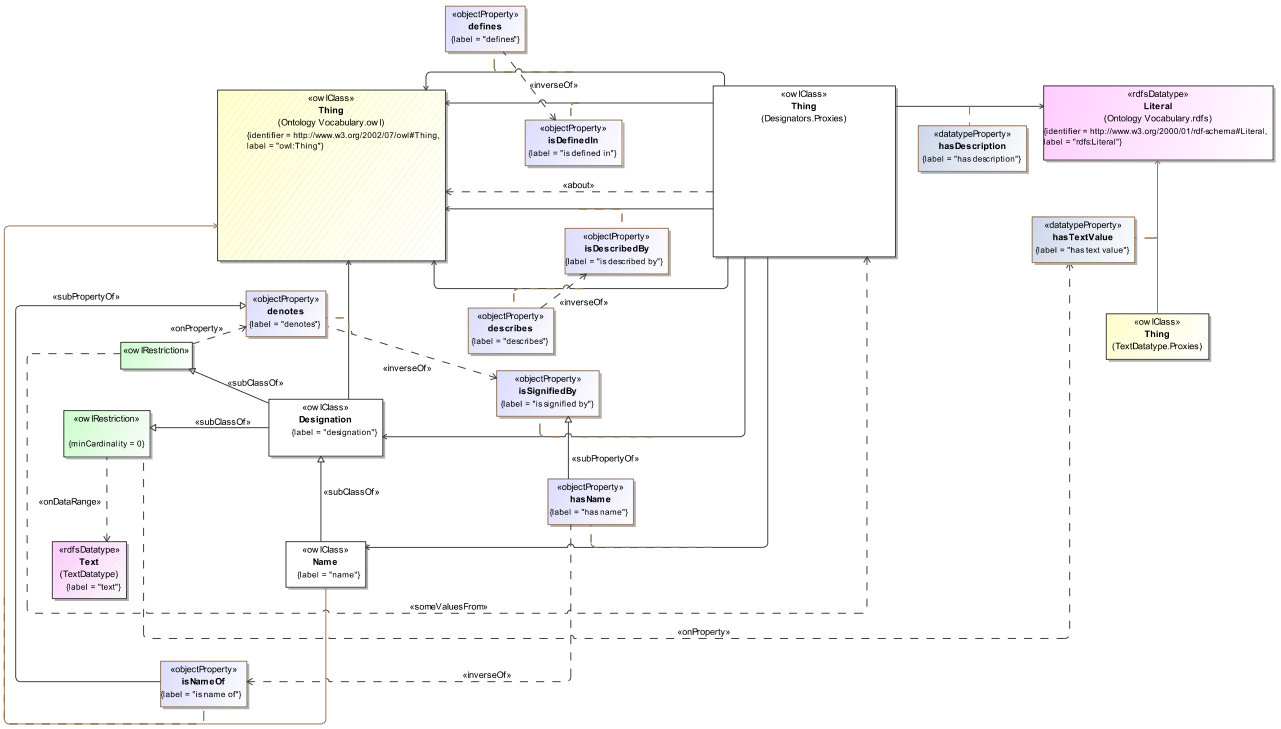

Figure 9: Overview of the Designators Ontology

The detailed annotations and axioms that comprise the Designators ontology are provided in Table 8.16, below.

Table 8.16: Designators Ontology Details

Classes

Name	Annotations	Class Expressions
Designation (designation)	Definition: representation for something, or for a conceptualization thereof, that denotes it in a domain or subject Note: A designation can be a term including appellations, a proper name, or a symbol. Note: A designation can be linguistic or non-linguistic. It can consist of various types of characters, but also punctuation marks such as hyphens and parentheses, governed by domain-, subject-, or language-specific conventions. Note: Note that the use of the min 0 cardinality restriction in the definition of this class is provided as a reminder that designators are expected, in many cases, to have a text value associated with them. There are cases where this is not true, however, including symbols. And, there may be cases where the value is not known. Additionally, not all tools support rdf:langString, thus its use in the definition of the Text datatype may cause errors, for example in value and some number restrictions. Min 0 cardinality constraints are ignored by reasoners and other processors, so this allows us to say that the possible values for this property are likely either xsd:string or rdf:langString, but does not require it depending on the environment in which the ontology is deployed. Synonym: designator Adapted from: ISO 1087 Terminology work and terminology science - Vocabulary, Second edition, 2019-09, clause 3.4.1 Adapted from: ISO 704 Terminology work - Principles and methods, Fourth edition, 2022-07, Figure 1	Property Restriction: ≥ 0 cmns-txt:hasTextValue.cmns-txt:Text Property Restriction: ∃ denotes.owl:Thing
Name (name)	Definition: designation for something by a linguistic expression Note: In ISO 1087, a name may be an appellation and is defined as a term that is applied to a group of objects whose relevant properties are identical, whereas a proper name is a designation that represents an individual object. Explanatory note: Note that unlike symbols and other designations, a name is explicitly not linguistically neutral. Adapted from: ISO/IEC 11179-3 Information technology - Metadata registries (MDR) - Registry metamodel and basic attributes, Third edition, 2013-02-15, clause 3.2.83	Parent Class: Designation Property Restriction: ∃ isNameOf.owl:Thing

Properties

Name	Annotations	Property Axioms
defines (defines)	Definition: specifies the meaning of something in terms of one or more of its essential qualities Note: A quality is an elementary characteristic of something. An 'essential quality' is one that provides a necessary criteria for being that thing and differentiating criteria for not being something else. See also: https://plato.stanford.edu/entries/definitions/	Inverse: isDefinedIn
denotes (denotes)	Definition: serves as a sign for something, or for a conceptualization thereof Note: Note that in some references, such as the semiotics ontology from Ontology Design Patterns, 'denotes' can be used to talk about, *e.g.*, entities denoted by proper nouns: the proper noun 'Leonardo da Vinci' denotes the person Leonardo da Vinci; as well as to talk about sets of entities that can be described by a common noun: the common noun 'person' denotes the collection of all persons in a domain of discourse. Other references that may be useful for interpreting 'denotes' include OntoLex. The interpretation of 'denotes' in this context is more general, but intended to reflect its usage in the semiotic triangle. See also: http://www.ontologydesignpatterns.org/cp/owl/semiotics.owl# See also: https://www.w3.org/2016/05/ontolex/ Scope note: This property could be specialized to differentiate the notion of referring to something, i.e., a referent, from the notion of evoking a concept. Consider that in OntoLex, the term denotes is used to designate the sign referent relationship specifically, which in ISO 704:2022 is called 'refers to' in Figure 1. This definition is also meant to cover the OntoLex notion of evokes, which in ISO 704:2022 is called designates or represents. Adapted from: ISO 1087 Terminology work and terminology science - Vocabulary, Second edition, 2019-09, clause 3.4.1 Adapted from: ISO 704 Terminology work - Principles and methods, Fourth edition, 2022-07, Figure 1	Domain: Designation
describes (describes)	Definition: conveys the nature of	Inverse: isDescribedBy
hasDescription (has description)	Definition: provides a textual statement, picture in words, or account that describes something Note: Note that the hasDescription property defined herein has an implicit range of rdfs:Literal. This is purposeful, so that users can specify any element that has a name with or without a language tag without concern for conflicting datatypes (*i.e.*, xsd:string vs. rdf:langString, which are logically disjoint).	Parent Property: cmns-txt:hasTextValue
hasName (has name)	Definition: is known by	Parent Property: isSignifiedBy Range: Name

		Inverse: isNameOf
isDefinedIn (is defined in)	Definition: indicates something that specifies the meaning associated with the subject Note: Typically, a concept, such as a classifier or identifier, will be defined in terms of a scheme, contract, specification, standard, or other reference.	
isDescribedBy (is described by)	Definition: has general nature or description of	
isNameOf (is name of)	Definition: denotes in some context	Parent Property: denotes Domain: Name
isSignifiedBy (is signified by)	Definition: has representation, denotation or sign	Range: Denotation Inverse: denotes

8.9 Ontology: Documents

The documents ontology defines a high-level concept of a document, and a similarly high-level notion of a reference, which may or may not be a document. Subordinate concepts include legal document, certificate, notice, reference document, and specification. A document in this ontology refines the FRBR (Functional Requirements for Bibliographic Records[8]) notion of an Expression, and aligns well with and can be mapped to FRBR, more recent work by the International Federation of Library Associations and Institutions[9] (IFLA), and other bibliographic ontologies. The conceptualization provided in the Documents ontology is designed primarily for mapping purposes, and to provide the hooks required for representation of references, such as those needed for defining quantities and units.

Metadata for the Documents ontology is given in Table 8.17.

Table 8.17: Documents Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/Documents/
rdfs:label	Commons Documents Ontology
dct:abstract	This ontology defines high-level concepts for representation of documents, including legal documents and records, such as a transaction record, purchase history, or payment history. It is deliberately lightweight in order to accommodate mappings to other document and bibliographic ontologies.
dct:contributor	Davide Sottara, Mayo Clinic
dct:contributor	Elisa Kendall, Thematix Partners LLC

[8] https://www.ifla.org/g/cataloguing/ifla-s-bibliographic-conceptual-models/

[9] https://www.ifla.org/

dct:contributor	Evan Wallace, U.S. National Institute of Standards and Technology (NIST)
dct:contributor	Pete Rivett, Federated Knowledge LLC
cmns-av:copyright	Copyright (c) 2014-2023 EDM Council, Inc.
cmns-av:copyright	Copyright (c) 2022-2023 Federated Knowledge LLC
cmns-av:copyright	Copyright (c) 2022-2023 Mayo Clinic
cmns-av:copyright	Copyright (c) 2022-2023 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2023 Object Management Group, Inc.
dct:license	https://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20230801/Documents/
skos:note	This ontology was derived from the Financial Industry Business Ontology (FIBO), and generalized for use in other domain areas.

An overview diagram for the Documents ontology is given in Figure 10.

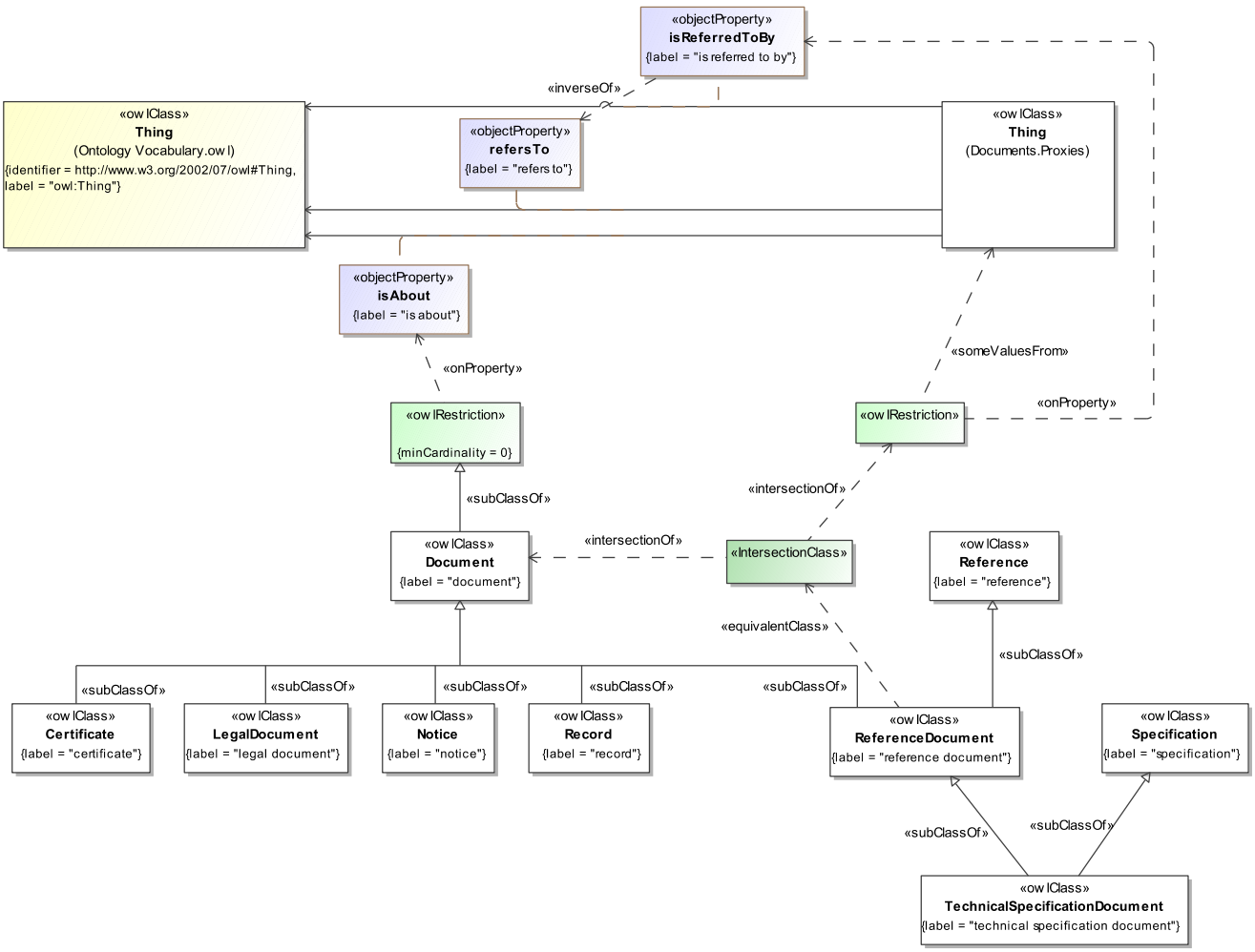

Figure 10: Documents Ontology Overview

The detailed annotations and axioms that comprise the Documents ontology are provided in Table 8.18, below.

Table 8.18: Documents Ontology Details

Classes

Name	Annotations	Class Expressions
Certificate (certificate)	Definition: document attesting to the truth of some fact or set of facts Explanatory note: A certificate may or may not also be a legal document, depending on the issuing authority and how it can be used. Explanatory note: Certificates, such as electronic certificates, including public keys, may be issued by some certificate authority. Adapted from: ISO 5127 - Information and documentation - Foundation and vocabulary,	Parent Class: Document

	Second edition, 2017-05, clause 3.1.1.38	
Document (document)	Definition: unitary expression of some realization of an intellectual or artistic work Note: See also ISO 25964–1:2011, definition 2.15; ISO 11005:2010, definition 3.1; ISO 15489–1:2016, definition 3.10; IEC 82045–1:2001, definition 3.2.3; ISO 9000:2015, definition 3.7.2 Note: The definition of document provided herein roughly corresponds to the concept of an expression in FRBR. A document is a realization of something that typically takes the form of alpha-numeric, musical, or choreographic notation, sound, image, etc., or any combination of such forms. A manifestation of the document must be inscribed, encoded, engraved, recorded, or otherwise imprinted in some medium. The concept of a manifestation of an expression corresponds to the ISO 5127 notion of a document. Documents can differ extensively in form and characteristics. Note: The manifestation of a document (FRBR expression) refers not only to written and printed materials in paper or microform versions (for example, conventional books, journals, diagrams, maps), but also to non-printed media such as machine-readable and digitized records, Internet and intranet resources, films, sound recordings, buildings, sites, monuments, three-dimensional objects or realia [when used to carry some sort of engraving]; and to collections of such items or parts of such items. (Note taken from ISO 25964–1:2011, definition 2.15.) Also, software, since recorded, can be considered a document. Explanatory note: A document, especially a legal document, may serve to establish one or several facts, and can be relied upon as a proof thereof. Usage note: This definition of document corresponds to a subclass of expression in FRBR. The notion of being a unitary expression is the differentiator between an FRBR expression and document in this sense. Adapted from: ‘Functional Requirements for Bibliographic Records’, Final Report, IFLA (International Federation of Library Associations and Institutions) Study Group on the Functional Requirements for Bibliographic Records, September 1997 - see https://repository.ifla.org/bitstream/123456789/811/2/ifla-functional-requirements-for-bibliographic-records-frbr.pdf Adapted from: ISO 5127 - Information and documentation - Foundation and vocabulary, Second edition, 2017-05, clause 3.1.1.38 See also: https://www.ifla.org/wp-content/uploads/2019/05	Property Restriction: ≥ 0 isAbout

	/assets/cataloguing/frbr/frbroo_v2.2.pdf	
LegalDocument (legal document)	Definition: document specifying the terms of, or provides evidence for, an agreement, attestation, certification, conditions, permissions, and/or decisions of legal persons, government entities, or courts of law, drawn up in accordance with certain rules that apply in the relevant jurisdiction(s) Example: Examples include some certificates, deeds, bonds, business documents (such as articles of incorporation, bylaws, partnership agreements), contracts, certain identity documents, wills, trusts, legislative acts, notarial acts, court writs or processes (such as related complaints and pleadings in the context of litigation as well as other documents relevant to some legal issue), and any law passed by a competent legislative body in municipal (domestic) or international law. Note: A legal document bears the original, official, or legal form of something, that can be fully attributed to its author(s), that records and formally expresses a legally enforceable act, process, or contractual duty, obligation, or right and that can be used to furnish decisive evidence for that act, process, or agreement. Note: Many legal documents only become 'legal' once they are signed and dated, and possibly notarized. Adapted from: ISO 5127 - Information and documentation - Foundation and vocabulary, Second edition, 2017-05, clause 3.4.6.02	Parent Class: Document
Notice (notice)	Definition: announcement, communication, intimation, or advance warning of something, usually, but not necessarily, to allow preparations to be made Example: registered trademark notice, disclaimer, copyright notice, overdue notice, recall notice Note: Although many notices are delivered electronically, certain legal notices must be given given in writing, often by regular mail or hand delivery, with the sender retaining sufficient proof of having given such notice (*e.g.*, through a certificate of service). Adapted from: ISO 5127 - Information and documentation - Foundation and vocabulary, Second edition, 2017-05	Parent Class: Document
Record (record)	Definition: memorialization and objective evidence of activities performed, events occurred, results achieved, or statements made, regardless of its characteristics, media, physical form, or the manner in which it is recorded or stored	Parent Class: Document

	Note: Records are created or received by an organization in routine transaction of its business or in pursuance of its legal obligations.	
Reference (reference)	Definition: source that may be used to ascertain, interpret, or understand something Explanatory note: In linguistics, a reference characterizes, provides context for, or specifies the relationship of one linguistic expression to another, *i.e.*, provides the information necessary to interpret the dependent expression. Explanatory note: References may be rendered in the form of a document, but may also take other forms, such as reference materials, scientific equations, and constants, including in some cases physical things, used as the basis for units of measure.	
ReferenceDocument (reference document)	Definition: document that is used as a reference for something Explanatory note: A reference document is typically one that provides pertinent details for consultation about a subject. Adapted from: ISO/IEC 11179-3 Information technology - Metadata registries (MDR) - Part 3: Registry metamodel and basic attributes, Third edition, 2013-02-15	Parent Class: Document, Reference Class Axiom: ≡ (Document ∩ (∃ isReferredToBy))
Specification (specification)	Definition: explicit requirement or set of requirements to be satisfied by something, such as a product, material, model, process or system Abbreviation: spec Adapted from: ISO 6707-2:2017 Buildings and civil engineering works - Vocabulary - Part 2: Contract and communication terms, clause 3.2.22	
TechnicalSpecificationDocument (technical specification document)	Definition: document that sets out detailed requirements to be satisfied by a product, material, process or system and the procedures for checking conformity to these requirements Note: Technical specifications may evolve from a functional specification and define the technical requirements for the selected solution as part of a business agreement. Explanatory note: A technical specification is a specification expressing technical requirements, such as one for designing and developing a solution to be implemented. Adapted from: ISO 10795:2019 Space systems - Programme management and quality - Vocabulary, clause 3.238 Adapted from: ISO 6707-2:2017 Buildings and civil engineering works - Vocabulary - Part 2: Contract and communication terms, clause 3.2.22	Parent Class: ReferenceDocument, Specification

Properties

Name	Annotations	Property Axioms
hasDataSource (has data source)	Definition: relates something, such as an agreement, contract, document, record, report, or process, to a source of data used to analyze, develop, explain, produce, or otherwise create it Usage note: Although in many cases an annotation property, such as dct:source, is sufficient for this purpose, there are occasions when a more complete description of a source is required, such as to meet data lineage requirements, for which this property may be used.	Parent Property: refersTo
isAbout (is about)	Definition: indicates the subject or topic of something, such as a document	
isReferredToBy (is referred to by)	Definition: indicates something that is referenced as a source for information or explanation	Inverse: refersTo
isSpecifiedIn (is specified in)	Definition: indicates the explicit source for some requirement, fact, or set of facts	Parent Property: refersTo Inverse: specifies
records (records)	Definition: documents for later reference	
refersTo (refers to)	Definition: makes reference to as a source for information or explanation	
specifies (specifies)	Definition: mentions, names or states something clearly and definitively Explanatory note: Specifies may be used to refer to a requirement, fact, or set of facts.	

8.10 Ontology: Identifiers

The identifiers ontology defines commonly used concepts for describing identifiers and the identification schemes that define them, such as various national and international identifiers for legal entities, financial instruments, and the like, derived from the patterns specified in ISO 11179-3, Metadata Registries.

Metadata for the Identifiers ontology is given in Table 8.19.

Table 8.19: Identifiers Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/Identifiers/
rdfs:label	Commons Identifiers Ontology
dct:abstract	The identifiers ontology defines commonly used concepts for describing identifiers and the identification schemes

	that define them, such as various national and international identifiers for legal entities, financial instruments, and the like, derived from the patterns specified in ISO 11179-3, Metadata Registries.
dct:contributor	Elisa Kendall, Thematix Partners LLC
dct:contributor	Evan Wallace, U.S. National Institute of Standards and Technology (NIST)
dct:contributor	Pete Rivett, agnos.ai
cmns-av:copyright	Copyright (c) 2014-2022 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2021-2022 agnos.ai U.K. Ltd
cmns-av:copyright	Copyright (c) 2021-2022 EDM Council, Inc.
cmns-av:copyright	Copyright (c) 2021-2022 Object Management Group, Inc.
dct:license	http://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20221101/Identifiers/
skos:changeNote	The https://www.omg.org/spec/Commons/20220501/Identifiers.rdf version of this ontology was modified to make the property 'identifies' functional (COMMONS-26).

An overview of the Identifiers ontology is given in Figure 11.

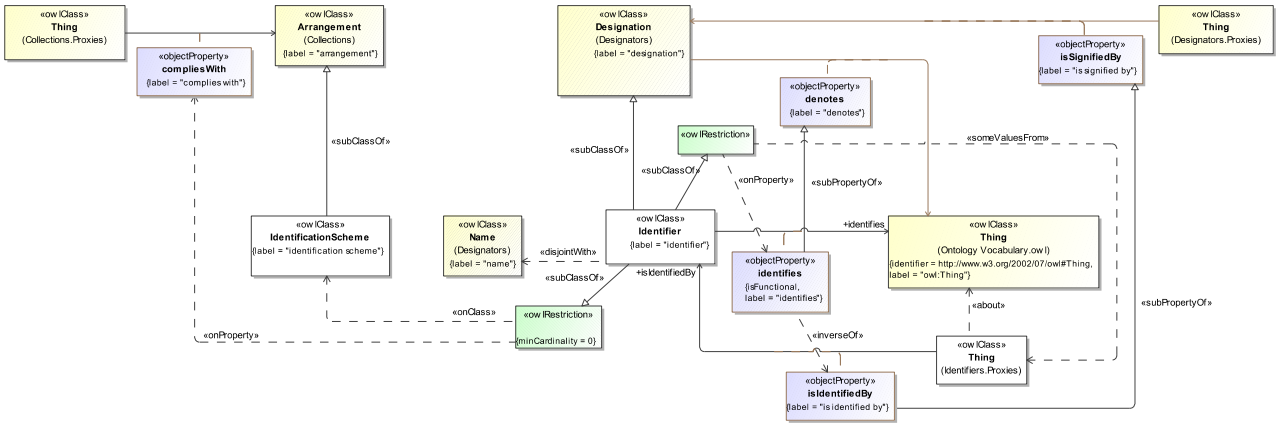

Figure 11: Overview of the Identifiers Ontology

The detailed annotations and axioms that comprise the Identifiers ontology are provided in Table 8.20, below.

Table 8.20: Identifiers Ontology Details

Classes

Name	Annotations	Class Expressions
IdentificationScheme (identification scheme)	Definition: system for minting identifiers for things that specifies constraints on the structure of the identifier Adapted from: ISO/IEC 11179-3 Information technology - Metadata registries (MDR) - Part 3: Registry metamodel and basic attributes, Third edition, 2013-02-15	Parent Class: cmns-col:Arrangement
Identifier (identifier)	Definition: sequence of characters uniquely identifying that with which it is associated Note: Note that some identifiers may be reused, or may be components of other identifiers, thus the restriction on what an identifier identifies is a 'some values' restriction rather than an exact cardinality. Examples of reusable identifiers include ticker symbols, and in the United States, vehicle license numbers, such as vanity plates that can be reassigned and moved from one car to another. Narrower constraints can be added to specific kinds of identifiers that are not reassignable and that identify exactly one thing, such as many national identifiers for people including passport numbers and, in the United States, social security numbers. Also, not all identifiers are explicitly defined in formal schemes, although they may be created or generated according to some formula. Source: ISO/IEC 11179-3 Information technology - Metadata registries (MDR) - Part 3: Registry metamodel and basic attributes, Third edition, 2013-02-15, clause 3.1.1	Parent Class: cmns-dsg:Designation Property Restriction: ≥ 0 cmns-col:compliesWith.IdentificationScheme Property Restriction: ∃ identifies.owl:Thing Class Axiom: ¬ cmns-dsg:Name

Properties

Name	Annotations	Property Axioms
identifies (identifies)	Definition: recognizes or establishes identity within some context	Type: owl:FunctionalProperty Parent Property: cmns-dsg:denotes Domain: Identifier
isIdentifiedBy (is identified by)	Definition: has an identifier that is unique within some context	Parent Property: cmns-dsg:isSignifiedBy Range: Identifier Inverse: identifiers

8.11 Ontology: Mapping Dates and Times to OWL Time

This ontology maps the Commons Dates and Times ontology to the widely used W3C Time Ontology in OWL recommendation, available at https://www.w3.org/TR/owl-time/. Note that users of this mapping need to be aware of datatypes that are not allowed in RDFS or OWL in the W3C Time ontology. Usage of this mapping enables use of the Allen intervals defined in the W3C ontology, however, which are useful for a number of applications.

Metadata for the Mapping Dates and Times to OWL Time ontology is given in Table 8.21.

Table 8.21: Mapping Dates and Times to OWL Time Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/MappingDatesAndTimesToOWLTime/
rdfs:label	Commons Mapping Dates and Times to OWL Time Ontology
dct:abstract	This ontology maps the Commons Dates and Times ontology to the widely used W3C Time Ontology in OWL recommendation, available at https://www.w3.org/TR/owl-time/. Note that users of this mapping need to be aware of the usage of datatypes that are not allowed in RDFS or OWL in the W3C Time ontology. Usage of this mapping enables use of the Allen intervals defined in the W3C ontology, however, which are useful for a number of applications.
dct:contributor	Elisa Kendall, Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2021-2022 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2022 Object Management Group, Inc.
dct:license	http://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20220501/MappingDatesAndTimesToOWLTime/

The detailed annotations and axioms that comprise the Mapping Dates and Times to OWL Time ontology are provided in Table 8.22, below.

Table 8.22: Mapping Dates and Times to OWL Time Ontology Details

Classes

Name	Annotations	Class Expressions
cmns-dt:Duration		Equivalent Class: time:TemporalDuration

cmns-dt:ExplicitDate		Parent Class: time:GeneralDateTimeDescription Property Restriction: = 1 time:year Property Restriction: = 1 time:month Property Restriction: = 1 time:day
cmns-dt:ProperInterval		Equivalent Class: time:ProperInterval
cmns-dt:TemporalEntity		Equivalent Class: time:TemporalEntity
cmns-dt:TimeInstant		Equivalent Class: time:Instant
cmns-dt:TimeInterval		Equivalent Class: time:Interval

Properties

Name	Annotations	Property Axioms
time:hasXSDDuration		Parent Property: cmns-dt:hasDurationValue
time:inXSDDateTimeStamp		Parent Property: cmns-dt:hasDateTimeStampValue
time:inXSDDate		Parent Property: cmns-dt:hasDateValue

8.12 Ontology: Parties and Situations

The parties and situations ontology defines the concept of a situation, which is a state of affairs or other reified relationship that holds for some period of time. It also defines the concept of an agent, agent role, party, party role, and other subordinate concepts required for build-up of complex situations. A number of linking relationships are also defined, along with property chains that enable navigation of the parties and roles related to a situation from multiple perspectives in a graph. These concepts are particularly useful for defining business relationships such as employment, ownership, control, and many others.

Metadata for the Parties and Situations ontology is given in Table 8.23.

Table 8.23: Parties and Situations Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/PartiesAndSituations/
rdfs:label	Commons Parties and Situations Ontology

dct:abstract	This ontology defines the high-level concepts of parties and the roles they play in various situations.
dct:contributor	Dean Allemang, Working Ontologist
dct:contributor	Elisa Kendall, Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2020-2023 EDM Council, Inc.
cmns-av:copyright	Copyright (c) 2020-2023 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2020-2023 Working Ontologist LLC
cmns-av:copyright	Copyright (c) 2022-2023 Pistoia Alliance, Inc.
cmns-av:copyright	Copyright (c) 2023 Object Management Group, Inc.
dct:license	https://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20230801/PartiesAndSituations/
skos:note	This ontology was originally designed for use in the Financial Industry Business Ontology (FIBO) for representing complex relationships between parties, such as employment, ownership and control. It has since been extended based on usage in other projects, such as the Pistoia Alliance Identification of Medicinal Products (IDMP) ontology project.
cmns-av:usageNote	Note that inference with respect to property chains, which this ontology makes extensive use of, requires a knowledge graph solution that understands these chains, or requires running a reasoner outside of the graph database and asserting the inferences in order to make use of them.

A summary diagram for the Parties and Situations ontology is given in Figure 12.

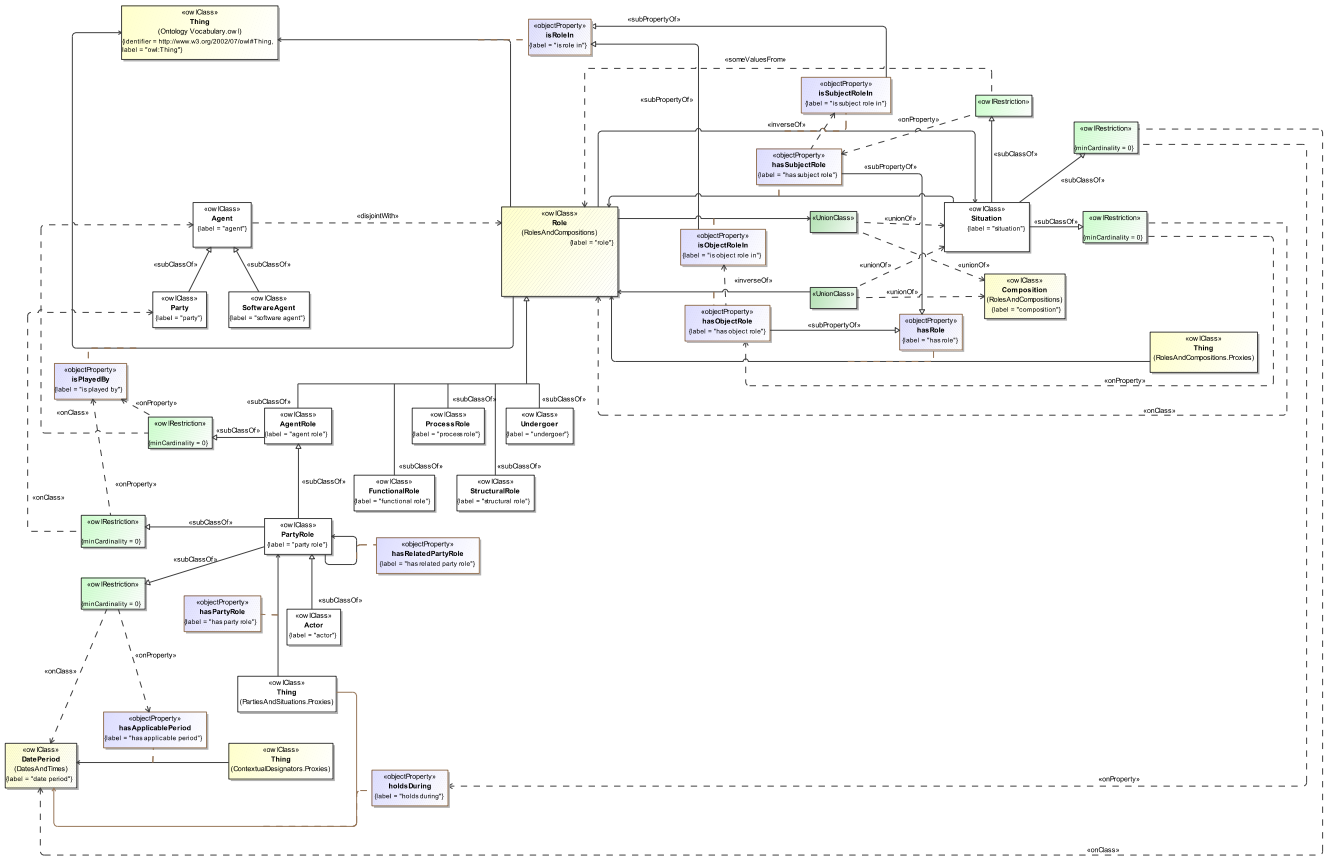

Figure 12: Parties and Situations Ontology Overview

The detailed annotations and axioms that comprise the Parties and Situations ontology are provided in Table 8.24, below.

Table 8.24: Parties and Situations Ontology Details

Classes

Name	Annotations	Class Expressions
Actor (actor)	Definition: primary performer in a relationship between parties, *i.e.*, the party that does something, causes something to happen, or otherwise plays an agentive role in the relationship Example: Examples include owner, controlling party, beneficiary, guarantor, partner in a partnership, shareholder, etc. Explanatory note: The concept of actor here is in a more linguistic sense, from core semantic theories reflecting actor/undergoer/null roles of an argument in an expression.	Parent Class: PartyRole

	Adapted from: ISO 14813-1:2015(en), Intelligent transport systems - Reference model architecture(s) for the ITS sector - Part 1: ITS service domains, service groups and services, clause 3.1 Adapted from: ISO 23234:2021(en), Buildings and civil engineering works - Security - Planning of security measures in the built environment, clause 3.4 Adapted from: ISO/TR 21965:2019(en), Information and documentation - Records management in enterprise architecture, clause 3.2.1	
Agent (agent)	Definition: something autonomous that can adapt to and interact with its environment Note: Agents can be human beings, organizations, software agents, robots and living things other than plants. They are defined as having the following three important properties: autonomy, interactive behavior, and adaptability. (1) Autonomy - an agent is capable of acting without direct external intervention. This includes software or other agents that have some degree of control over their internal state and can act based on their own experiences. They can also possess their own set of internal responsibilities and capabilities that enable them to act without any external choreography. This definition excludes agents that act on on behalf of (or as a proxy for) some person or thing (see AgentRole). (2) Interactive behavior - they are capable of exchanging communicating with other things in their environment. This includes, in the case of software agents, messages that can support requests for services and other kinds of resources, as well as event detection and notification. They can be synchronous or asynchronous in nature. The interaction can also be conversational in nature, such as negotiating contracts, marketplace-style bidding, or simply making a query. (3) Adaptability - an agent is capable of responding to other agents and/or its environment. Agents can react to communications and events and then respond appropriately. Software agents can be designed to make difficult decisions and even modify their behavior based on their experiences. In other words, they can learn and evolve. Note: Note that this does not necessarily imply that an agent is free to act as it sees fit, without constraint. Rather, an agent in the sense meant here is something which may or may not be subject to controls and constraints but is self-actualizing in its behavior in response to any such constraints. Direct source: http://www.omg.org/techprocess/meetings/sched	Property Restriction: ≥ 0 cmns-dsg:hasName.cmns-cxtdsg:ContextualName Class Axiom: ¬ Role

	ule/AMP.html See also: http://www.jamesodell.com/WhatIsAnAgent.pdf See also: http://www.jamesodell.com/WhyShouldWeCareAboutAgents.pdf	
AgentRole (agent role)	Definition: role played by any agent	Parent Class: Role Property Restriction: ≥ 0 cmns-rlcmp:isPlayedBy.Agent
Party (party)	Definition: person or organization	Parent Class: Agent
PartyRole (party role)	Definition: role played by an organization or individual that may be time bound Example: Examples include organization member, employee, issuer, owner, partner in a partnership, shareholder, and so forth. Note: Note that there may be cases where the identity of the party playing the role is not known, as well as cases where in some situation, such as ownership, there may be more than one party playing the role of owner. Scope note: The concept of a party role is used in contexts in which one would call someone a 'party to something', such as party to a contract or to a transaction, a supplier, buyer, customer, student, employee, and so forth. More specific roles such as those that are performed in the context of some activity or process are actors in that situation. Adapted from: ISO 14813-1:2015(en), Intelligent transport systems - Reference model architecture(s) for the ITS sector - Part 1: ITS service domains, service groups and services, clause 3.1 Adapted from: ISO 23234:2021(en), Buildings and civil engineering works - Security - Planning of security measures in the built environment, clause 3.4	Parent Class: AgentRole Property Restriction: ≥ 0 cmns-cxtdsg:hasApplicablePeriod.DatePeriod Property Restriction: ≥ 0 cmns-rlcmp:isPlayedBy.Agent
Situation (situation)	Definition: setting, state of being, or relationship that is relatively stable for some period of time Example: Examples include ownership, control, possession, affiliation, beneficial ownership, employment, and other similar situations. Note: From a usage perspective, situations are essentially reified relations, sometimes called mediating relationships.	Property Restriction: ≥ 0 holdsDuring.cmns-dt:DatePeriod Property Restriction: ≥ 0 hasObjectRole.Role Property Restriction: ∃ hasSubjectRole.Role
SoftwareAgent (software agent)	Definition: digital entity that perceives its environment and takes actions that maximize its chance of successfully achieving its goals Source: ISO/IEC TR 29119-11:2020(en), Software and systems engineering - Software	Class Axiom: ¬ Party

	testing - Part 11: Guidelines on the testing of AI-based systems, clause 3.1.73	
Undergoer (undergoer)	Definition: something that plays the role of the object or recipient in a situation, *i.e.*, the thing (or party) that the situation impacts, affects, or that otherwise plays a passive recipient / patient or thematic role Example: Examples include something that is owned or controlled.	Parent Class: Role

Properties

Name	Annotations	Property Axioms
actsIn (acts in)	Definition: indicates a situation in which the actor plays a primary role	Parent Property: isSubjectRoleIn Domain: Actor Range: Situation Inverse: hasActor
actsOn (acts on)	Definition: relates an actor in a given situation to the undergoer that they affect under the circumstances	Parent Property: (actsIn ○ hasUndergoer)
directlyAffects (directly affects)	Definition: relates an actor in a given situation to the thing (or party) that they impact under the circumstances	Parent Property: (actsIn ○ hasUndergoer ○ cmns-rlcmp:isPlayedBy) Inverse: experiencesWith
experiences (experiences)	Definition: relates something to a situation that affects them in some way	Parent Property: (cmns-rlcmp:playsRole ○ undergoes)
experiencesDirectly (experiences directly)	Definition: relates something directly to a party that drives a situation involving it	Parent Property: (cmns-rlcmp:playsRole ○ undergoes ○ hasActor ○ rlcmp:isPlayedBy)
experiencesWith (experiences with)	Definition: relates something to an actor that drives a situation involving it	Parent Property: (cmns-rlcmp:playsRole ○ undergoes ○ hasActor)
hasActiveParty (has active party)	Definition: relates a situation to the person or organization acting in a primary (agentive) role	Parent Property: (hasActor ○ rlcmp:isPlayedBy) Inverse: playsActivePartyIn
hasActiveRole (has active role)	Definition: relates a situation to something that is acting in a primary (agentive) role	Parent Property: (hasSubjectRole ○ rlcmp:isPlayedBy) Inverse: playsActiveRoleIn
hasActor (has actor)	Definition: identifies the primary party acting in a specific role with respect to a given situation	Parent Property: hasPartyRole, hasSubjectRole

		Domain: Situation Range: Actor
hasObjectRole (has object role)	Definition: identifies a person or thing that is affected by, or is a secondary argument in a specific role with respect to a given relation or situation	Parent Property: cmns-rlcmp:hasRole Domain: cmns-rlcmp:Composition ∪ Situation Range: Role
hasParty (has party)	Definition: identifies a party associated with an agreement, contract, policy, regulation, situation, or other arrangement	Range: Party
hasPartyRole (has party role)	Definition: identifies a specific role played by some person or organization as related to a situation, agreement, contract, policy, regulation, activity or other relationship	Parent Property: cmns-rlcmp:hasRole Range: PartyRole
hasRelatedPartyRole (has related party role)	Definition: relates a party acting in a specific role directly to another party acting in the same or another role Usage note: This property is intended as an abstract property, whose subproperties may or may not be symmetric, but could be inverses of one another.	Parent Property: cmns-rlcmp:hasRole Domain: PartyRole Range: PartyRole
hasSubjectRole (has subject role)	Definition: identifies the person or thing that is being discussed, described, dealt with, or is the main topic in a specific role with respect to a given situation	Parent Property: cmns-rlcmp:hasRole Domain: Situation Range: cmns-rlcmp:Role
hasUndergoer (has undergoer)	Definition: identifies an experiencer / passive or other object role in a given situation	Parent Property: hasObjectRole Domain: Situation Range: Undergoer
holdsDuring (holds during)	Definition: indicates a date period during which something is true	Parent Property: cmns-cxtdsg:hasApplicablePeriod Range: cmns-dt:DatePeriod
isAPartyTo (is a party to)	Definition: identifies an agreement, contract, policy, regulation, situation, or other arrangement that a party is associated with	Domain: Party Inverse: hasParty
isAffectedBy (is affected by)	Definition: relates an undergoer in a given situation to the actor that has an impact on them under the circumstances	Parent Property: (undergoes ○ hasActor)
isDirectlyAffectedBy (is directly affected by)	Definition: relates an undergoer in a given situation to the person or organization that has an impact on them under the circumstances	Parent Property: (undergoes ○ hasActor ○ rlcmp:isPlayedBy)
isExperiencedBy (is experienced by)	Definition: relates a situation to something that is directly involved in or affected by it	Parent Property: (hasUndergoer ○ rlcmp:isPlayedBy) Inverse: experiences

isObjectRoleIn (is object role in)	Definition: indicates a situation in which the role is secondary, such as an experiencer or passive participant	Parent Property: cmns-rlcmp:isRoleIn Domain: cmns-rlcmp:Role Range: cmns-rlcmp:Composition ∪ Situation Inverse: hasObjectRole
isRealizedIn (is realized in)	Definition: relates a situation or constituency to something that is affected by, or is a secondary argument to in a specific role with respect to a given relation or situation	Parent Property: (hasObjectRole ○ rlcmp:isPlayedBy) Inverse: realizes
isSubjectRoleIn (is subject role in)	Definition: indicates a situation in which the role is the primary topic	Parent Property: cmns-rlcmp:isRoleIn Domain: cmns-rlcmp:Role Range: Situation Inverse: hasSubjectRole
playsActivePartyIn (plays active party in)	Definition: relates a person or organization to a situation that they are directly involved in	Parent Property: (rlcmp:playsRole ○ actsIn)
playsActiveRoleIn (plays active role in)	Definition: relates something to a situation that it is directly involved in	Parent Property: (rlcmp:playsRole ○ isSubjectRoleIn)
playsActiveRoleThatAffects (plays active role that affects)	Definition: relates a person or organization to an undergoer they have an impact on under the circumstances	Parent Property: (rlcmp:playsRole ○ actsIn ○ hasUndergoer) Inverse: isDirectlyAffectedBy
playsActiveRoleThatDirectlyAffects (plays active role that directly affects)	Definition: relates a person or organization to something they have a direct impact on under the circumstances	Parent Property: (rlcmp:playsRole ○ actsIn ○ hasUndergoer ○ rlcmp:isPlayedBy) Inverse: experiencesDirectly
realizes (realizes)	Definition: relates something to a situation or constituency in which the role they play is secondary, such as an experiencer or passive participant	Parent Property: (rlcmp:playsRole ○ isObjectRoleIn)
undergoes (undergoes)	Definition: indicates a situation that the undergoer experiences	Parent Property: isObjectRoleIn Domain: Undergoer Range: Situation Inverse: hasUndergoer

8.13 Ontology: Quantities and Units

Several OMG task forces and other external industry groups in pharmaceuticals, manufacturing, finance and others have recognized the need for a well-designed ontology supporting quantities and units. While a number of ontologies exist that claim to fill this gap, few are well designed and some have moved away from OWL in order to meet other demands. Within OMG, the healthcare, finance, robotics, and retail task forces all have requirements for a quantities and units ontology. Such an ontology should align well with the library of quantities and units in the latest revision to SysML, enabling the equivalent reference content in the SysML libraries to be automatically generated for use with the quantities and units ontology.

The ontology specified herein is limited to scalar quantities. Work to develop an additional Commons ontology for arrays, vectors, and tensors, and a companion quantities and units extension to support tensor and vector quantities is underway, and the resulting ontologies will be added when available. Most applications do not need that level of sophistication however, and thus the scalar version is designed to fulfill the requirements raised to date outside of the systems engineering community at OMG.

Metadata for the Quantities and Units ontology is given in Table 8.25.

Table 8.25: Quantities and Units Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/QuantitiesAndUnits/
rdfs:label	Commons Quantities and Units Ontology
dct:abstract	This ontology provides a core set of concepts for quantities, units, systems of quantities, and systems of units. The most widely accepted, scrutinized, and globally used system of quantities and system of units are the International System of Quantities (ISQ) and the International System of Units (SI). They are formally standardized through [ISO 31] and [IEC 60027]. The harmonization of these two sets of standards into one new set [ISO/IEC 80000] has been published by ISO in 2009 and 2010. This ontology is based on the Object Management Group (OMG)'s SysML standard and on ISO/IEC 80000-1:2009, which refers normatively to the ISO/IEC Guide 99:2007. It is compatible with and can be mapped directly to the OMG Date Time Vocabulary (DTV) Quantities Ontology, the de-facto QUDT ontology representing Units of Measure, Quantity Kinds, Dimensions and Data Types (see http://www.qudt.org/), the Units of Measurement Ontology (UO) ontology available from the BioPortal (https://bioportal.bioontology.org/ontologies/UO) and others, as well as the quantities and units library in the SysML specification.
dct:contributor	Davide Sottara, Mayo Clinic
dct:contributor	Elisa Kendall, Thematix Partners LLC
dct:contributor	Evan Wallace, U.S. National Institute of Standards and Technology (NIST)
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owl:versionIRI	https://www.omg.org/spec/Commons/20230801/QuantitiesAndUnits/

An overview diagram for the Quantities and Units ontology is given in Figure 13.

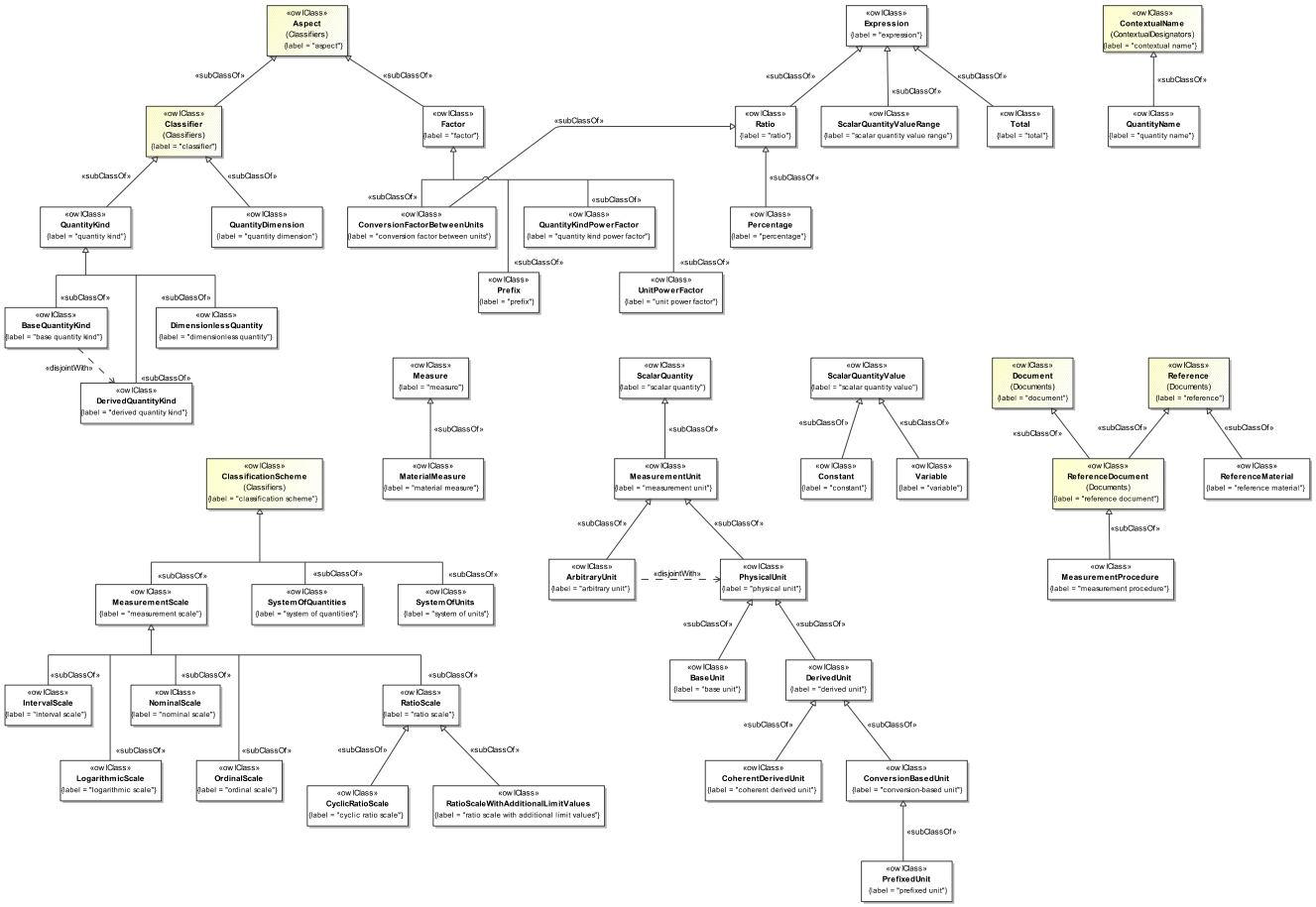

Figure 13: Quantities and Units Ontology Overview

The detailed annotations and axioms that comprise the Quantities and Units ontology are provided in Table 8.26, below.

Table 8.26: Quantities and Units Ontology Details

Classes

Name	Annotations	Class Expressions
ArbitraryUnit (arbitrary unit)	Definition: arbitrarily defined unit of measurement, where a relation of the unit to a physical unit of the SI does not exist or is unknown Explanatory note: Arbitrary units represent references to materials or procedures that are defined outside of the SI system. A quantity value is arbitrarily assigned to the reference preparation or the result of a measurement procedure, usually specific for a particular substance. This generally precludes comparability of quantity values across different systems and components for this type of units. Adapted from: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique	Parent Class: MeasurementUnit Property Restriction: ≥ 0 cmns-doc:refersTo.MaterialMeasure Property Restriction: ≥ 0 cmns-doc:refersTo.MeasurementProcedure Property Restriction: ≥ 0 cmns-doc:refersTo.ReferenceMaterial

	identification and exchange of units of measurement, clause 3.1.1	
BaseQuantityKind (base quantity kind)	Definition: quantity in a conventionally chosen subset of a given system of quantities, where no quantity in the subset can be expressed in terms of the other quantities within that subset Example: The International System of Quantities (ISQ) comprises these base quantities (with their SI base measurement units): length (meter), mass (kilogram), duration (second), electric current (ampere), thermodynamic temperature (kelvin), amount of substance (mole), and luminous intensity (candela). These base quantities are not mutually comparable. All quantities of any one of these kinds are, however, mutually comparable. Note: The subset mentioned in the definition is termed the 'set of base quantities'. Base quantities are referred to as being mutually independent since a base quantity cannot be expressed as a product of powers of the other base quantities. Synonym: base quantity Synonym: simple quantity kind Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.2 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.4 Source: https://www.omg.org/spec/SysML/	Parent Class: QuantityKind Property Restriction: = 1 cmns-dsg:isDefinedIn.SystemOfQuantities
BaseUnit (base unit)	Definition: measurement unit that is defined by a system of units to be the reference measurement unit for a base quantity Example: In the SI, the meter is the base unit of length. In the CGS systems, the centimeter is the base unit of length. Note: In each coherent system of units, there is only one base unit for each base quantity. A base unit may also serve for a derived quantity of the same quantity dimension. Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.3 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.10	Parent Class: PhysicalUnit
CoherentDerivedUnit (coherent derived unit)	Definition: derived unit that, for a given system of quantities and for a chosen set of base units, is a product of powers of base units with no other	Parent Class: DerivedUnit

	proportionality factor than one Example: If the meter, the second, and the mole are base units, the mole per cubic meter is the coherent derived unit of amount-of-substance concentration when amount-of-substance concentration is defined by the quantity equation c = n/V. The kilometer per hour and the knot, given as examples of derived units, are not coherent derived units in such a system of quantities. Note: A power of a base unit is the base unit raised to an exponent. Coherence can be determined only with respect to a particular system of quantities and a given set of base units. Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.4 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.12	
Constant (constant)	Definition: symbol that represents a value that does not change (i.e., is fixed) with respect to a formula or expression	Parent Class: ScalarQuantityValue
ConversionBasedUnit (conversion-based unit)	Definition: derived unit that is defined with respect to another reference unit through an explicit conversion relationship Source: https://www.omg.org/spec/SysML/	Parent Class: DerivedUnit Property Restriction: ≥ 0 hasExpression.Expression
ConversionFactorBetweenUnits (conversion factor between units)	Definition: ratio of two measurement units for quantities of the same kind Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.6 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.24	Parent Class: Factor, Ratio Property Restriction: = 1 hasQuantityKind.QuantityKind
CyclicRatioScale (cyclic ratio scale)	Definition: measurement scale that represents a ratio scale with a periodic cycle Example: ‘cyclic degree’ (to express planar angular measures) with modulus = 360 and unit ‘degree’ Example: ‘hour of day’ with modulus = 24 and unit ‘hour’ Source: https://www.omg.org/spec/SysML/	Parent Class: RatioScale
DerivedQuantityKind (derived quantity kind)	Definition: quantity, in a system of quantities, defined in terms of the base quantities of that system Note: In a system of quantities having the base quantities length and mass, mass density is a	Parent Class: QuantityKind Property Restriction: ≥ 0 hasFactor.QuantityKindPowerFactor

	derived quantity defined as the quotient of mass and volume (length to the power three). Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.7 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.11 Source: https://www.omg.org/spec/SysML/	Property Restriction: ∃ isDerivedFrom.QuantityKind
DerivedUnit (derived unit)	Definition: measurement unit for a derived quantity, *i.e.*, one that is defined with respect to one or more base units, such as as a product of powers of one or more other measurement units Example: The meter per second, symbol m/s, and the centimeter per second, symbol cm/s, are derived units of speed in the SI. The kilometer per hour, symbol km/h, is a measurement unit of speed outside the SI but accepted for use with the SI. The knot, equal to one nautical mile per hour, is a measurement unit of speed outside the SI. Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.8 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.5 Source: https://www.omg.org/spec/SysML/	Parent Class: PhysicalUnit Property Restriction: ≥ 0 hasFactor.UnitPowerFactor Property Restriction: ∃ isDerivedFrom.BaseUnit
DimensionlessQuantity (dimensionless quantity)	Definition: quantity for which all the exponents of the factors corresponding to the base quantities in its quantity dimension are zero Example: Plane angle, solid angle, refractive index, relative permeability, mass fraction, friction factor, Mach number Note: Some quantities of dimension one are defined as the ratios of two quantities of the same kind. The coherent derived unit is the number one, symbol 1. Note: The measurement units and values of quantities of dimension one are numbers, but such quantities convey more information than a number. Note: The term ‘dimensionless quantity’ is commonly used and is included for historical reasons. It stems from the fact that all exponents are zero in the symbolic representation of the dimension for such quantities. The term ‘quantity of dimension one’ reflects the convention in which the symbolic representation of the dimension for such quantities is the symbol 1. This dimension is not a number, but the neutral element for multiplication of dimensions.	Parent Class: QuantityKind

	Synonym: quantity of dimension one Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.10 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.8 Source: https://www.omg.org/spec/SysML/	
Expression (expression)	Definition: finite combination of symbols that are well-formed according to applicable rules	Property Restriction: ≥ 0 hasArgument.Constant Property Restriction: ≥ 0 hasArgument.Variable
Factor (factor)	Definition: number or quantity that when multiplied with another produces a given number or expression	Parent Class: cmns-cls:Aspect
IntervalScale (interval scale)	Definition: measurement scale that represents quantitative values and for which mode, median and mean can be calculated Example: Celsius and Fahrenheit are examples of interval scales: they represent equality or inequality among intervals of temperature, but not ratios of temperature, because their zero points are arbitrary. Rating scales, where it is assumed that the distances between the single expressions of evaluation (score) are equal, are also interval scales with no natural zero point. Note: Linear interval scales allow both multiplication by a positive number and a constant shift, *e.g.*, the conversion from Celsius to Fahrenheit. Source: https://plato.stanford.edu/entries/measurement-science/ Source: https://www.statista.com/statistics-glossary/definition/320/interval_scale/ Source: https://www.omg.org/spec/SysML/	Parent Class: MeasurementScale
LogarithmicScale (logarithmic scale)	Definition: measurement scale on which the actual distance of a point from the scale's zero is proportional to the logarithm of the corresponding scale number rather than to the number itself Example: A logarithmic scale (or log scale) is a way of displaying numerical data over a very wide range of values in a compact way - typically the largest numbers in the data are hundreds or even thousands of times larger than the smallest numbers. Such a scale is nonlinear: the numbers 10 and 20, and 60 and 70, are not the same distance apart on a log scale. Rather, the numbers 10 and 100, and 60 and 600 are equally	Parent Class: MeasurementScale

	spaced. Thus moving a unit of distance along the scale means the number has been multiplied by 10 (or some other fixed factor). Source: https://plato.stanford.edu/entries/measurement-science/ Source: https://en.wikipedia.org/wiki/Logarithmic_scale/ Source: https://www.omg.org/spec/SysML/	
MaterialMeasure (material measure)	Definition: something that reproduces or supplies one or more quantities, each with an assigned quantity value Example: Ruler, standard weight, volume measure Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.14	Parent Class: Measure
Measure (measure)	Definition: amount or degree of something; the dimensions, capacity, or amount of something ascertained by measuring Note: Measure refers to the phenomenon or phenomena to be measured in a data set. In a data set, the instance of a measure is often called an observation. Source: https://stats.oecd.org/glossary/detail.asp?ID=7062	
MeasurementProcedure (measurement procedure)	Definition: detailed description of a measurement according to one or more measurement principles (*i.e.* phenomena, observables) and to a given measurement method, based on a measurement model and including any calculation to obtain a measurement result Example: Lowering of the concentration of glucose in blood in a fasting rabbit is an observable that can be applied to the measurement of insulin concentration in a preparation. Together with a description of the measurement method this can be used to define a measurement procedure. Note: A measurement procedure can include a statement concerning a target measurement uncertainty. Note: A measurement procedure is usually documented in sufficient detail to enable an operator to perform a measurement. Synonym: SOP Synonym: standard operating procedure Source: ISO 11240 Health informatics - Identification of medicinal products - Data	Parent Class: cmns-doc:ReferenceDocument

	elements and structures for the unique identification and exchange of units of measurement, clause 3.1.16	
MeasurementScale (measurement scale)	Definition: ordered set of quantity values of quantities of a given kind of quantity used in ranking, according to magnitude, quantities of that kind Note: Note that the majority of scalar quantities can be expressed by just using a MeasurementUnit directly as its measurement reference. This implies expression of a scalar quantity value on a ratio scale. However, for full coverage of all quantity value expressions, additional explicit measurement scales with additional semantics are needed, such as ordinal scale, interval scale, ratio scale with additional limit values, cyclic ratio scale and logarithmic scale. Synonym: quantity-value scale Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.27 Source: https://www.omg.org/spec/SysML/ Source: https://plato.stanford.edu/entries/measurement-science/	Parent Class: cmns-cls:ClassificationScheme Property Restriction: ≥ 0 hasMaximumPermissiveValue.ScalarQuantityValue Property Restriction: ≥ 0 hasMinimumPermissiveValue.ScalarQuantityValue Property Restriction: ≥ 0 isMaximumInclusive.xsd:boolean Property Restriction: ≥ 0 isMinimumInclusive.xsd:boolean Property Restriction: ≥ 0 cmns-cls:classifies.MeasurementUnit
MeasurementUnit (measurement unit)	Definition: real scalar quantity, defined and adopted by convention, with which any other quantity of the same kind can be compared to express the ratio of the second quantity to the first one as a number Example: week, day, hour, minute, second, kilogram, joule, meter Note: A Unit is a quantity in terms of which the magnitudes of other quantities that have the same quantity kind can be stated. A unit often relies on precise and reproducible ways to measure the unit. For example, a unit of length such as meter may be specified as a multiple of a particular wavelength of light. A unit may also specify less stable or precise ways to express some value, such as a cost expressed in some currency, or a severity rating measured by a numerical scale. Note: Depending on the nature of the reference scale, the unit of measurement expression may stand either for a physical unit of measurement that is related to a system of quantities (*e.g.* SI units) or for an arbitrarily defined unit of measurement, which may refer to a certain reference material, a standard measurement procedure, a material measure or even to a combination of those. Note: For a given quantity, the short term ‘unit’ is often combined with the quantity name, such as ‘mass unit’ or ‘unit of mass’.	

	Note: Measurement units are designated by conventionally assigned names and symbols. Note: Measurement units of quantities of dimension one are numbers. In some cases, these measurement units are given special names, *e.g.* radian, steradian, and decibel, or are expressed by quotients such as millimole per mole equal to 10 to the power minus 3 and microgram per kilogram equal to 10 to the power minus 9. Note: Measurement units of quantities of the same quantity dimension may be designated by the same name and symbol even when the quantities are not of the same kind. For example, joule per kelvin and J/K are respectively the name and symbol of both a measurement unit of heat capacity and a measurement unit of entropy, which are generally not considered to be quantities of the same kind. However, in some cases special measurement unit names are restricted to be used with quantities of specific kind only. For example, the measurement unit 'second to the power minus one' (1/s) is called hertz (Hz) when used for frequencies and becquerel (Bq) when used for activities of radionuclides. As another example, the joule (J) is used as a unit of energy, but never as a unit of moment of force, *i.e.* the newton meter (N m). Synonym: unit of measurement Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.33 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.9 Source: https://www.omg.org/spec/SysML/	
NominalScale (nominal scale)	Definition: measurement scale that represents objects as belonging to classes that have no particular order Example: Many nominal scales are qualitative in nature. A common example of a nominal scale is that of gender identity, which is a way of describing one's persistent inner concept of their gender. While the terminology from a psychological and medical perspective continues to evolve, the scale covers individuals who self identify as male or female as well as those that have a less determinant perspective, such as transsexual or non-binary. Source: https://plato.stanford.edu/entries/measurement-science/ Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4589638/	Parent Class: MeasurementScale

OrdinalScale (ordinal scale)	Definition: quantity-value scale for ordinal quantities, *i.e.*, one that represents order but no further algebraic structure Example: For example, the Mohs scale of mineral hardness represents minerals with numbers ranging from 1 (softest) to 10 (hardest), but there is no empirical significance to equality among intervals or ratios of those numbers. Note: An ordinal quantity-value scale may be established by measurements according to a measurement procedure. Note: Ordinal scales allow any transformation function as long as it is monotonic and increasing. Synonym: ordinal quantity-value scale Synonym: ordinal value scale Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.28 Source: https://plato.stanford.edu/entries/measurement-science/ Source: https://www.omg.org/spec/SysML/	Parent Class: MeasurementScale
Percentage (percentage)	Definition: ratio value expressed as a fraction of 100, *i.e.*, in which the denominator is fixed rather than variable and equal to 100 Note: The percent value is computed by multiplying the numeric value of the ratio by 100. Note: While many percentage values are between 0 and 100, there is no mathematical restriction and percentages may take on other values (positive or negative), particularly in the case of comparisons (percent change).	Parent Class: Ratio
PhysicalUnit (physical unit)	Definition: unit of measurement that is defined using a physical quantity Note: Its definition relates measured quantities to the base quantities through a set of well-defined equations. Note: Physical units and their related scales are defined independently of the measurement procedure and the measured components. They relate to an internationally standardized system of units and equations governing the mathematical relations between those units. Synonym: physical unit of measurement Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.21	Parent Class: MeasurementUnit Property Restriction: ∃ cmns-dsg:isDefinedIn.SystemOfUnits

Prefix (prefix)	Definition: named multiple or sub-multiple multiplication factor used in the specification of a derived unit Note: A prefix is a word or symbol for attachment to the name or symbol of a unit in order to form units that are multiples or sub-multiples of that unit. Note: A system of units may specify a set of prefixes. Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.22	Parent Class: Factor Property Restriction: = 1 hasFactorValue.owl:rational
PrefixedUnit (prefixed unit)	Definition: conversion-based unit that is defined with respect to another measurement reference unit through a linear conversion relationship with a named prefix that represents a multiple or submultiple of a unit Source: https://www.omg.org/spec/SysML/	Parent Class: ConversionBasedUnit Property Restriction: ∃ hasFactor.Prefix
QuantityDimension (quantity dimension)	Definition: expression of the dependence of a quantity on the base quantities of a system of quantities as a product of powers of factors corresponding to the base quantities, omitting any numerical factor Note: A power of a factor is the factor raised to an exponent. Each factor is the dimension of a base quantity. Note: In a given system of quantities, - quantities of the same kind have the same quantity dimension, - quantities of different quantity dimensions are always of different kinds, and - quantities having the same quantity dimension are not necessarily of the same kind. Note: In deriving the dimension of a quantity, no account is taken of its scalar, vector, or tensor character. Note: The conventional symbolic representation of the dimension of a base quantity is a single upper case letter in roman (upright) type. The conventional symbolic representation of the dimension of a derived quantity is the product of powers of the dimensions of the base quantities according to the definition of the derived quantity. The dimension of a quantity Q is denoted by dim Q. Synonym: dimension Synonym: dimension of a quantity Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of	Parent Class: cmns-cls:Classifier Property Restriction: ≥ 0 hasFactor.QuantityKindPowerFactor

	measurement, clause 3.1.9 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.7 Source: https://www.omg.org/spec/SysML/	
QuantityKind (quantity kind)	Definition: aspect common to mutually comparable quantities Example: The quantities diameter, circumference, and wavelength are generally considered to be quantities of the same kind, namely, of the kind of quantity called length. Example: The quantities heat, kinetic energy, and potential energy are generally considered to be quantities of the same kind, namely, of the kind of quantity called energy. Example: The quantities moment of force and energy are, by convention, not regarded as being of the same kind, although they have the same dimension. Similarly for heat capacity and entropy, as well as for number of entities, relative permeability, and mass fraction. Note: Quantities of the same kind within a given system of quantities have the same quantity dimension. However, quantities of the same dimension are not necessarily of the same kind. Synonym: kind of quantity Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.12 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.2 Source: https://www.omg.org/spec/SysML/	Parent Class: cmns-cls:Classifier Property Restriction: ≥ 0 hasMeasurementUnit.MeasurementUnit Property Restriction: ≥ 0 specializes.QuantityKind Property Restriction: ≥ 0 cmns-dsg:isDefinedIn.SystemOfQuantities Property Restriction: = 1 hasDimension.QuantityDimension
QuantityKindPowerFactor (quantity kind power factor)	Definition: factor in a product of powers that defines a derived quantity Source: https://www.omg.org/spec/SysML/	Parent Class: Factor Property Restriction: = 1 hasExponent.owl:rational Property Restriction: ∃ hasQuantityKind.QuantityKind
QuantityName (quantity name)	Definition: human-readable textual representation of the quantity Note: A number of systems of quantities and units encode a quantity, such as a unit of measure, via a generally accepted abbreviation. URIs representing such quantities are very useful in applications that require globally unique, machine readable names, but are less accessible to people. This concept is intended to provide the corresponding name for a given quantity in the context of a specific system of quantities and units for human consumption.	Parent Class: ContextualName Property Restriction: ≥ 0 cmns-cxtdsg:isDefinedApplicableIn.SystemOfQuantities Property Restriction: ≥ 0 cmns-cxtdsg:isDefinedApplicableIn.SystemOfUnits Property Restriction: ∃ cmns-dsg:isNameOf.ScalarQuantity

Ratio (ratio)	Definition: proportional relationship between two different quantity values that gives rise to a datum of a specific quantity kind Note: A ratio is a quantity measured with respect to some other quantity, or in mathematics a quotient of two numbers or expressions, arrived at by dividing one by the other. Synonym: rate Source: https://stats.oecd.org/glossary/detail.asp?ID=6688 Source: https://www150.statcan.gc.ca/n1/edu/power-pouvoir/glossary-glossaire/5214842-eng.htm#r	Parent Class: Expression Property Restriction: = 1 hasDenominator.ScalarQuantityValue Property Restriction: = 1 hasNumerator.ScalarQuantityValue
RatioScale (ratio scale)	Definition: measurement scale that represents quantitative values, allows comparison of differences in values, has a fixed zero value and is invariant under multiplication by a positive number Example: The Kelvin scale is a ratio scale, as are the familiar scales representing mass in kilograms, length in meters and duration in seconds. Source: https://plato.stanford.edu/entries/measurement-science/ Source: https://www.omg.org/spec/SysML/	Parent Class: MeasurementScale
RatioScaleWithAdditionalLimitValues (ratio scale with additional limit values)	Definition: measurement scale that that represents a ratio scale that has additional limit values Source: https://www.omg.org/spec/SysML/	Parent Class: RatioScale
ReferenceMaterial (reference material)	Definition: material, sufficiently homogeneous and stable with reference to specified properties, which has been established to be fit for its intended use in measurement or in examination of nominal properties Note: Some reference materials have assigned quantity values that are metrologically traceable to a measurement unit outside a system of units. Such materials include vaccines to which International Units (IU) have been assigned by the World Health Organization (WHO). Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.26	Parent Class: cmns-doc:Reference
ScalarQuantity (scalar quantity)	Definition: property of a phenomenon, body, or substance, where the property has a magnitude that can be expressed by means of a number and a reference	Property Restriction: ≥ 0 cmns-dsg:hasName.QuantityName Property Restriction: ∃ hasQuantityKind.QuantityKind

	Example: second, kilogram, joule, meter Note: A quantity as defined in ISO 80000 is a scalar. However, a vector or a tensor, the components of which are quantities, is also considered to be a quantity. Note: A reference can be a measurement unit, a measurement procedure, a reference material, or a combination of such. Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.24 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.1 Source: https://www.omg.org/spec/SysML/	
ScalarQuantityValue (scalar quantity value)	Definition: number and reference together expressing the magnitude of a quantity Note: According to the type of reference, a quantity value is either - a product of a number and a measurement unit; the measurement unit one is generally not indicated for quantities of dimension one, or - a number and a reference to a measurement procedure, or - a number and a reference material. Synonym: measurement Synonym: value of a quantity Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clauses 3.1.19, 3.1.25 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.19 Source: https://www.omg.org/spec/SysML/	Property Restriction: ≥ 0 expressesTheMagnitudeOf.ScalarQuantity Property Restriction: = 1 hasNumericValue.xsd:decimal Property Restriction: ∃ hasMeasurementUnit.MeasurementUnit
ScalarQuantityValueRange (scalar quantity value range)	Definition: expression of the lowest possible value and/or highest possible value for some scalar quantity	Parent Class: Expression Property Restriction: ≤ 1 hasLowerBound.ScalarQuantityValue Property Restriction: ≤ 1 hasUpperBound.ScalarQuantityValue
SystemOfQuantities (system of quantities)	Definition: set of quantities together with a set of non-contradictory equations relating those quantities Example: The International System of Quantities (ISQ) is an example of a SystemOfQuantities, defined in ISO 31 and ISO/IEC 80000. Note: Ordinal quantities, such as Rockwell C hardness, and nominal properties, such as color of light, are usually not considered to be part of a	Parent Class: cmns-cls:ClassificationScheme Property Restriction: ≥ 0 cmns-col:comprises.SystemOfQuantities Property Restriction: ≥ 0 cmns-cxtdsg:uses.SystemOfQuantities Property Restriction: ∃ cmns-dsg:defines.QuantityKind

	system of quantities because they are related to other quantities through empirical relations only. Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.29 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.3 Source: https://www.omg.org/spec/SysML/	
SystemOfUnits (system of units)	Definition: set of base units and derived units, together with their multiples and submultiples, defined in accordance with given rules, for a given system of quantities Source: ISO 11240 Health informatics - Identification of medicinal products - Data elements and structures for the unique identification and exchange of units of measurement, clause 3.1.30 Source: ISO 80000-1:2009 Quantities and units - Part 1: General, clause 3.13 Source: https://www.omg.org/spec/SysML/	Parent Class: cmns-cls:ClassificationScheme Property Restriction: ≥ 0 cmns-col:comprises.SystemOfUnits Property Restriction: ≥ 0 cmns-cxtdsg:uses.SystemOfUnits Property Restriction: = 1 cmns-col:compliesWith.SystemOfQuantities Property Restriction: ∃ cmns-dsg:defines.MeasurementUnit
Total (total)	Definition: sum of the values for some characteristic of all units	Parent Class: Expression
UnitPowerFactor (unit power factor)	Definition: factor in a product of powers that defines a derived unit Source: https://www.omg.org/spec/SysML/	Parent Class: Factor Property Restriction: = 1 hasMeasurementUnit.MeasurementUnit Property Restriction: = 1 hasExponent.owl:rational
Variable (variable)	Definition: symbol that represents a parameter in a formula or expression	Parent Class: ScalarQuantityValue

Properties

Name	Annotations	Property Axioms
describesActualExpression (describes actual expression)	Definition: specifies the calculation or expression used to determine the value of something Note: In cases where some expression can only be calculated in SPARQL or via rules, this property is useful for stating what that calculation should be using the input arguments to the expression.	Parent Property: cmns-dsg:hasDescription
expressesTheMagnitudeOf (expresses the magnitude of)	Definition: indicates the subject or topic of something, such as a document	Range: ScalarQuantity
hasArgument (has argument)	Definition: indicates a specific input to a function, formula or expression, also known as an independent variable	Range: ScalarQuantityValue ∪ ScalarQuantityValueRange

	Note: Note that this property and its subproperties apply in the context of quantities and units as well as statistical measures. They are not intended to support more general mathematics.	
hasDenominator (has denominator)	Definition: specifies the quantity value that is the part of a fraction 'below the line' and signifies the value by which the numerator should be divided Note: If a fraction is considered as an ordered pair, the denominator is the second argument of the fraction.	Parent Property: hasArgument Type: FunctionalProperty Range: ScalarQuantityValue ∪ ScalarQuantityValueRange
hasDimension (has dimension)	Definition: indicates a measurable extent associated with a given quantity kind in some system of quantities, which may be derived, depending on the choice of base quantity	Parent Property: cmns-cls:isClassifiedBy Domain: QuantityKind Range: QuantityDimension
hasExponent (has exponent)	Definition: indicates the number of times a number should be multiplied by itself	Type: FunctionalProperty Range: owl:rational
hasExpression (has expression)	Definition: specifies a finite combination of symbols, including constants, variables that may be ordered via one or more operators, that is well-formed according to rules that depend on the language and context	Range: Expression
hasFactor (has factor)	Definition: indicates a number or quantity that when multiplied with another produces a given number or expression	Parent Property: hasArgument
hasFactorValue (has factor value)	Definition: indicates the numeric multiple or submultiple multiplication factor	Type: FunctionalProperty Range: owl:rational
hasLowerBound (has lower bound)	Definition: specifies the quantity value that is the lower value of a pair of values representing a range	Parent Property: hasArgument, hasQuantityValue Type: FunctionalProperty Range: ScalarQuantityValue
hasMaximumPermissiveValue (has maximum permissive value)	Definition: indicates the maximum allowed value for a measurement on the given scale	Parent Property: hasQuantityValue Type: FunctionalProperty Domain: MeasurementScale Range: ScalarQuantityValue
hasMeasurementUnit (has measurement unit)	Definition: indicates the unit in which something is expressed	Range: MeasurementUnit
hasMinimumPermissiveValue (has minimum permissive value)	Definition: indicates the minimum allowed value for a measurement on the given scale	Parent Property: hasQuantityValue Type: FunctionalProperty Domain: MeasurementScale Range: ScalarQuantityValue
hasNumerator (has numerator)	Definition: specifies the quantity value that is the part of a fraction 'above the line' and signifies the value to be divided by the denominator	Parent Property: hasArgument Type: FunctionalProperty

	Note: If a fraction is considered as an ordered pair, the numerator is the first argument of the fraction.	Range: ScalarQuantityValue ∪ ScalarQuantityValueRange
hasNumericValue (has numeric value)	Definition: indicates a particular magnitude or designation for a given observable characteristic that is a number Source: https://www.omg.org/spec/SysML/	Type: FunctionalProperty Range: xsd:decimal
hasQuantityKind (has quantity kind)	Definition: indicates the class of mutually comparable quantities involved in the definition of an individual quantity or factor	Parent Property: cmns-cls:isClassifiedBy Range: QuantityKind
hasQuantityValue (has quantity value)	Definition: relates something (an expression, formula, etc.) to its magnitude expressed as a number together with its unit of measure (if applicable)	Range: ScalarQuantityValue
hasQuantityValueRange (has quantity range)	Definition: relates something (an expression, formula, etc.) to its magnitude expressed as range of numbers together with their unit(s) of measure (if applicable)	Parent Property: hasExpression Range: ScalarQuantityValueRange
hasUpperBound (has upper bound)	Definition: specifies the quantity value that is the higher value of a pair of values representing a range	Parent Property: hasArgument, hasQuantityValue Type: FunctionalProperty Range: ScalarQuantityValue
isDerivedFrom (is derived from)	Definition: indicates something from which the subject is obtained or determined Example: a derived quantity is derived from a base quantity; a derived unit is derived from a base unit	
isDimensionOf (is dimension of)	Definition: indicates a measurable extent associated with a given quantity kind in some system of quantities, which may be derived, depending on the choice of base quantity	Parent Property: cmns-cls:classifies Domain: QuantityDimension Range: QuantityKind Inverse: hasDimension
isMaximumInclusive (is maximum inclusive)	Definition: indicates whether something, such as a measurement scale, includes the absolute maximum permissive value or not	Type: FunctionalProperty Range: xsd:boolean
isMinimumInclusive (is minimum inclusive)	Definition: indicates whether something, such as a measurement scale, includes the absolute minimum permissive value or not	Type: FunctionalProperty Range: xsd:boolean
isValueOf (is value of)	Definition: is the measure that the value represents	Parent Property: cmns-cxtdsg:appliesTo Domain: ScalarQuantityValue Inverse: hasQuantityValue
specializes (specializes)	Definition: indicates something whose nature is more general (broader than) the subject	

8.14 Ontology: Roles and Compositions

The roles and compositions ontology defines the concept of a role, supporting the representation of participants in compositions, situations, and relationships, as well as properties that link the role to something that plays that role, that links something to a role it has (*e.g.*, a role that is pertinent to a situation or composition), as well as inverses that enable role traversal in a graph. In addition, it defines the notion of a composition that can be used, for example to relate something, such as a product or recipe, to its ingredients or constituents, and/or to the roles such constituents play in the composition, and optionally to some context, such as a jurisdiction, in which the composition is relevant.

Metadata for the Roles and Compositions ontology is given in Table 8.27.

Table 8.27: Roles and Compositions Ontology Metadata

Metadata Term	Value
OntologyIRI	https://www.omg.org/spec/Commons/RolesAndCompositions/
rdfs:label	Commons Roles and Compositions Ontology
dct:abstract	This ontology defines the high-level things defining roles, which enable specification of the various participants in something, and the notion of a composition, i.e., relating something that is a specification for a 'whole', such as a product or recipe, to its ingredients or constituents, potentially with respect to some context-specific requirements.
dct:contributor	Dean Allemang, Working Ontologist
dct:contributor	Elisa Kendall, Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2020-2023 EDM Council, Inc.
cmns-av:copyright	Copyright (c) 2020-2023 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2020-2023 Working Ontologist LLC
cmns-av:copyright	Copyright (c) 2022-2023 Pistoia Alliance, Inc.
cmns-av:copyright	Copyright (c) 2023 Object Management Group, Inc.
dct:license	https://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20230801/RolesAndCompositions/
skos:note	This ontology was derived from the Financial Industry Business Ontology (FIBO) and extended based on usage in other projects, such as the Pistoia Alliance Identification of Medicinal Products (IDMP) ontology project.

A summary diagram for the Roles and Compositions ontology is given in Figure 14.

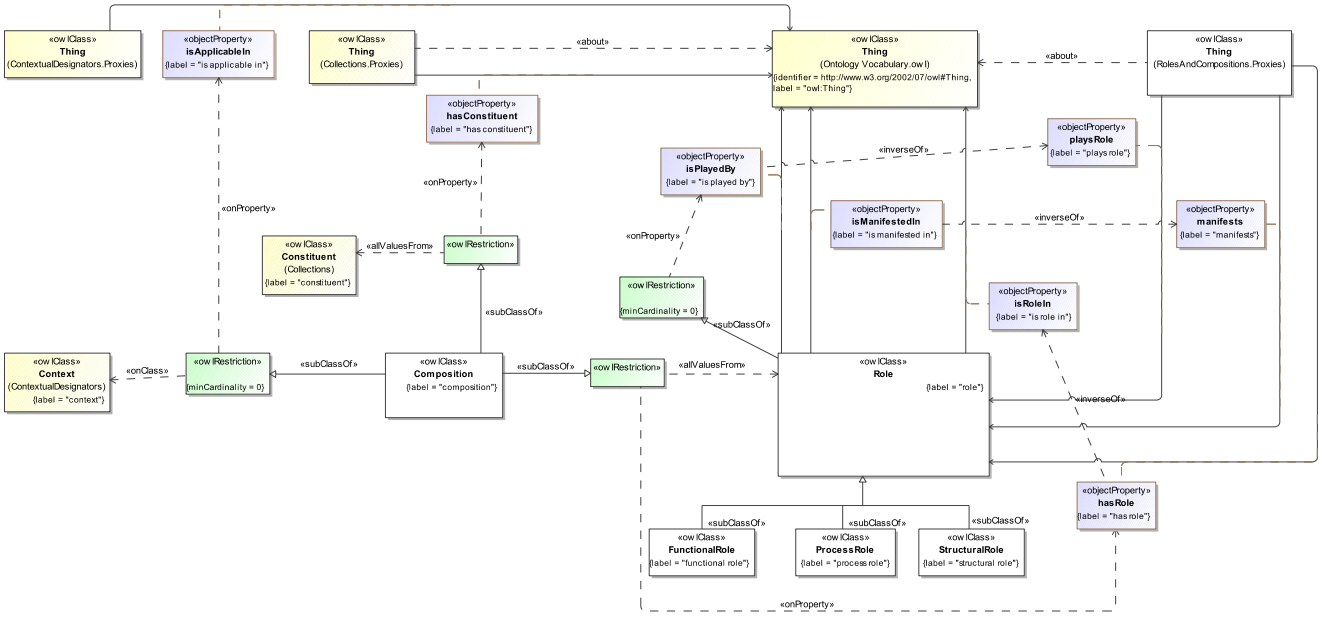

Figure 14: Roles and Compositions Ontology Overview

The detailed annotations and axioms that comprise the Roles and Compositions ontology are provided in Table 8.28, below.

Table 8.28: Roles and Compositions Ontology Details

Classes

Name	Annotations	Class Expressions
Composition (composition)	Definition: distinct thing resulting from bringing together other things, possibly in specific roles, for a particular purpose Explanatory note: The composition may be specified based on the roles that the things play in the composition, such as the roles that various ingredients play in a recipe or pharmaceutical product, and such things may or may not be transformed in some way through the process of combining them. Quantification including the nature and amount of each thing, potentially including the ratio of the quantities, may be required depending kind of composition. Usage note: The properties hasConstituent and hasRole are included in value restrictions rather than via number restrictions to facilitate their use in complex property chains and other axioms as needed for some applications. Adapted from: ISO/IEC 18384-1:2016,	Property Restriction: ∀ cmns-col:hasConstituent.cmns-col:Constituent Property Restriction: ∀ hasRole.Role Property Restriction: ≥ 0 cmns-cxtdsg:isApplicableIn.cmns-cxtdsg:Context

	Information technology - Reference Architecture for Service Oriented Architecture (SOA RA) - Part 1: Terminology and concepts for SOA, clause 2.5 and ISO/IEC 18384-3:2016, Information technology - Reference Architecture for Service Oriented Architecture (SOA RA) - Part 3: Service Oriented Architecture ontology, clause 8.2 Adapted from: ISO/TS 19807-1:2019(en), Nanotechnologies - Magnetic nanomaterials - Part 1: Specification of characteristics and measurements for magnetic nanosuspensions, clause 3.4	
FunctionalRole (functional role)	Definition: role representing an underlying functionality that something, such as a person, organization, process, or service, is expected to perform or deliver Note: Functional roles can be assigned to be performed during an act. Adapted from: ISO 21298:2017(en), Health informatics - Functional and structural roles, clause 3.9 Adapted from: ISO/IEC 19763-8:2015(en), Information technology - Metamodel framework for interoperability (MFI) - Part 8: Metamodel for role and goal model registration, clause 3.1.2	Parent Class: Role
ProcessRole (process role)	Definition: role that associates resources and participants to a structured set of activities involving various enterprise entities, that is designed and organised for a given purpose Adapted from: ISO 12651-2:2014(en), Electronic document management - Vocabulary - Part 2: Workflow management, clause 3.33 Adapted from: ISO 18629-1:2004(en), Industrial automation systems and integration - Process specification language - Part 1: Overview and basic principles	Parent Class: Role
Role (role)	Definition: named specific behavior of something participating in a particular context Adapted from: ISO/IEC 19763-8:2015(en), Information technology - Metamodel framework for interoperability (MFI) - Part 8: Metamodel for role and goal model registration, clause 3.1.7	Property Restriction: ≥ 0 isPlayedBy
StructuralRole (structural role)	Definition: role specifying relations between entities in the sense of competence, often reflecting organizational or structural relations (hierarchies) Source: ISO 21298:2017(en), Health informatics - Functional and structural roles, clause 3.26	Parent Class: Role

Properties

Name	Annotations	Property Axioms
hasRole (has role)	Definition: identifies something or someone playing a part in something, such as a composition	Range: Role
isManifestedIn (is manifested in)	Definition: indicates something in which the role is realized, appears, or occurs	Domain: Role Inverse: manifests
isPlayedBy (is played by)	Definition: indicates something or someone, such as a person, organization, or other element filling a role Example: A party, counterparty, or third party to a contract is played by an organization or person; an issuer of a financial instrument is typically played by an organization; an ingredient in a recipe may be played by a substance.	Domain: Role Inverse: playsRole
isRoleIn (is role in)	Definition: identifies something, such as a composition, situation, or contract, involving the role	Domain: Role Inverse: hasRole
manifests (manifests)	Definition: indicates a role that realizes, displays, or shows something, typically in some context	Range: Role
playsRole (plays role)	Definition: indicates a part that someone or something plays under some circumstance Example: an organization may play the role of employer, issuer, regulatory agency, bank, custodian, manufacturer, vendor, etc.; a person may play the role of employee, examiner, banker, seller, buyer, etc.	Range: Role

8.15 Ontology: Text Datatype

The text datatype ontology defines a custom datatype that combines language tagged and plain string values. This text datatype is useful in cases where it is not clear whether string values will be tagged or not, but where it is anticipated that multilingual strings might be appropriate.

Metadata for the Text Datatype ontology is given in Table 8.29.

Table 8.29: Text Datatype Ontology Metadata

Metadata Term	Value
`OntologyIRI`	`https://www.omg.org/spec/Commons/TextDatatype/`
`rdfs:label`	`Commons Text Datatype Ontology`
`dct:abstract`	`The text datatype ontology defines a custom datatype that combines language tagged and plain string values. This text datatype is useful in cases where it is not clear whether string values will be tagged or not, but where it is anticipated that multilingual strings might be`

	appropriate.
dct:contributor	Elisa Kendall, Thematix Partners LLC
dct:contributor	Evren Sirin, Stardog Union
cmns-av:copyright	2020-2022 Stardog Union
cmns-av:copyright	Copyright (c) 2020-2022 Thematix Partners LLC
cmns-av:copyright	Copyright (c) 2022 Object Management Group, Inc.
dct:license	http://opensource.org/licenses/MIT
owl:versionIRI	https://www.omg.org/spec/Commons/20221101/TextDatatype/
skos:note	Note that custom datatypes are outside the OWL 2 RL profile and so its usage in applications may need to be commented out.

An overview of the Text Datatype ontology is given in Figure 15.

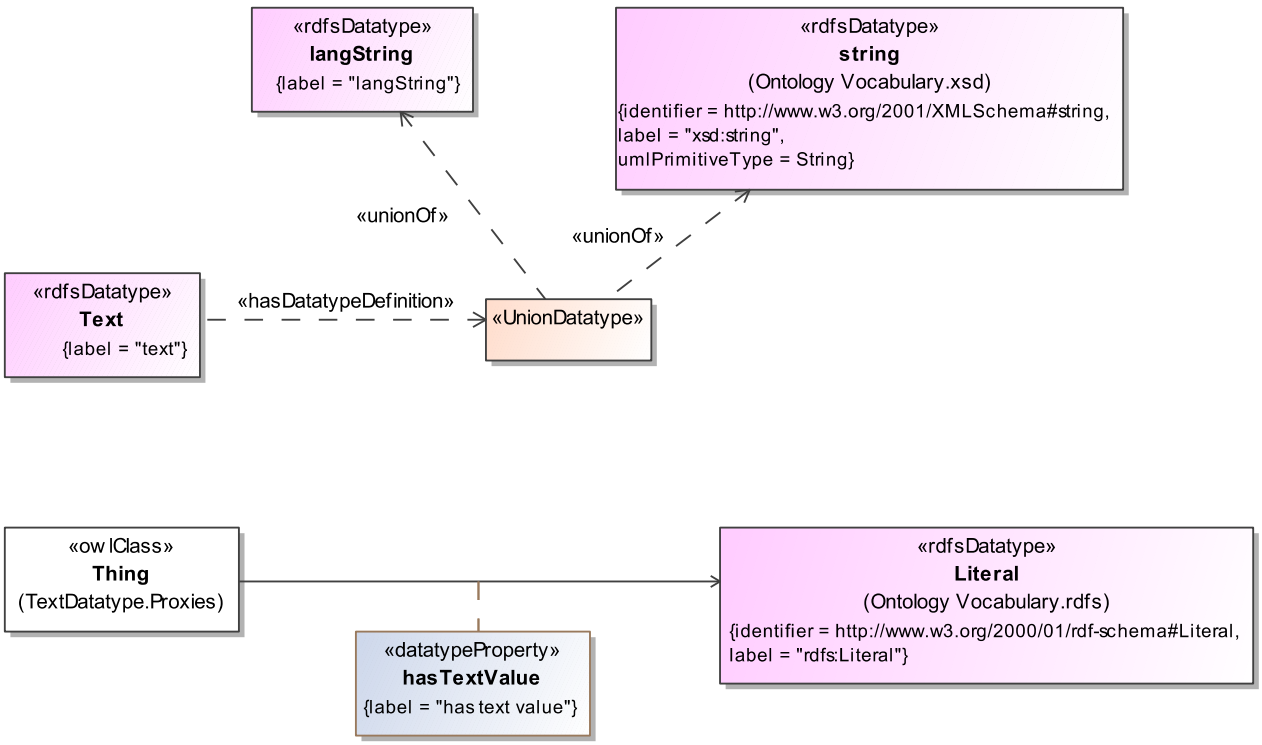

Figure 15: Overview of the Text Datatype Ontology

The detailed annotations and axioms that comprise the Text Datatype ontology are provided in Table 8.30, below.

Table 8.30: Text Datatype Ontology Details

Datatypes

Name	Annotations	Class Expressions
rdf;langString (langString)	Definition: literal with a non-empty language tag Note: This datatype declaration is included to support language-tagged strings, as defined in RDF 1.1. The rdf:langString datatype has not been incorporated directly in OWL 2 to date, and so it must be declared in order to enable its inclusion in the declaration of the Text datatype. Language-tagged strings must be well-formed according to section 2.2.9 of [BCP47]. Source: BCP 47: Tags for Identifying Languages, available at https://tools.ietf.org/search/bcp47 Source: https://www.w3.org/TR/rdf11-concepts/#section-Datatypes	
Text (text)	Definition: datatype that maps to xsd:string and rdf:langString base types for string-valued data properties and annotations Note: Text is data in the form of characters, symbols, words, phrases, paragraphs, sentences, tables, or other character arrangements, intended to convey a meaning, and whose interpretation is essentially based upon the reader's knowledge of some natural language or artificial language. Note: There are cases where the representation of certain features of something, such as a name, which might be multilingual or might not, defaults to rdfs:Literal when left unspecified, although it should be limited to plain strings or language-typed strings (*i.e.*, exclude numbers, binary types, and so forth). There is no combined datatype available in RDF or OWL, however, which is the role that this datatype is intended to fulfill. Scope note: This composite datatype should be used in cases where a standard representation using one of the options in the union for string values does not work. Note that certain tools may not support rdf:langString, including, but not limited to some versions of Protege, and that custom datatypes are not supported in OWL 2 RL so it may need to be ignored or commented out in OWL 2 RL applications. Source: ISO/IEC 11179-3 Information technology - Metadata registries (MDR) - Part 3: Registry metamodel and basic attributes, Third edition, 2013-02-15 Usage note: Commons users that depend on tools that lack support for rdf:langString may not want to use this datatype in their applications. Testing with specific reasoners, for example, is advised.	Equivalent Datatype: ∪ (xsd:string, rdf:langString)

Properties

Name	Annotations	Property Axioms
hasTextValue (has text value)	Definition: provides a string value for something, with or without a language tag Note: Note that although the intended range for this property is Text, we have left the range undefined so that it can be used with tools that do not support rdf:langString.	

Annex A: Deliverables

(normative)

The Commons ontologies are delivered as (1) RDF/XML serialized OWL (normative and definitive), and (2) Turtle serialized OWL (normative and definitive).

Each of the ontologies included in the Commons Ontology Library makes normative reference to the DCMI Dublin Core Metadata Terms [Dublin Core] and W3C Simple Knowledge Organization System (SKOS) Recommendation [SKOS], which are not part of this specification.

The individual RDF/XML files are UTF-8 conformant XML files that are also OWL 2 compliant, and may be examined using any text editor, XML editor, or RDF or OWL editor. They have been verified for syntactic correctness via the W3C RDF Validator and pass a series of unit-level tests provided by the EDM Council in our Open Knowledge Graph Innovation Laboratory (OKG IL) that cover a range of syntactic and modeling pattern issues. They have also been checked for logical consistency using the HermiT OWL 2 reasoner from Oxford University. It is anticipated that the OWL ontologies will be dereference-able, together with technical documentation (HTML) from the OMG site.

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Annex B: Examples

(informative)

The ontologies included in the Commons Ontology Library leverage modeling patterns found in many data management and knowledge graph based applications. Some of these patterns are reused in more specific parts of the library, such as many of the annotation properties given in the Annotation Vocabulary. Examples for cases that are not provided in the library itself may be helpful to implementers and a number of such examples that we hope will clarify how to use the ontologies are given below.

8.16 Classifiers and Classification Schemes

From an ontological perspective, a classification scheme is typically used to 'put things in buckets' – a controlled vocabulary, organizing scheme, set of categories to support faceted searching and the like. ISO/IEC 11179-3:2013 Information technology – Metadata registries (MDR) – Part 3: Registry metamodel and basic attributes[10] provides a pattern for representing classification schemes and the classifiers defined in such schemes, which the ontology follows. In finance, the set of 'asset classes' used to classify financial instruments, such as those specified in ISO 10962, Securities and related financial instruments – Classification of financial instruments (CFI) code[11], represent examples of both classifiers and codes at the same time. Another such scheme is the North American Industry Classification System (NAICS), used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy[12] Recently published ISO standards for the identification of medicinal products include several classification schemes. For example, in the ISO 11238:2018 Health informatics – Identification of medicinal products – Data elements and structures for the unique identification and exchange of regulated information on substances[13], taxonomic structures for classifying substances as polymers, proteins, structurally diverse substances, and mixtures are derived from biological matrices. The example that follows shows a kind of classifier for substance names, specified in the ISO 11238 standard for describing and identifying substances, and includes a controlled vocabulary of valid values. Thus, the class 'substance name classifier' is a subclass of 'classifier', and each of the valid values is modeled as a named individual whose type is 'substance name classifier'. Note that the use of 'min 0' in a restriction is quite useful to show users that while the main ontology for substances does not require a value for all possible substance names it classifies, since new substances are added to various repositories on a regular basis, using inverse reasoning on individuals of type substance name for the property "is classified by" would yield that information.

```
<owl:Class rdf:about="&idmp-sub;SubstanceNameClassifier">
       <rdfs:subClassOf rdf:resource="&cmns-cls;Classifier"/>
       <rdfs:subClassOf>
              <owl:Restriction>
                     <owl:onProperty rdf:resource="&cmns-cls;classifies"/>
                     <owl:onClass rdf:resource="&idmp-sub;SubstanceName"/>
```

[10] See https://www.iso.org/standard/76748.html

[11] See https://www.iso.org/standard/81140.html.

[12] See https://www.census.gov/naics/.

[13] See https://www.iso.org/standard/69697.html.

```
                        <owl:minQualifiedCardinality
rdf:datatype="&xsd;nonNegativeInteger">0</owl:minQualifiedCardinality>
                    </owl:Restriction>
             </rdfs:subClassOf>
             <rdfs:label>substance name classifier</rdfs:label>
             <dct:source>ISO 11238:2018 Health informatics - Identification of medicinal
products (IDMP) - Data elements and structures for the unique identification and exchange
of regulated information on substances, clause 6.4</dct:source>
             <dct:source>ISO/TS 19844:2018(E) Health informatics - Identification of
medicinal products (IDMP) - Implementation guidelines for ISO 11238 for data elements and
structures for the unique identification and exchange of regulated information on
substances, clause 6.3.2</dct:source>
             <skos:definition>classifier that describes the nature of the substance name
from a pre-defined ISO 19844 code set</skos:definition>
             <cmns-av:synonym>substance name type</cmns-av:synonym>
      </owl:Class>
```

Two of the named individuals that are specified in the standard and enumerated in the ISO 19844 implementation guide as a part of this scheme include:

```
      <owl:NamedIndividual rdf:about="&idmp-sub;SubstanceNameClassifier-BrandName">
             <rdf:type rdf:resource="&idmp-sub;SubstanceNameClassifier"/>
             <rdfs:label>substance name classifier - brand name</rdfs:label>
             <dct:source>ISO 11238:2018 Health informatics - Identification of medicinal
products (IDMP) - Data elements and structures for the unique identification and exchange
of regulated information on substances, clause 6.4</dct:source>
             <dct:source>ISO/TS 19844:2018(E) Health informatics - Identification of
medicinal products (IDMP) - Implementation guidelines for ISO 11238 for data elements and
structures for the unique identification and exchange of regulated information on
substances, clause 6.3.2</dct:source>
             <skos:definition>substance name classifier for a name by which a company
identifies a given substance typically for marketing purposes</skos:definition>
             <cmns-dsg:isDefinedIn rdf:resource="&idmp-sub;ISO11238-
ClassificationScheme"/>
             <cmns-txt:hasTextValue>Brand Name</cmns-txt:hasTextValue>
      </owl:NamedIndividual>


      <owl:NamedIndividual rdf:about="&idmp-sub;SubstanceNameClassifier-OfficialName">
             <rdf:type rdf:resource="&idmp-sub;SubstanceNameClassifier"/>
             <rdfs:label>substance name classifier - official name</rdfs:label>
             <dct:source>ISO 11238:2018 Health informatics - Identification of medicinal
products (IDMP) - Data elements and structures for the unique identification and exchange
of regulated information on substances, clause 6.4</dct:source>
             <dct:source>ISO/TS 19844:2018(E) Health informatics - Identification of
medicinal products (IDMP) - Implementation guidelines for ISO 11238 for data elements and
structures for the unique identification and exchange of regulated information on
substances, clause 6.3.2, B.4.27</dct:source>
             <skos:definition>substance name classifier for a name that is typically
nonproprietary used in a given jurisdiction and domain to refer to a specific
substance</skos:definition>
             <skos:example>INN: International Nonproprietary Name, also known as rINN,
recommended International Nonproprietary Name or pINN, proposed International
Nonproprietary Name or INNM, Modified International Nonproprietary Name published by WHO:
World Health Organization: in accordance with rules.</skos:example>
             <skos:note>The domain, jurisdiction, and authority that assigned the name
(USAN, INN, JAN etc.) and the language of the name are also captured.</skos:note>
```

```
            <cmns-dsg:isDefinedIn rdf:resource="&idmp-sub;ISO11238-
ClassificationScheme"/>
            <cmns-txt:hasTextValue>Official</cmns-txt:hasTextValue>
      </owl:NamedIndividual>
```

The representation of the scheme for the set of classifiers defined by ISO 11238 to which these substance name classifiers conform is shown below.

```
      <owl:NamedIndividual rdf:about="&idmp-sub;ISO11238-ClassificationScheme">
            <rdf:type rdf:resource="&cmns-cls;ClassificationScheme"/>
            <rdfs:label>ISO 11238 classification scheme</rdfs:label>
            <rdfs:seeAlso
rdf:datatype="&xsd;anyURI">https://www.iso.org/standard/71965.html</rdfs:seeAlso>
            <skos:definition>system for classifying substances and substance-related
information specified in the ISO 11238 specification</skos:definition>
      </owl:NamedIndividual>
```

8.17 Codes and Code Sets

A similar pattern is defined in the library for the representation of codes and code sets, also following the pattern provided in ISO 11179-3. A code set, also called a code system, typically includes a finite number of codes at any point in time, such as the set of codes specified in ISO 10383:2012 Securities and related financial instruments – Codes for exchanges and market identification (MIC), which are revised on a monthly basis by the registration authority. Each MIC code represents a single, unique market, and as such is also an identifier, whereas the NAICS codes mentioned above are both classifiers and codes. The distinction between being an identifier and being a classifier is that the latter is used to characterize a group of things rather than an individual thing. Some code sets are versioned on a regular basis, such as the International Statistical Classification of Diseases and Related Health Problems (ICD), published by the World Health Organization (WHO). The ICD is revised periodically and is currently in its 11th revision. The example provided below defines the concept of a substance code. Certain codes that are also classifiers are used in the IDMP standards as controlled vocabularies. A controlled vocabulary, as defined in ISO 11238, is a “finite set of values that represent the only allowed values for a data item”. Such a vocabulary can include codes, text values, or numeric values according to the standard. One example is used in the implementation guide for ISO 11238 to indicate whether a certain characteristic is required or optional, depending on the kind of substance.

```
      <owl:Class rdf:about="&idmp-sub;ConformanceLevel">
            <rdfs:subClassOf rdf:resource="&cmns-cls;Classifier"/>
            <rdfs:subClassOf rdf:resource="&cmns-cds;CodeElement"/>
            <rdfs:label>conformance level</rdfs:label>
            <dct:source>ISO/TS 19844:2018(E) Health informatics - Identification of
medicinal products (IDMP) - Implementation guidelines for ISO 11238 for data elements and
structures for the unique identification and exchange of regulated information on
substances, clause 5</dct:source>
            <owl:equivalentClass>
                  <owl:Class>
                        <owl:oneOf rdf:parseType="Collection">
                              <rdf:Description rdf:about="&idmp-sub;ConformanceLevel-
Mandatory">
                              </rdf:Description>
                              <rdf:Description rdf:about="&idmp-sub;ConformanceLevel-
Conditional">
                              </rdf:Description>
                              <rdf:Description rdf:about="&idmp-sub;ConformanceLevel-
Optional">
```

```
                                    </rdf:Description>
                                </owl:oneOf>
                            </owl:Class>
                        </owl:equivalentClass>
                        <skos:definition>classifier that describes whether an element is required
for a given substance type or a specified substance group</skos:definition>
                        <skos:scopeNote>Conformance is not meant to be applied globally.
Conformance will be expressed based on the following terminology: Mandatory, Conditional
and Optional. Whether a data element is conditional by data, by process or by regional
rule will be defined within regional implementation guides.</skos:scopeNote>
        </owl:Class>
```

An example individual code defined as a member of this controlled vocabulary is given below.

```
        <owl:NamedIndividual rdf:about="&idmp-sub;ConformanceLevel-Conditional">
                <rdf:type rdf:resource="&idmp-sub;ConformanceLevel"/>
                <rdfs:label>conformance level - conditional</rdfs:label>
                <dct:source>ISO 11238:2018 Health informatics - Identification of medicinal
products (IDMP) - Data elements and structures for the unique identification and exchange
of regulated information on substances, clause 5.9</dct:source>
                <dct:source>ISO/TS 19844:2018(E) Health informatics - Identification of
medicinal products (IDMP) - Implementation guidelines for ISO 11238 for data elements and
structures for the unique identification and exchange of regulated information on
substances, clause 5</dct:source>
                <skos:definition>conformance level that applies to data elements ‘within a
category’ as applicable, that are subject to business rules and may become required by:
data rules; process rules; regional rules</skos:definition>
                <skos:note>Conditional applies when there are alternative data sources for
a given data element(s) to identify a Substance/Specified Substance. Regional
implementation of the ISO 11238 and ISO/TS 19844 may elevate the conditional conformance
categories to mandatory per regional requirements.</skos:note>
                <cmns-col:isMemberOf rdf:resource="&idmp-sub;ISO19844-CodeSet"/>
                <cmns-txt:hasTextValue>CONDITIONAL</cmns-txt:hasTextValue>
        </owl:NamedIndividual>
```

The corresponding code set is defined as follows.

```
        <owl:NamedIndividual rdf:about="&idmp-sub;ISO19844-CodeSet">
                <rdf:type rdf:resource="&cmns-cds;CodeSet"/>
                <rdfs:label>ISO 19844 code set</rdfs:label>
                <rdfs:seeAlso
rdf:datatype="&xsd;anyURI">https://www.iso.org/standard/71965.html</rdfs:seeAlso>
                <skos:definition>set of controlled vocabularies and codes for reporting of
substance-related information specified in the ISO/TS 19844 guidelines</skos:definition>
        </owl:NamedIndividual>
```

8.18 Identifiers and Identification Schemes

Another pattern is defined in the library for the representation of identifiers and identification schemes, again following the pattern provided in ISO 11179-3. Chemical substances typically are assigned numerous codes and identifiers world-wide, which may be minted by some regulatory agency or organization such as a pharmaceutical company. Reconciliation of such codes is a difficult process and can be near impossible to do without having an unambiguous representation of the molecular formula for the substance. Although the intent is to assign a registration authority to create a globally unique substance identifier per the definition of substance identifier given in the ISO 11238 standard,

none has been established to date. The definition of the more general substance code, which is both a code element and identifier, is given below.

```
	<owl:Class rdf:about="&idmp-sub;SubstanceCode">
		<rdfs:subClassOf rdf:resource="&cmns-cds;CodeElement"/>
		<rdfs:subClassOf rdf:resource="&cmns-id;Identifier"/>
		<rdfs:subClassOf>
			<owl:Restriction>
				<owl:onProperty rdf:resource="&idmp-sub;hasComment"/>
				<owl:maxCardinality
rdf:datatype="&xsd;nonNegativeInteger">1</owl:maxCardinality>
			</owl:Restriction>
		</rdfs:subClassOf>
		<rdfs:subClassOf>
			<owl:Restriction>
				<owl:onProperty rdf:resource="&idmp-sub;hasChangeDate"/>
				<owl:maxQualifiedCardinality
rdf:datatype="&xsd;nonNegativeInteger">1</owl:maxQualifiedCardinality>
				<owl:onDataRange rdf:resource="&cmns-dt;CombinedDateTime"/>
			</owl:Restriction>
		</rdfs:subClassOf>
		<rdfs:subClassOf>
			<owl:Restriction>
				<owl:onProperty rdf:resource="&cmns-id;identifies"/>
				<owl:onClass rdf:resource="&idmp-sub;Substance"/>
				<owl:qualifiedCardinality
rdf:datatype="&xsd;nonNegativeInteger">1</owl:qualifiedCardinality>
			</owl:Restriction>
		</rdfs:subClassOf>
		<rdfs:label>substance code</rdfs:label>
		<skos:definition>sequence of characters denoting a registered code for a
given substance that is associated with a publicly recognized code
system</skos:definition>
		<skos:example>CAS Registry numbers, EC numbers, FDA UNII codes, EMA XEVMPD
codes, ASK numbers, EPA Pesticide codes</skos:example>
		<skos:example>These codes include Chemical Abstract Service (CAS) Registry
Numbers, European Inventory of Existing Commercial Chemical Substances (EINECS), European
Drug Codes (XEVMPD) and Japanese Drug Codes.</skos:example>
		<skos:note>Codes typically facilitate mapping and linking of substances to
a variety of information sources.</skos:note>
		<skos:note>The actual code shall be captured using the same format that is
used in the code system. Only codes associated with a code system shall be captured. The
code shall be specifically associated with a given substance. Many public and non-public
databases identify substances with a code and these codes can be very helpful in mapping
substances to various systems. Codes shall always be verified against the source system.
Different jurisdictions may require a code from a code system or multiple code systems to
be associated and submitted with a substance.</skos:note>
		<cmns-av:adaptedFrom>ISO 11238:2018 Health informatics - Identification of
medicinal products (IDMP) - Data elements and structures for the unique identification
and exchange of regulated information on substances, clause 7.2.8</cmns-av:adaptedFrom>
		<cmns-av:adaptedFrom>ISO/TS 19844:2018(E) Health informatics -
Identification of medicinal products (IDMP) - Implementation guidelines for ISO 11238 for
data elements and structures for the unique identification and exchange of regulated
information on substances, clause 6.5</cmns-av:adaptedFrom>
	</owl:Class>
```

For example, a UNII is a unique code and identifier for a substance that has been registered by the U.S. Food and Drug Administration.

```
	<owl:Class rdf:about="&idmp-ra;UniqueIngredientNumber">
		<rdfs:subClassOf rdf:resource="&idmp-sub;SubstanceCode"/>
		<rdfs:label>unique ingredient number</rdfs:label>
		<skos:definition>10-character, randomly generated alpha-numeric string that
is used to identify substances in medicinal products in the FDA Global Substance
Registration System (G-SRS)</skos:definition>
		<skos:note>The first nine characters are randomly generated followed by a
check character. The integrity check on the UNII is stronger than both the EC# and the
CAS Registry Number because of the random generation from a large number of potential
UNIIs and the fact that there are 36 possible check characters compared to 10 with both
the EC# and CAS Registry Number.</skos:note>
		<skos:scopeNote>The UNII is freely available for use and there is a
mechanism whereby a manufacturer can petition for the generation of a UNII through the
FDA. The system has the capability for both public and restricted access to information,
and can be adapted to produce specified substance identifiers.</skos:scopeNote>
		<cmns-av:abbreviation>UNII</cmns-av:abbreviation>
		<cmns-av:directSource>ISO 11238:2018 Health informatics - Identification of
medicinal products (IDMP) - Data elements and structures for the unique identification
and exchange of regulated information on substances, clause A.1.5</cmns-av:directSource>
	</owl:Class>
```

Note that some additional details, such as the registration authority and registry have been elided for the sake of simplifying the example. The corresponding code set and identification scheme is defined as follows.

```
	<owl:NamedIndividual rdf:about="&idmp-ra;UniqueIngredientNumber-CodeSet">
		<rdf:type rdf:resource="&cmns-cds;CodeSet"/>
		<rdf:type rdf:resource="&cmns-id;IdentificationScheme"/>
		<rdfs:label>unique ingredient number code set</rdfs:label>
		<skos:definition>code set and identification scheme that specifies the
rules for generating the 10-character alpha-numeric string used to identify substances in
medicinal products in the FDA Global Substance Registration System
(G-SRS)</skos:definition>
	</owl:NamedIndividual>
```

An example individual UNII for the substance, amlodipine, is given below.

```
	<owl:NamedIndividual rdf:about="&idmp-amp;UNII-1J444QC288">
		<rdf:type rdf:resource="&idmp-ra;UniqueIngredientNumber"/>
		<rdfs:label>1J444QC288</rdfs:label>
		<dct:source
rdf:resource="https://precision.fda.gov/uniisearch/srs/unii/1J444QC288"/>
		<cmns-id:identifies
rdf:resource="https://gsrs.ncats.nih.gov/api/v1/substances/1J444QC288"/>
		<cmns-id:identifies rdf:resource="&idmp-amp;Amlodipine"/>
		<cmns-txt:hasTextValue>1J444QC288</cmns-txt:hasTextValue>
	</owl:NamedIndividual>
```

Details with respect to the registry and registration authority have been elided to simplify the example.

8.19 Role and Composition

The notion of a composition is widely used in UML modeling, but is not provided “out of the box” in the Web Ontology Language (OWL). Ontologists frequently need to reify relationships, for example to represent ternary relations, without having a single pattern built into the language for doing so, although several options are described in ‘Defining N-ary Relations on the Semantic Web’[14].

The model described herein provides a pattern for representing roles and compositions and incorporates three restrictions on composition that are optional: (1) inclusion of constituents – parts of something, (2) inclusion of roles, and (3) context.

One common kind of composition is that of a recipe. A recipe has ingredients, each of which may have some amount, and possibly other properties associated with them. In the case of pharmaceutical ingredients which are substances playing the role of ingredients, for example, each has an amount and a strength as well as certain jurisdiction-specific details.

Figure 1, below, provides a partial, high-level diagram from an explanatory wiki page for the Identification of Medicinal Products (IDMP-O)[15] ontology project for a pharmaceutical product composition, showing the relationships between the composition and its ingredients.

In the diagram, the ‘has ingredient’ property is a subproperty of ‘has role’ in the Commons Roles and Compositions ontology.

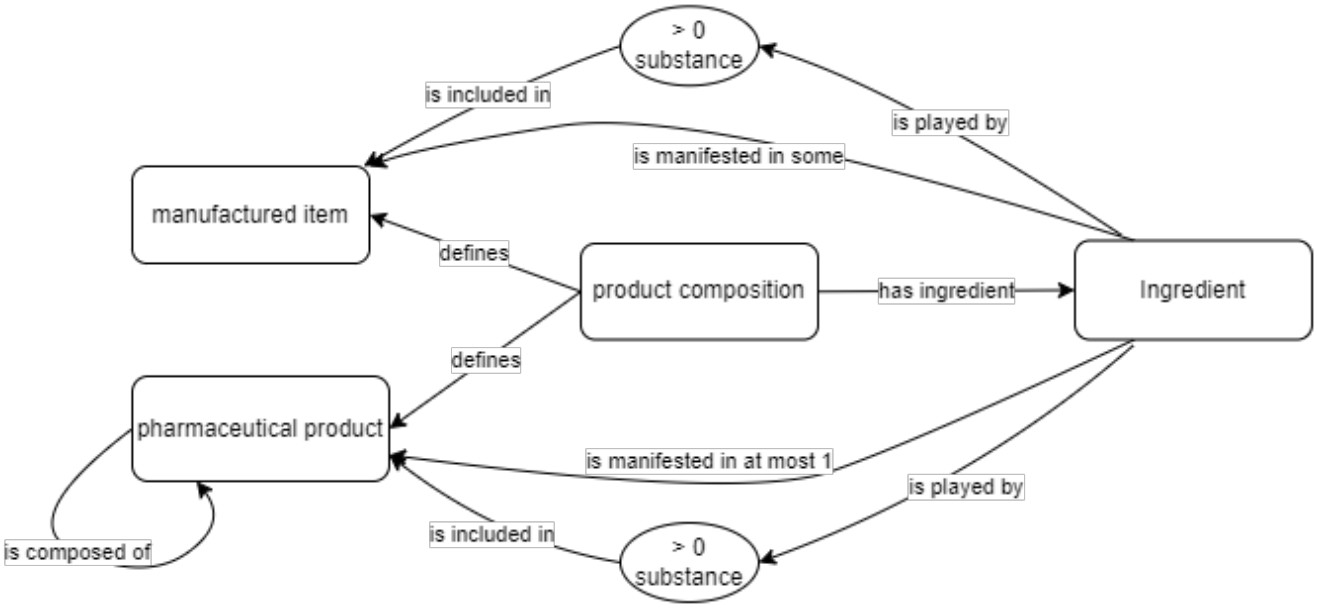

Figure 16. Example product composition

A turtle representation of the OWL definitions for product composition, has ingredient and the ingredient class are given below.

[14] https://www.w3.org/TR/swbp-n-aryRelations/

[15] https://wiki.edmcouncil.org/display/IDMP/Pattern%3A+Representing+Ingredients+-+APPROVED

```
idmp-mprd:ProductComposition
      a owl:Class ;
      rdfs:subClassOf
            cmns-rlcmp:Composition ,
            [
                  a owl:Restriction ;
                  owl:onProperty idmp-mprd:hasReferenceStrength ;
                  owl:onClass idmp-mprd:ReferenceStrength ;
                  owl:minQualifiedCardinality "0"^^xsd:nonNegativeInteger ;
            ] ,
            [
                  a owl:Restriction ;
                  owl:onProperty idmp-sub:hasIngredient ;
                  owl:someValuesFrom idmp-sub:Ingredient ;
            ] ,
            [
                  a owl:Restriction ;
                  owl:onProperty cmns-dsg:defines ;
                  owl:someValuesFrom [
                        a owl:Class ;
                        owl:unionOf (
                              idmp-sub:ManufacturedItem
                              idmp-mprd:MedicinalProduct
                              idmp-mprd:PharmaceuticalProduct
                        ) ;
                  ] ;
            ]
            ;
      rdfs:label "product composition" ;
      skos:definition "composition that defines some product based on its
relationship(s) to some other substance(s) (ingredient(s)), potentially with a
given strength, in some context" ;
      cmns-av:usageNote "From an implementation (mapping) perspective, this
product composition class provides the basis for a (blank) node in the
relationship 'product realizes ingredient role played by some substance', where
the ingredient role may be that of an active ingredient which, in turn, may have
some basis of strength in some context. The same product composition could be
used to link inactive ingredients to a product in which they are realized. A
given product may include multiple active ingredients, each of which may have a
different basis of strength." ;
      .

idmp-sub:hasIngredient
      a owl:ObjectProperty ;
      rdfs:subPropertyOf cmns-rlcmp:manifests ;
      rdfs:label "has ingredient" ;
      rdfs:range idmp-sub:Ingredient ;
      skos:definition "relates a substance or product composition to an
ingredient of that composition" ;
      cmns-av:usageNote "This property should be used primarily in a
manufacturing context where differentiation of substances or pharmaceutical
products in a product from other elements that play roles in the manufacturing
```

```
context is important." ;
      .


idmp-sub:Ingredient
      a owl:Class ;
      rdfs:subClassOf
            cmns-rlcmp:FunctionalRole ,
            [
                  a owl:Restriction ;
                  owl:onProperty cmns-rlcmp:isPlayedBy ;
                  owl:onClass [
                        a owl:Restriction ;
                        owl:onProperty cmns-col:isIncludedIn ;
                        owl:onClass idmp-sub:ManufacturedItem ;
                        owl:minQualifiedCardinality
"0"^^xsd:nonNegativeInteger ;
                  ] ;
                  owl:minQualifiedCardinality "0"^^xsd:nonNegativeInteger ;
            ]
            [
                  a owl:Restriction ;
                  owl:onProperty cmns-rlcmp:isManifestedIn ;
                  owl:onClass idmp-mprd:PharmaceuticalProduct ;
                  owl:maxQualifiedCardinality "1"^^xsd:nonNegativeInteger ;
            ] ,
            [
                  a owl:Restriction ;
                  owl:onProperty cmns-rlcmp:isManifestedIn ;
                  owl:onClass idmp-sub:ManufacturedItem ;
                  owl:minQualifiedCardinality "0"^^xsd:nonNegativeInteger ;
            ] ,
            [
                  a owl:Restriction ;
                  owl:onProperty idmp-mprd:hasStrength ;
                  owl:onClass idmp-mprd:Strength ;
                  owl:minQualifiedCardinality "0"^^xsd:nonNegativeInteger ;
            ] ,
            [
                  a owl:Restriction ;
                  owl:onProperty cmns-rlcmp:isPlayedBy ;
                  owl:onClass [
                        a owl:Restriction ;
                        owl:onProperty cmns-col:isIncludedIn ;
                        owl:onClass idmp-mprd:PharmaceuticalProduct ;
                        owl:minQualifiedCardinality
"0"^^xsd:nonNegativeInteger ;
                  ] ;

                  owl:minQualifiedCardinality "0"^^xsd:nonNegativeInteger ;
            ]
            ;
```

```
      rdfs:label "ingredient" ;
      dct:source "ISO/TS 20443:2017(E) Health informatics - Identification of
medicinal products (IDMP) - Implementation guidelines for ISO 11615 data
elements and structures for the unique identification and exchange of regulated
medicinal product information, table D.1, clause D.2.1" ;

      dct:source "ISO 11615:2017 Health informatics - Identification of
medicinal products (IDMP) - Data elements and structures for the unique
identification and exchange of regulated information on substances, clauses
3.1.28 and 9.7, Figure 12" ;
      skos:note "An ingredient is part of a medicinal product, either alone or
in combination with other ingredients. The ingredient is also a component of a
pharmaceutical product. Ingredient is equal to a substance with the indication
of the specific role it is playing in the product." ;
      skos:definition "role of a substance that is specifically part of or used
in the preparation of some manufactured item, pharmaceutical product,
medication, or drug" ;
      idmp-cmpl:hasConformanceToISOLevel idmp-cmpl:ConformanceToISOLevel-
NamingConformant ;
      cmns-av:synonym "pharmacological role" ;
      cmns-av:usageNote
            "An ingredient is defined as a material in the ISO 11238 standard
rather than as a role, which would make the model inconsistent. Thus this
concept is consistent in terms of its name but not in terms of its
definition." ,
            "Note that any inactive ingredient that is described as 'ingredient
not otherwise specified' in the ISO/TS 20443 implementation guide will simply be
classified as an ingredient at this level in the hierarchy in the ontology, or
as an inactive ingredient without other differentiation."
            ;
      .
```