



CTS2 Entity Description Services

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1 Introduction

This document describes the information model and corresponding services for the `EntityDescription` and `Association` resources. Entity descriptions describe entities - a collective term for a variety of terminological resources that can be referred to as “classes,” “concepts,” “terms,” “categories,” “roles,” “predicates,” “properties,” and “individuals” in different contexts and models. `EntityDescription` is a structured model of the “non-semantic” or “lexical” aspects of these descriptions while `Association` models the formal or “semantic” relationships between them.

`EntityDescription` represents the classes *CodeSystemEntity*, *CodeSystemEntityVersion*, *CodeSystemNode*, *CodeSystemConcept*, *CodeSystemConceptCode*, *Designation*, *DesignationType*, *AssociationType*, and *DefinedEntityProperty* in the CTS2 SFM, while `Association` addresses *CodeSystemEntityVersionAssociation*.

From the OWL perspective, `EntityDescription` represents the collection of “annotation properties” - properties that are not inherited and do not participate in the formal reasoning process, while `Association` represents everything else. From the perspective of SNOMED-CT, `EntityDescription` represents the contents of the *Identifier* and *Description* and *RefsetLanguage* tables while `Association` models the *Relationship* tables.

1.1 Notation

Model elements are referenced using Typewriter font.

1.2 Identifiers

- Class names are capitalized camel case (`CodeSystemCatalog`, `String`).
- Attribute and role names are lower camel case (`version`, `sourceAndRole`).
- Enumeration values are all capital letters with underscores ('_') introduced as needed for clarity. (`EMPTY`, `STOP_ON_ERROR`)
- Method names are lowerCamelCase.

1.3 Stereotypes

The following stereotypes are used throughout the model:

- **dataType** - UML dataType semantics.
- **enumeration** - UML enumeration semantics.
- **interface** - UML interface semantics.
- **mixin** - a class that provides a certain functionality to be inherited by a subclass, while not meant for instantiation.
- **opt** - an optional parameter in a method call. This stereotype should always be accompanied by a 0.. 1 cardinality and is provided to make optionality visible in the modeling tool.
- **optparam** - an optional attribute in a class instance. This indicates that an implementation must be able to distinguish three alternatives: (1) add or change the attribute to whatever is in the class, (2) remove the attribute if its minimum cardinality is zero, and (3) leave the attribute unchanged.

- **delta** - a method call that changes the state of the service. Note that the semantics of this stereotype is the inverse of the *is query model attribute*.
- **exception** - an exception.
- **exceptionSet** - a set of exceptions, the members of which are represented by aggregation.

1.4 Read Only Attributes

The CTS2 PIM is based on a RESTful architectural style. Resources can be created, updated, read, and/or deleted, and every resource has one or more immutable characteristics - characteristics that, if changed, would change the identity of the resource itself. In the information model we distinguish these characteristics from those that can be modified by declaring the identifying characteristics as *ReadOnly*. The computational model utilizes a pattern based on this information where the *create* operation(s) supply the identifying characteristics plus any of the non-optional mutable characteristics. The *update* operations then supply a unique identifier and a set of one or more mutable characteristics to be changed.

2 Entity Description Information Model

2.1 Entity Description Model

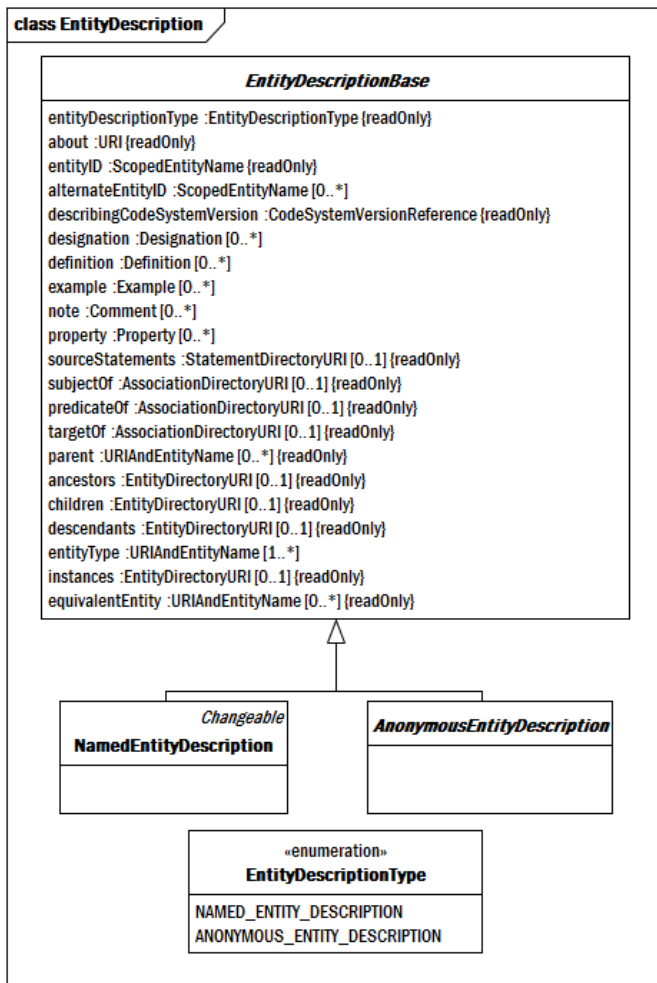


Figure 2.1 - Entity Description

EntityDescription represents the set of assertions about a particular entity (class, predicate, and/or individual) that are made by a specified version of a code system. It includes the set of designations that signify the entity in various languages or contexts, definitions where appropriate, examples, various forms of comments and any additional properties that are not classified elsewhere. It also contains information and links about where the entity fits in the code system hierarchy, including identifiers and, when available, references to its “parent” entities as well as references to the class(es) that it instantiates.

Note that there can be multiple `EntityDescription` entries for the same resource - one for every code system that makes assertions about it. Some of these descriptions may be fairly sparse - if a code system, for example, asserts: `wine:Wine rdfs:subClassOf owl:Class`, it is making assertions about both `rdfs:subClassOf` and `owl:Class` but, unless it explicitly imports these resources, the `EntityDescription` entries for these will be very minimal.

The requirement to support the OWL 2 notion of anonymous individuals has added considerable complexity to this model. Anonymous individuals appear to be a model of uniquely identifiable referential determiners, where the identity of the individual is only available in some context. As an example, the “primary residence of David Markwell” or “the fourth house on Main Street” refer to unique individuals without naming them. As in linguistics, the identity of these resources is contextual and local to the code system.

To support this class of resource, we have to create two distinct types of entity description - those with identity (e.g., `sct:90708001(Kidney Disease)`, `wine:Riesling`) and those without.

2.1.1 Class `AnonymousEntityDescription`

An entity description that is local to a given code system version. Anonymous entity descriptions are not changeable and have no external URI.

Superclasses

- Every instance of `AnonymousEntityDescription` is also an instance of `EntityDescriptionBase`.

Invariants

1. The `entityDescriptionType` must be `ANONYMOUS_ENTITY_DESCRIPTION`.
2. The about URI of an anonymous entity description is a Local URI meaning that it cannot be used outside the context of the given service.
3. The scoping namespace of an anonymous entity description must be the same as the name of the code system version.

2.1.1.1 Class `EntityDescriptionBase`

The attributes common to both named and anonymous entity descriptions. `EntityDescriptionBase` is an abstract class and cannot be directly instantiated.

Attributes

- **`entityDescriptionType`** - discriminant that determines whether the particular description is about a named resource or it is an expression whose description constitutes its identity. See OWL¹ specification on Anonymous Individuals² for further detail.
- **`about`** - the URI that represents the entity (class, predicate, and/or individual) referenced by this `EntityDescription` about is a `PersistentURI` when `entityDescriptionType` is `NAMED_ENTITY_DESCRIPTION` and `LocalURI` when `entityDescriptionType` is `ANONYMOUS_ENTITY_DESCRIPTION`.

1. <http://www.w3.org/TR/2009/REC-owl>

2. [syntax-20091027/#Anonymous Individuals](http://www.w3.org/TR/2009/REC-owl-syntax-20091027/#Anonymous_Individuals)

- **entityID** - the local namespace name and entity name that, together, uniquely name this referenced within the context of a CTS2 service instance. As an example, a service instance may choose to designate the entity referenced by the about URI of <http://www.w3.org/TR/2003/PR-owl-guide-20031209/wine#CabernetSauvignon> with the namespaceName “wine” and the name “CabernetSauvignon.”

The name portion of ScopedEntityName must uniquely name the particular entity within the context of the code system version.

- **alternateEntityID** - alternative unique identifiers that reference the about entity in the context of describing code system version. The namespace names the context from which the name (or code) is derived. Note that it is possible for the entityID name and/or one more alternateEntityId names to be represented in the designation attribute as well. This would occur when the name serves a dual role of unique identifier and human readable label.

An example of alternateEntityId would be the SNOMED-CT fully specified name, which serves as a unique identifier in human readable form. This might or might not also be considered a designation depending on the context and use case. Similarly, the SNOMED-CT Clinical Terms V3 Identifier (CTV3) and SNOMED-3 identifiers would appear here as well, as would the HL7’s case sensitive and case insensitive unit of measure identifiers.

- **describingCodeSystemVersion** - a reference to the version of an ontology or code system that makes the set of assertions contained in this description. Note that this references the “asserting,” not the “containing” code system version. As an example, the Wine Ontology imports the Food Ontology, which, in turn contains descriptions of PotableLiquid. A service that represented a (version of) the Wine Ontology would contain an entity description about “<http://www.w3.org/TR/2003/PR-owl-guide-20031209/food#PotableLiquid>” (namespaceName: food, name: PotableLiquid). The describingCodeSystemVersion, however, would be “<http://www.w3.org/TR/2003/PR-owl-guide-20031209/wine#>” even though this entity was described in the food ontology. Note also that if both the food and wine ontology were represented in a service, the service would contain two entity descriptions - one from the food ontology perspective and one from the wine ontology perspective.
- **designation** - a “string of (UNICODE) characters in a given natural language, such as English or Japanese.”³ A designation provides the strongest clues as to the meaning of a class, predicate or individual. While designations are not mandatory in an entity description, as all that may be available to a service is a code, service implementers are strongly encouraged to provide at least one preferred or alternate designation to make the description visible to text search engines.
- **definition** - an explanation of the intended meaning of a concept. An EntityDescription may have multiple definitions, each derived from a different source, represented in a different language or having a different purpose. Definitions apply only to classes and predicates, not individuals.
- **example** - an example of an instance or instances of the referenced entity, typically written for human consumption. Examples apply only to classes and predicates, not individuals.
- **note** - a note or comment about the history, status, use or other descriptions about the EntityDescription. Observe that note, as used in the CTS2 specification, does include examples or definitions.
- **property** - additional “non-semantic” (annotation) assertions about the entity being described that do not fit into the designation, definition, note, or example or entityId categories.
- **sourceStatements** - a DirectoryURI that resolves to the list of statements that were used in the assembly of this description. Statements need only be present in service instances that support the STATEMENT profile, and serves as a bridge between atomic structure contained in the source resource and the CTS2 rendering.

3. <http://www.w3.org/TR/2009/CR-skos-reference-20090317/#labels>

- **subjectOf** - an `AssociationDirectoryURI` that resolves to a list of active associations (“semantic” assertions) in which the about entity appears as a subject and that are assertedBy the `describingCodeSystemVersion`. `subjectOf` is only included in an `EntityDescription` when resolution would yield at least one result. This attribute will only be present in CTS2 service implementations that support the ASSOCIATION QUERY profile.
- **predicateOf** - a `DirectoryURI` that resolves to the list of active associations (“semantic” assertions) in which the about entity appears as a predicate and that are assertedBy the `describingCodeSystemVersion`. `predicateOf` is only included in an `EntityDescription` when resolution would yield at least one result. This attribute will only be present in CTS2 service implementations that support the ASSOCIATION QUERY profile.
- **targetOf** - a `DirectoryURI` that resolves to the list of active associations (“semantic” assertions) in which the about entity appears as either a direct target or the target of a contained `BNode` and that are assertedBy the `describingCodeSystemVersion`. `targetOf` is only included in an `EntityDescription` when resolution would yield at least one result. This attribute will only be present in CTS2 service implementations that support the ASSOCIATION QUERY profile.
- **parent** - the set of direct “parents” asserted by `describingCodeSystemVersion`. It is the responsibility of the service to determine what predicate(s) represent “parent/child” relationships. Typically “parent” is associated with “`rdfs:subClassOf`” in the OWL/RDF world and `skos:broader/skos:narrower` in the SKOS environment. It is possible, however for some code systems to have other relationships as well. As an example, some of the Open Biomedical Ontologies (OBO) use a mixture of `subClassOf` and `partOf` relationships.
- **ancestors** - a `DirectoryURI` that resolves to the transitive closure of the “parents” relationship(s). The primary purpose for this attribute is to provide a handle for subsumption queries. As an example, to determine whether Class X was a subclass of Class Y, one would query whether the `EntityReference` to Y was a member of `X.ancestors`.
- **children** - a `DirectoryURI` that resolves to the list of direct “children” asserted by `describingCodeSystemVersion`. As with parent, it is the responsibility of the service to determine what predicate(s) represent “parent/child” relationships. `children` may also include entity references that appear in the target of `bnodes` if they are determined to be such by the service.
- **descendants** - a `DirectoryURI` that resolves to the transitive closure of the “children” relationship(s). The primary purpose for this attribute is to provide a handle for subsumption queries. As an example, a second way to determine whether Class X was a subclass of Class Y, one would query whether the `EntityReference` to X was a member of `Y.descendants`.
- **entityType** - the set of type(s) which the `entityReference` is an instance of. Because this is a terminology service, `entityType` must include one of `owl:class`, `owl:individual`, `rdf:predicate`, or `skos:concept`, although it may carry many other types as well.
- **instances** - a `DirectoryURI` that resolves to the list of entities that asserted to be instances of the type represented by about URI. This element is present only if resolution will return a non-empty set.
- **equivalentEntity** - an entity that has been determined to be equivalent to the about entity in the context of the assertions made by `describingCodeSystemVersion`.

Invariants

1. Every `entityID` and `alternateEntityID` for a given entity must be unique.

2.1.1.2 Class `NamedEntityDescription`

An entity description that is referenced by a globally unique external URI.

Superclasses

- Every instance of `NamedEntityDescription` is also an instance of `EntityDescriptionBase`.
- Every instance of `NamedEntityDescription` is also an instance of `Changeable`.

Invariants

1. `entityDescriptionType` must be `NAMED_ENTITY_DESCRIPTION`.
2. The about URI of a named entity description is an external, globally unique URI.
3. The `entryID` of a `NamedEntityDescription` is the about URI.

2.1.1.3 Enum `EntityDescriptionType`

A discriminant that identifies whether a subclass of `EntityDescriptionBase` is a `NamedEntityDescription` or an `AnonymousEntityDescription`.

Enumeration Types:

- **`NAMED_ENTITY_DESCRIPTION`** - the `EntityDescription` describes an entity that has a published URI.
- **`ANONYMOUS_ENTITY_DESCRIPTION`** - the `EntityDescription` describes an entity whose identity is implicit and known only in the context of the describing code system version.

2.2 Designations

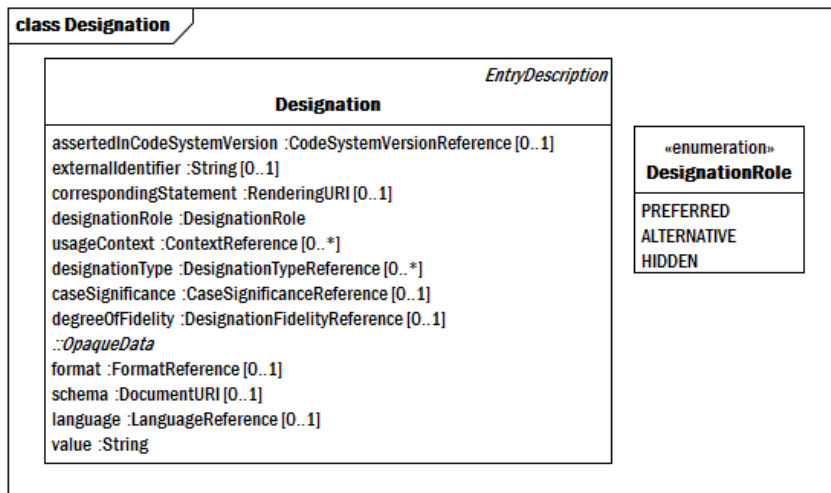


Figure 2.2 - Designation

2.2.1 Class Designation

A Designation is identical to a Lexical Label⁴ as defined in SKOS⁵. It is a “string of (UNICODE) characters in a given natural language, such as English or Japanese.” “These labels provide the strongest clues as to the meaning of a (SKOS concept).” The CTS2 specification generalizes the label use to include not only SKOS concepts but any class, predicate or individual - collectively referred to as Entity. Note that Designation is intended only for identifiers that are interpreted by human beings. Numeric codes and other machine readable identifiers should be recorded as ScopedEntityNames.

Superclasses

- Every instance of Designation is also an instance of EntryDescription.

Attributes

- **assertedInCodeSystemVersion** - the code system version in which this designation is asserted. If absent, it is the same as the EntityDescriptionContainingCodeSystemVersion.
- **externalIdentifier** - an identifier that is assigned to this designation / entity pair by the authoring body. As an example this would carry the SCTID for SNOMED-CT concepts.
- **correspondingStatement** - a URI that, when de-referenced, provides the equivalent Statement that forms this designation. This is only present when the STATEMENT profile is supported by the implementing service.
- **designationRole** - an indicator that determines the particular role that this designation plays.
- **usageContext** - the context(s) in which this designation is applicable.
- **designationType** - the type of designation (e.g., abbreviation, eponym, short name, long name, etc.) of the given designation.
- **caseSignificance** - identifies the significance that case plays in the value of this particular designation.
- **degreeOfFidelity** - a measure of how closely this designation actually matches the intended meaning of the target entity. Typical values might represent “exact,” “approximate,” “broader,” “narrower,” etc.

2.2.1.1 Enum DesignationRole

The role that a designation plays in respect to the referenced Entity. DesignationRole is intended to convey the same semantics as the three types of SKOS Label⁶ - skos:prefLabel (PREFERRED), skos:altLabel (ALTERNATIVE), and skos:hiddenLabel (HIDDEN). The SKOS consistency rules with respect to preferred labels also apply to designation with two exceptions:

1. There can be more than one preferred label for the same language if the usage Context is different.
2. If the service implementation supports structured data, it is possible to have more than one preferred label for the same language and context as long as each has a different format.

4. <http://www.w3.org/TR/skos-reference/#labels>

5. <http://www.w3.org/2004/02/skos/intro>

6. <http://www.w3.org/TR/skos-reference/#labels>

Enumeration Types:

- **PREFERRED** - The preferred human-readable representation of the entity in a given language, context (aka. domain in SKOS terms) and format. PREFERRED is equivalent to skos:prefLabel.
- **ALTERNATIVE** - The acceptable alternative human-readable representation of the entity in a given language, context (aka. domain in SKOS terms) and format. The term “synonym” is often used to indicate an alternate designation although strictly speaking, “synonym” is a term-term relationship. ALTERNATIVE is equivalent to skos:altLabel
- **HIDDEN** - The designation may be used to represent the entity under certain circumstances, but it is not normally displayed. Hidden designations are used primarily for search terms and typically represent common misspellings or deprecated usages. HIDDEN is equivalent to skos:hiddenLabel

2.3 Types of Entity Description

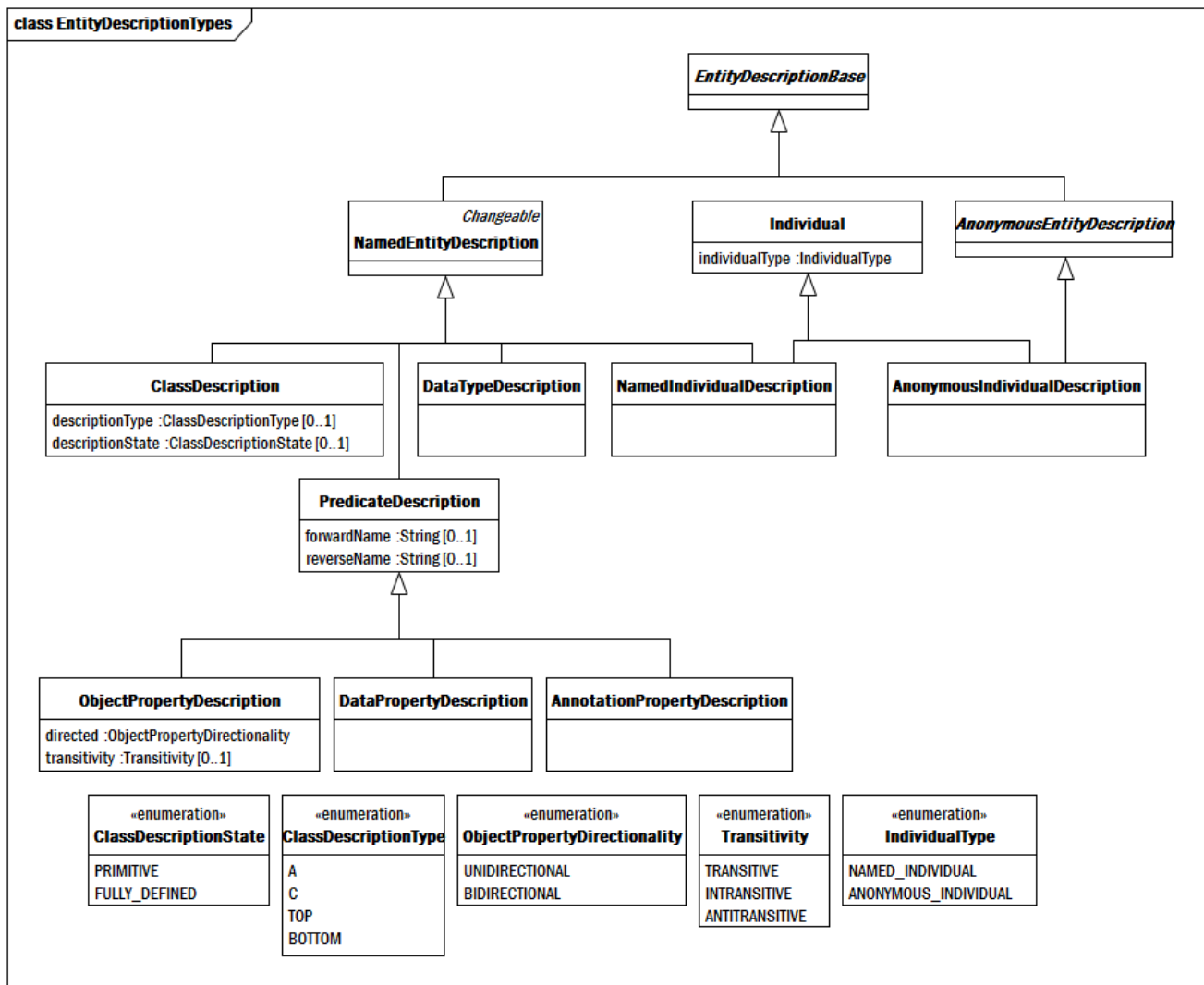


Figure 2.3 - Types of EntityDescription

The diagram above shows the various flavors of `EntityDescription` that are explicitly called out by the CTS2 specification. This diagram is a variation on a similar diagram in `Entities, Literals, and Anonymous Individuals`⁷ from the OWL2 syntax⁸ specification. The degree of formality exhibited by the various code systems that can be imported into the CTS2 specification can vary considerably. On one end of the spectrum, there are reasonably simple resources that are expressed as lists of code/value pairs. These would be loaded as simple `NamedEntityDescriptions`. More elaborate resources may make a distinction between “concepts” and “roles,” which, depending on how specific the notion of “concept” was would either be loaded as their corresponding `ClassDescriptions` and `PredicateDescriptions`. RDF and OWL based resources would take up the whole spectrum of types.

It should be noted, however, that while not explicitly stated in the diagram, the assumption is that the leaf classes are disjoint - something declared as an individual is assumed not to be a class, which presents an interesting issue to the model designers. One solution would be to specify all of the attributes of class, predicate, etc. at the `EntityDescriptionBase` level and then to remove the inapplicable ones in the leaf nodes. As an example, we could have added `forwardName` and `reverseName` to `EntityDescriptionBase` and then declared that they are not present in class descriptions. We felt, however, that this was unnecessarily complex and, instead, will count on providers of more sophisticated services to use a variation on punning or to extend the `EntityDescriptionBase` class to support this.

2.3.1 Class `AnnotationPropertyDescription`

A `PredicateDescription` that describes a predicate used for “lexical” annotation of an entity or other resource. Annotation properties are “semantically weak” (see below) in the sense that they are not inherited through subclass associations.

“For annotations properties note that annotations are not ‘semantic-free’ under the OWL 2 RDF-Based Semantics. Just like every other triple or set of triples occurring in an RDF graph, an annotation is assigned a truth value by any given OWL 2 RDF-Based interpretation. Hence, although annotations are meant to be ‘semantically weak,’ i.e., their formal meaning does not significantly exceed that originating from the RDF Semantics specification, adding an annotation may still change the meaning of an ontology.”⁹

Superclasses

- Every instance of `AnnotationPropertyDescription` is also an instance of `PredicateDescription`.

Invariants

1. `entityType` must include `owl:AnnotationProperty`.

2.3.1.1 Class `AnonymousIndividualDescription`

An “intensional” description of an individual that describes the individual by its characteristics without supplying its identity. As an example, the description “The sole occupant of 773 Main Street in Sioux City, South Dakota” would reference an anonymous individual.

“If an individual is not expected to be used outside a particular ontology, one can use an anonymous individual, which is identified by a local node ID rather than a global IRI. Anonymous individuals are analogous to blank nodes in RDF.”¹⁰

7. <http://www.w3.org/TR/2009/REC-owl2-syntax-20091027/#Entities.2C.Literals.2C.and.Anonymous.Individuals>

8. <http://www.w3.org/TR/2009/REC-owl2-syntax-20091027/>

9. <http://www.w3.org/TR/2009/REC-owl2-rdf-based-semantics-20091027/#Introduction.28Informative.29>

10. <http://www.w3.org/TR/2009/REC-owl2-syntax-20091027/#Anonymous.Individuals>

Superclasses

- Every instance of `AnonymousIndividualDescription` is also an instance of `Individual`.
- Every instance of `AnonymousIndividualDescription` is also an instance of `AnonymousEntityDescription`.

2.3.1.2 Class `ClassDescription`

The description of an entity that is a Class, Type, or “Concept.” “Classes can be understood as sets of individuals.” ¹¹

Superclasses

- Every instance of `ClassDescription` is also an instance of `NamedEntityDescription`.

Attributes

- **descriptionType** - the specific role that the class description plays, if known.
- **descriptionState** - an indicator that states whether the class description contains only necessary assertions (`PRIMITIVE`) or is considered to be both necessary and sufficient assertions (`FULLY_DEFINED`).

Invariants

1. `entityType` must include one `owl:Class`.

2.3.1.3 Class `DataPropertyDescription`

A `PredicateDescription` whose domain is a set of literals.

“Data properties connect individuals with literals. In some knowledge representation systems, functional data properties are called attributes.” ¹²

Superclasses

- Every instance of `DataPropertyDescription` is also an instance of `PredicateDescription`.

Invariants

1. `entityType` must include `owl:DataProperty`.

2.3.1.4 Class `DataTypeDescription`

The description of a data type, which, in this context, represents a constraint on the set of possible values in a text or literal field. “Datatypes are entities that refer to sets of data values.”

Superclasses

- Every instance of `DataTypeDescription` is also an instance of `NamedEntityDescription`.

11. <http://www.w3.org/TR/2009/REC-owl2-syntax-20091027/#Classes>

12. <http://www.w3.org/TR/2009/REC-owl2-syntax-20091027/#Object Properties>

Invariants

1. `entityType` must include `owl:DataType`.

2.3.1.5 Class `Individual`

An instance of a category or class. “Individuals in the OWL 2 syntax represent actual objects from the domain.”

Attributes

- **`individualType`** - a discriminant that determines whether the `Individual` is anonymous or named.

Invariants

1. `entityType` must include `owl:Individual`.

2.3.1.6 Class `NamedIndividualDescription`

A description of an individual that has identity.

Superclasses

- Every instance of `NamedIndividualDescription` is also an instance of `Individual`.
- Every instance of `NamedIndividualDescription` is also an instance of `NamedEntityDescription`.

Invariants

1. `entityType` must include `owl:NamedIndividual`.

2.3.1.7 Class `ObjectPropertyDescription`

The description of a “semantic” predicate. “Object properties connect pairs of individuals.”

Superclasses

- Every instance of `ObjectPropertyDescription` is also an instance of `PredicateDescription`.

Attributes

- **`directed`** - an indicator that states whether the object property is unidirectional (i.e., requires an inverse to be explicitly declared) or is bidirectional.
- **`transitivity`** - transitivity characteristics of the property. If not supplied, transitivity characteristics are either unknown or not applicable (i.e., `domain ? range = 0`).

Invariants

1. `entityType` must include `owl:ObjectProperty`.

2.3.1.8 Class `PredicateDescription`

`PredicateDescription` covers the spectrum of entities deemed “Role” in description logic, “Relation” in predicate logic, “Property” in RDF and OWL, and “Association” in Ontylog DL. It describes the nature and the purpose of the role, not the individual elements.

Note that section 2.4.2.11 of the HL7 SFM calls for an attribute called “associationKind.” While we are not absolutely certain what this was intended to represent, we believe that its intent is probably subsumed under the various individual types as well as the transitivity attribute.

`forwardName` and `reverseName` are called for in the SFM. The way that they are represented in this model lacks the ability to represent them in a multi-lingual environment that may cause difficulties down the line. Service implementers who are concerned about this aspect are encouraged to extend the service to allow forward and reverse Name to be returned in the language appropriate to the service viewer.

The `directed` attribute is actually more of a characteristic of the type of logic being used than the individual properties, but returning it as an attribute of a property seems sufficient.

The HL7 SFM `ruleSetId` construct is not supported in this specification.

Superclasses

- Every instance of `PredicateDescription` is also an instance of `NamedEntityDescription`.

Attributes

- **forwardName** - the name assigned to the predicate when applied in the source to target direction. The primary purpose of this attribute is to provide some notion of “directional” semantics, as predicates named “part” or “broader term” often lack sufficient information to understand where the whole or broader component goes. Implementers will note that, as opposed to official designations, `forwardName` and `reverseName` are not keyed by language. Implementers are encouraged to develop designations and use the `forwardName` and `reverseName` tags if a richer model is desired.
- **reverseName** - the name assigned to the predicate when applied in the target to source direction. The primary purpose of this attribute is to provide some notion of “directional” semantics, as predicates named “part” or “broader term” often lack sufficient information to understand where the whole or broader component goes.

Invariants

1. `entityType` must include `rdf:Property`.

2.3.1.9 Enum `ClassDescriptionState`

Determines whether a class description is considered to consist of necessary or necessary and sufficient definitions of the member individuals.

Enumeration Types:

- **PRIMITIVE** - The defining assertions of the class description are necessary for all individuals that are members of the class. If an individual is asserted to be a member of the class, it can be asserted that it possesses all of the defining characteristics.
- **FULLY_DEFINED** - The defining assertions of the class description are both necessary and sufficient. If an individual is asserted to be a member of the class, it can be asserted that it possesses all of the defining characteristics and, if an individual is determined to possess all of the defining characteristics in the class definition, it can be asserted to be a member of the class.

2.3.1.10 Enum `ClassDescriptionType`

The type, from a description logic perspective, of a class description.

Enumeration Types:

- **A** - an atomic class description
- **C** - a complex class description
- **TOP** - a class that represents the set of all individuals in the domain of discourse represented by the containing code system or ontology.
- **BOTTOM** - a class that represents the set that contains no individuals in the context of the containing domain or ontology.

2.3.1.11 Enum IndividualType

A discriminant that identifies the type of individual description.

Enumeration Types:

- **NAMED_INDIVIDUAL** - the Individual type is a `NamedIndividualDescription`.
- **ANONYMOUS_INDIVIDUAL** - the Individual type is an `AnonymousIndividualDescription`.

2.3.1.12 Enum ObjectPropertyDirectionality

Indicates whether the semantics of an object property are unidirectional (i.e., $r(a, b) \rightarrow r(b, a)$ or bidirectional ($r(a, b) \rightarrow r(b, a)$).

Enumeration Types:

- **UNIDIRECTIONAL** - $r(a, b) \rightarrow r(b, a)$
- **BIDIRECTIONAL** - $r(a, b) \rightarrow r(b, a)$

2.3.1.13 Enum Transitivity

An indicator that determines whether an object property is considered to be transitive.

Enumeration Types:

- **TRANSITIVE** - asserts $\forall a, b, c: C \text{ op}(a, b) \wedge \text{Ap}(b, c) \rightarrow p(a, c)$
- **INTRANSITIVE** - asserts $\forall a, b, c: C \text{ o } (p(a, b) \wedge \text{Ap}(b, c) \rightarrow p(a, c))$
- **ANTITRANSITIVE** - asserts $\forall a, b, c: C \text{ o } p(a, b) \wedge \text{Ap}(b, c) \rightarrow \neg p(a, c)$

2.4 Entity Description Directories

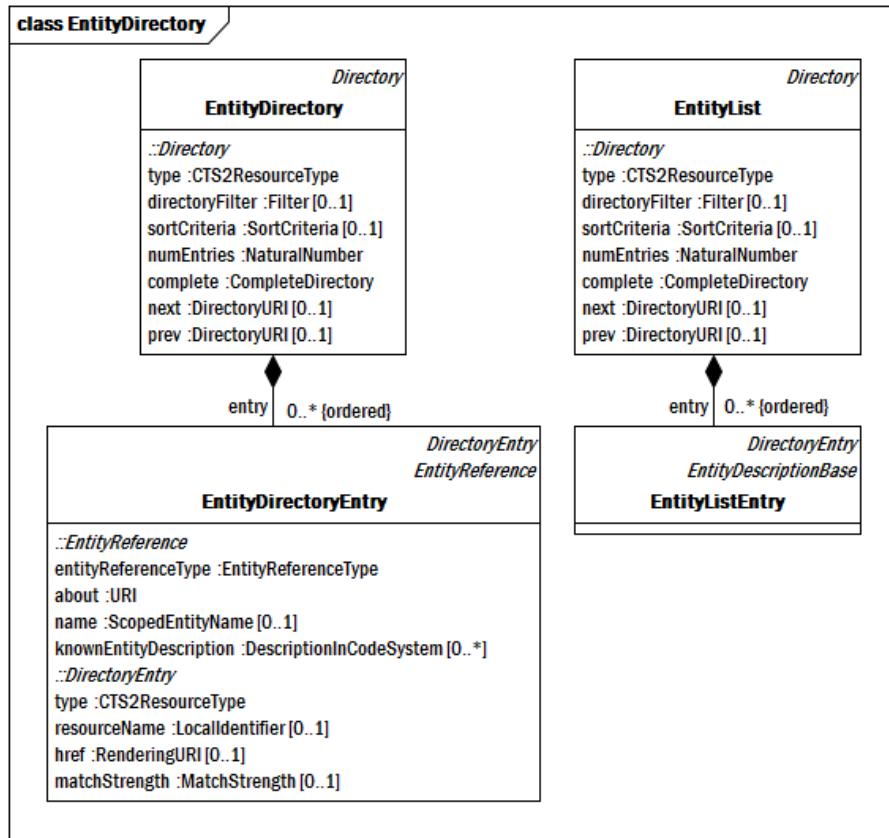


Figure 2.4 - Entity Description Directory

2.4.1 Class EntityDirectory

A directory of Entity resources that meet a specified criteria.

Superclasses

- Every instance of EntityDirectory is also an instance of Directory.

Attributes

- entry - an entry in the directory

2.4.1.1 Class EntityDirectoryEntry

A synopsis of an Entity along with information about how to access the complete resource.

Superclasses

- Every instance of EntityDirectoryEntry is also an instance of DirectoryEntry.

- Every instance of `EntityDirectoryEntry` is also an instance of `EntityReference`.

2.4.1.2 Class EntityList

A collection of complete `Entity` resources that meet a specified criteria.

Superclasses

- Every instance of `EntityList` is also an instance of `Directory`.

Attributes

- **entry** - an entry in the list.

2.4.1.3 Class EntityListEntry

An instance of `Entity` that meets a specified filter criteria.

Superclasses

- Every instance of `EntityListEntry` is also an instance of `DirectoryEntry`.
- Every instance of `EntityListEntry` is also an instance of `EntityDescriptionBase`.

3 Entity Description Services

3.1 Entity Description Read Service

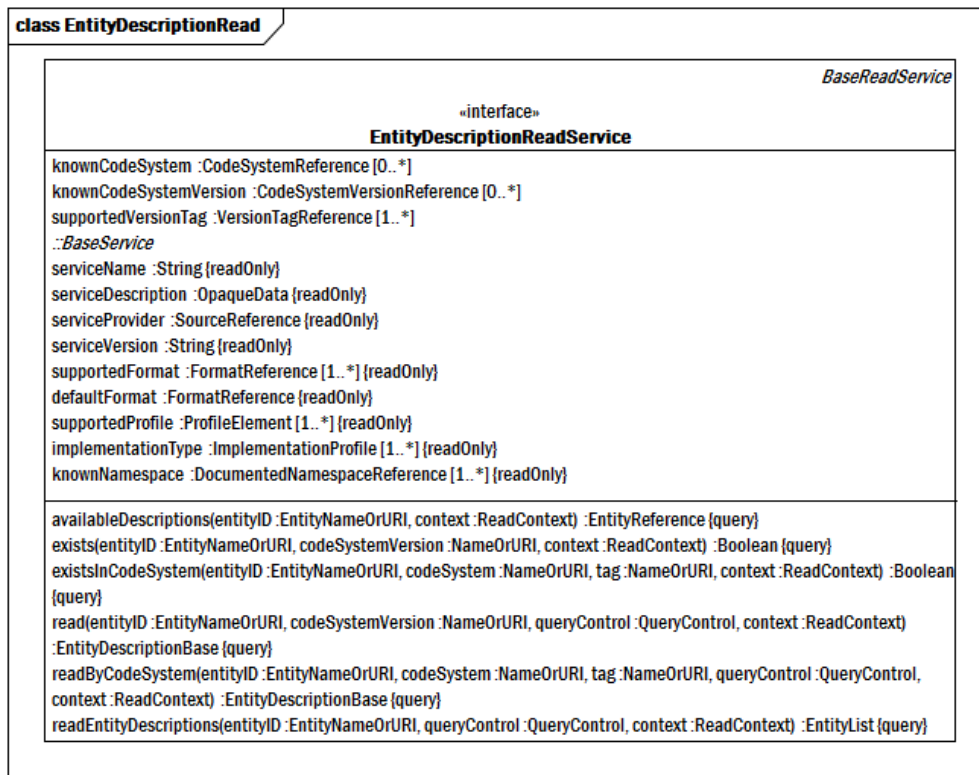


Figure 3.1 - Entity Description Read Service

The **EntityDescriptionReadService** provides direct access to **EntityDescriptions** contained in specific code system versions. **EntityDescriptions** are identified by either the about URI or a namespace/name pair. They can be accessed via a named code system version or by identifying a code system and supplying a version tag that is assigned to a particular version at a particular point in time.

3.1.1 Interface EntityDescriptionReadService

A service that provides direct read access to **EntityDescriptions** by namespace/name or URI in the context of a particular code system or code system version.

Superclasses

- Every instance of **EntityDescriptionReadService** is also an instance of **BaseReadService**.

Attributes

- **knownCodeSystem** - the name and URI of a code system that is known to this service.

- **knownCodeSystemVersion** - the name and URI of the code system version that are recognized by this service.
- **supportedVersionTag** - the set of version tags supported by this service. All service implementations must support the CURRENT version tag.

Invariants

1. Service must be presented in the supportedProfile list.
2. All known code systems include URIs.
3. Every code system reference is also included in known Namespace.

3.1.1.1 Operation: availableDescriptions

Return the available EntityDescriptions for the referenced entity. This returns a list of the latest versions of all of the code systems that make assertions about the referenced entity.

Input Parameters

- **entityID** - the namespace/name or URI of the target entity (Type: EntityNameOrURI).
- **context_{OPT}** - parameters that control the language, date, and other contextual variables (Type: ReadContext).

Return Type: EntityReference

Exceptions

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The EntityNameOrURI is not known to the service.
- **UnsupportedLanguage** - The referenceLanguage is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more changeSetContext is not supported by the service.

3.1.1.2 Operation: exists

Determine if the specified entity description exists in the specified code system version.

Input Parameters

- **entityID** - the namespace/name or URI of the target entity (Type: EntityNameOrURI).
- **codeSystemVersion** - the local identifier or URI of the describing code system version (Type: NameOrURI).
- **context_{OPT}** - parameters that control the language, date, and other contextual variables (Type: ReadContext).

Return Type: Boolean

Exceptions

- **UnknownCodeSystemVersion** - The referenced CodeSystemVersion is not recognized by the service.

- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.

3.1.1.3 Operation: **existsInCodeSystem**

Determine if the specified entity description exists in the specified code system.

Input Parameters

- **entityID** - the namespace/name or URI of the target entity (Type: `EntityNameOrURI`).
- **codeSystem** - the local identifier or URI of the describing code system version (Type: `NameOrURI`).
- **tag_{OPT}** - the name or URI of a version tag that resolves to the code system version describing the entity. If omitted, tag defaults to `CURRENT` (Type: `NameOrURI`).
- **context_{OPT}** - parameters that control the language, date, and other contextual variables (Type: `ReadContext`).

Return Type: `Boolean`

Exceptions

- **UnknownCodeSystem** - The referenced `CodeSystem` is not recognized by the service.
- **UnsupportedVersionTag** - The `versionTag` is not recognized by the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.

3.1.1.4 Operation: **read**

Retrieve an entity description from a specified code system version.

Input Parameters

- **entityID** - the namespace/name or the `ExternalURI` of the entity whose description is to be retrieved (Type: `EntityNameOrURI`).
- **codeSystemVersion** - the local identifier or the URI of the code system version describing the referenced entity (Type: `NameOrURI`).
- **queryControl_{OPT}** - parameters that control the ordering, timeout, and query behavior (Type: `QueryControl`).
- **context_{OPT}** - parameters that control the language, date, and other contextual variables (Type: `ReadContext`).

Return Type: `EntityDescriptionBase`

Exceptions

- **UnknownCodeSystemVersion** - The referenced `CodeSystemVersion` is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.
- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The `format` is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.

Preconditions

1. The code system version name or URI must be known to the service.

3.1.1.5 Operation: `readByCodeSystem`

Retrieve the specified entity description from the specified code system.

Input Parameters

- **entityID** - the namespace/name or URI of the referenced entity (Type: `EntityNameOrURI`).
- **codeSystem** - the local identifier or URI of the referencing code system (Type: `NameOrURI`).
- **tag_{OPT}** - the name or URI of a version tag that resolves to the code system version describing the entity. If omitted, tag defaults to CURRENT. (Type: `NameOrURI`).
- **queryControl_{OPT}** - parameters that control the ordering, timeout, and query behavior (Type: `QueryControl`).
- **context_{OPT}** - parameters that control the language, date, and other contextual variables (Type: `ReadContext`).

Return Type: `EntityDescriptionBase`

Exceptions

- **UnsupportedVersionTag** - The `versionTag` is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.
- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The `format` is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.

3.1.1.6 Operation: readEntityDescriptions

Retrieve all of the `EntityDescriptions` for the supplied entity Id. This function will return the current `EntityDescription` for every describing code system version that makes non-semantic assertions about the referenced entity.

Input Parameters

- **entityID** - the namespace/name or URI of the target entity. (Type: `EntityNameOrURI`).
- **queryControl**_{OPT} - parameters that control the ordering, timeout, and query behavior (Type: `QueryControl`).
- **context**_{OPT} - parameters that control the language, date, and other contextual variables (Type: `ReadContext`).

Return Type: `EntityList`

Exceptions

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.

- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.
- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The `format` is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.

3.2 Entity Description Query Service

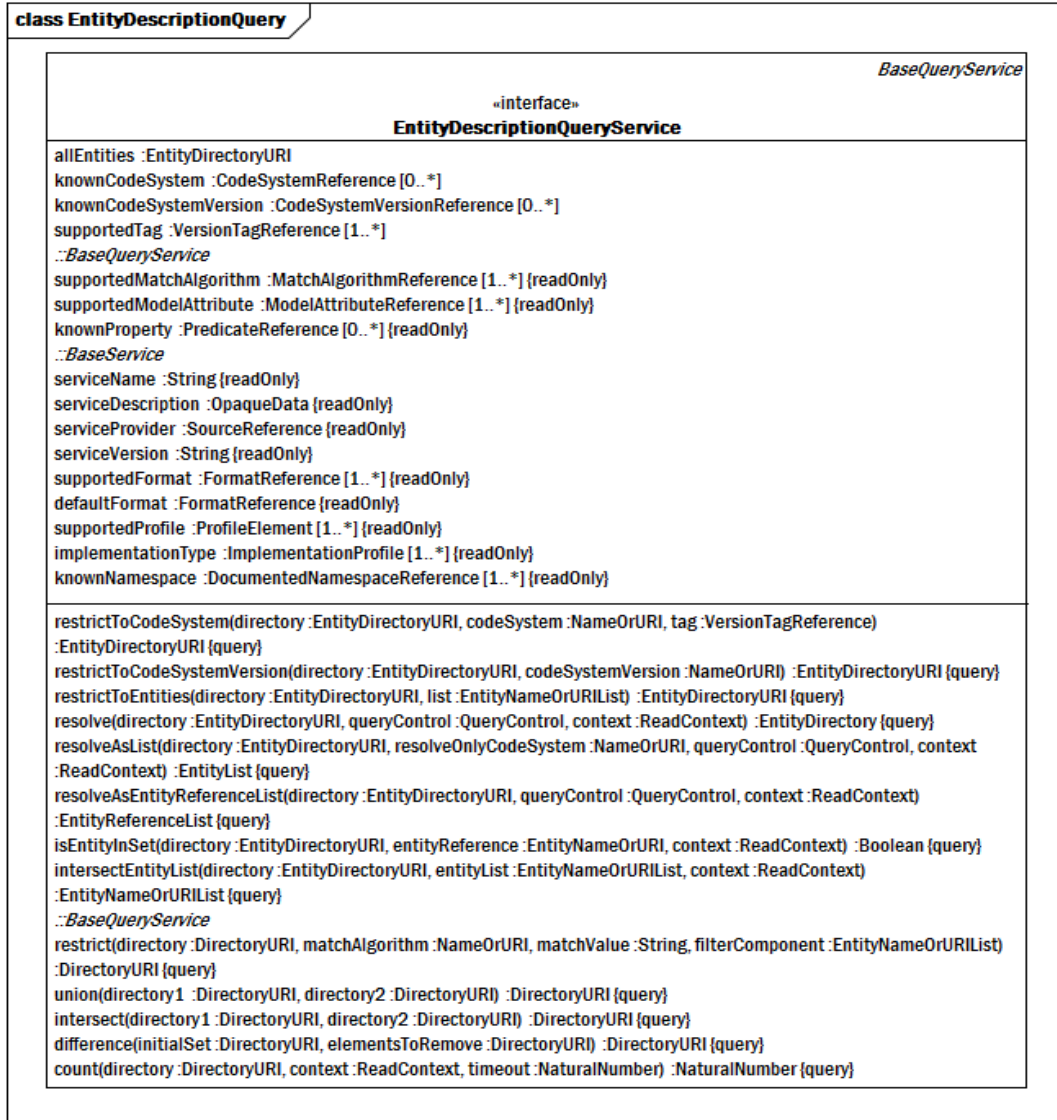


Figure 3.2 - Entity Description Query Service

EntityDescriptionQueryService provides the functionality necessary to select subsets of the set of EntityDescriptions known to the service via various restriction criteria, the intersection, union, and difference of these sets and the ability to render the result of these queries in different formats. It also provides tools to determine the presence or absence of EntityReferences in these sets.

3.2.1 Interface EntityDescriptionQueryService

A service that allows the selection, manipulation, and rendering of sets of EntityDescriptions.

Superclasses

- Every instance of `EntityDescriptionQueryService` is also an instance of `BaseQueryService`.

Attributes

- **allEntities** - a `DirectoryURI` that resolves to all entities known to the service.
- **knownCodeSystem** - the code systems that are known to the service. This is a list rather than a directory URI because of the requirement that the `ENTITY_QUERY` service be independent from the `CODE_SYSTEM_CATALOG_QUERY`, and `CODE_SYSTEM_VERSION_CATALOG_QUERY` profiles.
- **knownCodeSystemVersion** - the code system versions known to the service. As with `knownCodeSystem`, this is a list rather than a directory URI because of the requirement that the `ENTITY_QUERY` service be independent from the `CODE_SYSTEM_CATALOG_QUERY` and `CODE_SYSTEM_VERSION_CATALOG_QUERY` profiles.
- **supportedTag** - the set of version tags that are recognized by this service.

3.2.1.1 Operation: restrictToCodeSystem

Return an `EntityDirectoryURI` that references only the `EntityReferences` in directory that have assertions about the (`EntityDescriptions`) in the tagged version of the supplied code system. Note that this does not constrain the `knownEntityDescription` attribute within the `EntityReference` itself - an `EntityReference` that has assertions in code system A and B would still have two `knownEntityDescription` entries even after this restriction is applied. Further constraint can be accomplished via the `resolve` functions.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of `EntityReferences` (Type: `EntityDirectoryURI`).
- **codeSystem** - the name or URI of the code system which filters the set of entities to be returned (Type: `NameOrURI`).
- **tag_{OPT}** - the name or URI of version tag that identifies which code system version is to be used for the purposes of restriction. If omitted, the `CURRENT` tag will be used (Type: `VersionTagReference`).

Return Type: `EntityDirectoryURI`

Exceptions

- **UnknownCodeSystem** - The referenced `CodeSystem` is not recognized by the service.
- **UnsupportedVersionTag** - The `versionTag` is not recognized by the service.
- **InvalidDirectoryType** - The type represented by the supplied `directory` URI is not the one required by the service invocation.
- **InvalidDirectoryURI** - The supplied `directory` URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied `directory` URI is not the one required by the service invocation.

3.2.1.2 Operation: restrictToCodeSystemVersion

Return an `EntityDirectoryURI` that references only the `EntityReferences` in directory that have assertions about the (`EntityDescriptions`) in the named code system version.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of `EntityReferences` (Type: `EntityDirectoryURI`).
- **codeSystemVersion**_{OPT} - the name or URI of a code system version used to restrict the set of entities in directory (Type: `NameOrURI`).

Return Type: `EntityDirectoryURI`

Exceptions

- **UnknownCodeSystemVersion** - The referenced `CodeSystemVersion` is not recognized by the service.
- **InvalidDirectoryURI** - The supplied `directory` URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied `directory` URI is not the one required by the service invocation.

3.2.1.3 Operation: restrictToEntities

Return an `EntityDirectoryURI` that represents the set of `EntityReferences` common to `directory` and `list`.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of `EntityReferences` (Type: `EntityDirectoryURI`).
- **list** - the list of namespace/names or URIs to intersect with the directory (Type: `EntityNameOrURIList`)

Return Type: `EntityDirectoryURI`

Exceptions

- **InvalidDirectoryURI** - The supplied `directory` URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied `directory` URI is not the one required by the service invocation.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

3.2.1.4 Operation: resolve

Return an `EntityDirectory` that contains the set of `EntityReferences` identified by `directory`.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of `EntityReferences` (Type: `EntityDirectoryURI`).
- **queryControl**_{OPT} - parameters that control the ordering, timeout, and query behavior (Type: `QueryControl`).
- **context**_{OPT} - parameters that control the language, date, and time and other contextual variables (Type: `ReadContext`).

Return Type: `EntityDirectory`

Exceptions

- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.
- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The `format` is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.
- **InvalidDirectoryURI** - The supplied `directory` URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied `directory` URI is not the one required by the service invocation.

3.2.1.5 Operation: `resolveAsList`

Return a directory containing the set of `EntityDescriptions` identified by `directory`. One `EntityDescription` entry will be returned for each known `EntityDescription` in the corresponding `EntityReference`. This means that it is possible for there to be zero, one, or more `EntityDescriptions` returned per `EntityReference`. The `restrictToCodeSystem` or `restrictToCodeSystemVersion` operations can be used to constrain the set of references to a single code system.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of `EntityReferences` (Type: `EntityDirectoryURI`).
- **resolveOnlyCodeSystem_{OPT}** - the name or URI of a code system. If present, the service will return only the `EntityDescriptions` whose `describingCodeSystemVersion.codeSystem` matches the supplied parameter. If omitted, multiple `EntityDescriptions` may be returned per `EntityReference`. (Type: `NameOrURI`)
- **queryControl_{OPT}** - parameters that control the ordering, timeout, and query behavior (Type: `QueryControl`).
- **context_{OPT}** - parameters that control the language, date, and time, and other contextual variables (Type: `ReadContext`).

Return Type: EntityList

Exceptions

- **UnknownCodeSystem** - The referenced CodeSystem is not recognized by the service.
- **UnsupportedLanguage** - The referenceLanguage is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more changeSetContext is not supported by the service.
- **UnsupportedMatchAlgorithm** - The matchAlgorithm is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The format is not supported by the service implementation.
- **QueryTimeout** - The timeLimit was exceeded by the service.
- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.

3.2.1.6 Operation: resolveAsEntityReferenceList

Return a complete EntityReferenceList that contains all of the EntityReferences identified by directory.

Input Parameters

- **directory** - a DirectoryURI that resolves to a set of EntityReferences (Type: EntityDirectoryURI).
- **queryControl_{OPT}** - parameters that control the ordering, timeout, and query behavior. In this case, the ordering parameter is ignored and maxToReturn regulates the maximum number of entries in the list - if more than maxToReturn entries are available, an error will be returned instead. (Type: QueryControl)
- **context_{OPT}** - parameters that control the language, date and time, and other contextual variables (Type: ReadContext).

Return Type: EntityReferenceList

Exceptions

- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.

- **UnsupportedMatchAlgorithm** - The matchAlgorithm is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The format is not supported by the service implementation.
- **QueryTimeout** - The timeLimit was exceeded by the service.
- **UnsupportedLanguage** - The referenceLanguage is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more changeSetContext is not supported by the service.

3.2.1.7 Operation: isEntityInSet

Determine whether the supplied entity name or URI is in the set referenced by directory.

Input Parameters

- **directory** - a DirectoryURI that resolves to a set of EntityReferences (Type: EntityDirectoryURI).
- **entityReference** - the name or URI of the target entity (Type: EntityNameOrURI).
- **context** - parameters that control the language, date and time, and other contextual variables (Type: ReadContext).

Return Type: Boolean

Exceptions

- **UnsupportedLanguage** - The referenceLanguage is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more changeSetContext is not supported by the service.
- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The EntityNameOrURI is not known to the service.

3.2.1.8 Operation: intersectEntityList

Return an `EntityReferenceList` that represents the intersection of the supplied list and the directory.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of `EntityReferences` (Type: `EntityDirectoryURI`).
- **entityList** - a list of namespace/names or URIs of the entities to be intersected (Type: `EntityNameOrURIList`).
- **context**_{OPT} - parameters that control the language, date and time, and other contextual variables (Type: `ReadContext`).

Return Type: `EntityNameOrURIList`

Exceptions

- **InvalidDirectoryURI** - The supplied `directory` URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied `directory` URI is not the one required by the service invocation.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

3.3 Entity Description History Service

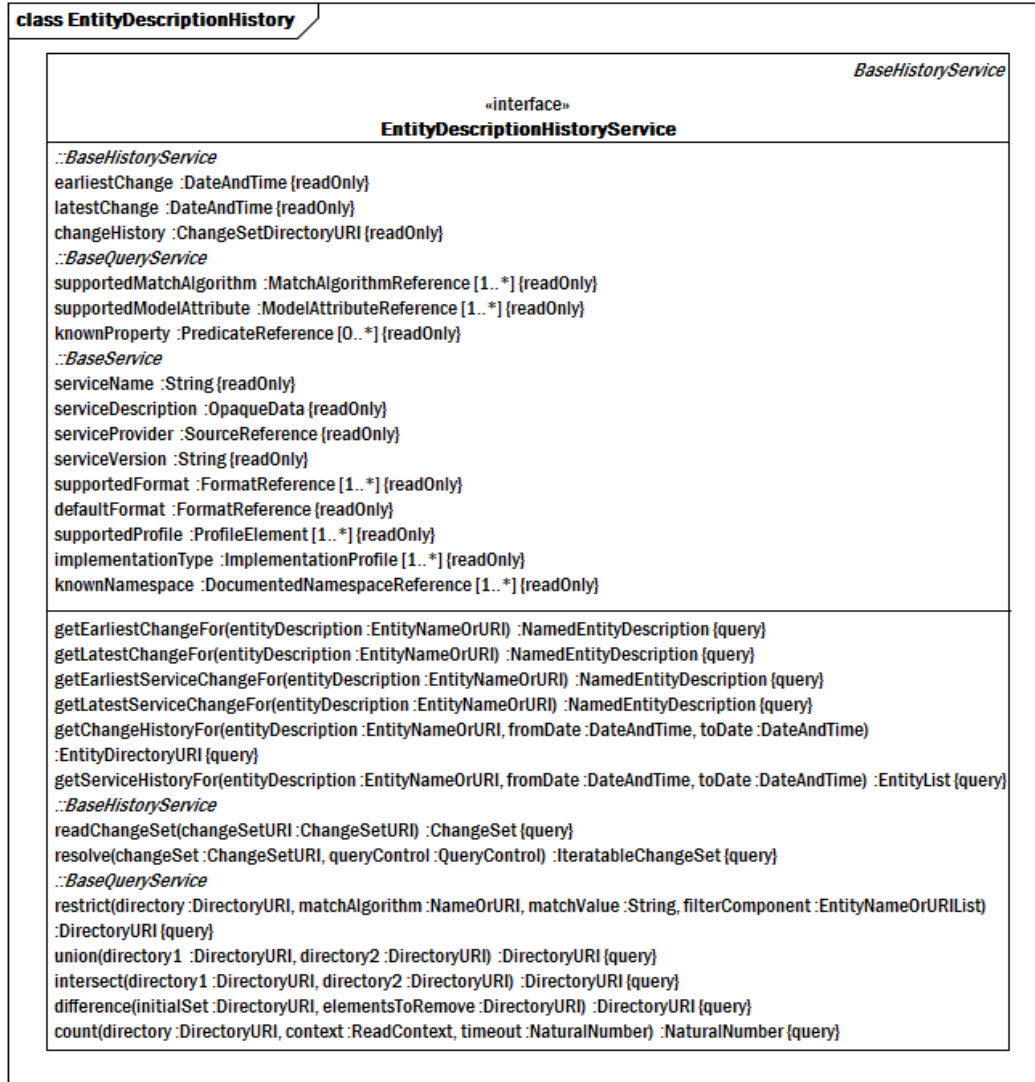


Figure 3.3 - Entity Description History

The *EntityDescriptionHistoryService* allows the client to find the first change, last change, and the set of changes that occurred to an *EntityDescription* in a particular range of time. Changes can be viewed either from the perspective of the service - determining when a change became visible to the service clients or from the perspective of the publisher - determining when the author of the change stated that it was to become active.

3.3.1 Interface EntityDescriptionHistoryService

A service that provides a historical perspective on what changes occurred to a given *EntityDescription*.

Superclasses

- Every instance of `EntityDescriptionHistoryService` is also an instance of `BaseHistoryService`.

3.3.1.1 Operation: `getEarliestChangeFor`

Select from the set of `ChangeSets` that contain one or more changes for the referenced entity the `ChangeSet` that has the earliest `officialEffectiveDate` and return the first change for the named entity in the set.

Input Parameters

- **entityDescription** - the namespace/name or URI of the `entityDescription` being queried (Type: `EntityNameOrURI`).

Return Type: `NamedEntityDescription`

Exceptions

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

3.3.1.2 Operation: `getLatestChangeFor`

Select from the set of `ChangeSets` that contain one or more changes for the referenced entity the `ChangeSet` that has the latest `officialEffectiveDate` and return the last change for the named entity in the set.

Input Parameters

- **entityDescription** - the namespace/name or URI of the `entityDescription` being queried (Type: `EntityNameOrURI`).

Return Type: `NamedEntityDescription`

Exceptions

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

3.3.1.3 Operation: `getEarliestServiceChangeFor`

Get the first change that was applied to the named entity from the perspective of the service.

Input Parameters

- **entityDescription** - the namespace/name or URI of the `entityDescription` being queried (Type: `EntityNameOrURI`).

Return Type: `NamedEntityDescription`

Exceptions

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

3.3.1.4 Operation: **getLatestServiceChangeFor**

Get the last change that was applied to the named entity from the perspective of the service.

Input Parameters

- **entityDescription** - the namespace/name or URI of the entityDescription being queried (Type: `EntityNameOrURI`).

Return Type: `NamedEntityDescription`

Exceptions

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

3.3.1.5 Operation: **getChangeHistoryFor**

Return a directory of `EntityDescriptions` matching the supplied namespace/name or URI whose `ChangeSet.officialEffectiveDate` falls between `fromDate` and `toDate`. The order of the dates controls the return order - if `fromDate` is later than `toDate` the return order is latest to earliest, otherwise it is earliest to latest.

Input Parameters

- **entityDescription** - The namespace/name or URI of the entityDescription being queried (Type: `EntityNameOrURI`).
- **fromDate_{OPT}** - The starting date. If later than `toDate`, the return order is latest to earliest, otherwise it is earliest to latest. (Type: `DateAndTime`)
- **toDate_{OPT}** - The end date. If later than `fromDate`, the order is earliest to latest, otherwise it is latest to earliest. (Type: `DateAndTime`).

Return Type: `EntityDirectoryURI`

Exceptions

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

3.3.1.6 Operation: **getServiceHistoryFor**

Return a directory of `EntityDescriptions` matching the supplied namespace/name or URI whose changes became visible in the service between `fromDate` and `toDate`. The order of the dates controls the return order - if `fromDate` is later than `toDate` the return order is latest to earliest, otherwise it is earliest to latest.

Input Parameters

- **entityDescription** - the namespace/name or URI of the entityDescription being queried (Type: `EntityNameOrURI`).
- **fromDate_{OPT}** - the earliest possible service change date. `fromDate` must be less than `changeDate`. If not supplied, earliest possible time is not checked. (Type: `DateAndTime`)
- **toDate_{OPT}** - the latest possible service change date. `changeDate` must be less than or equal to `toDate`. If not supplied, `toDate` is not checked (Type: `DateAndTime`).

Return Type: `EntityList`

Exceptions

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

3.4 Entity Description Maintenance Service

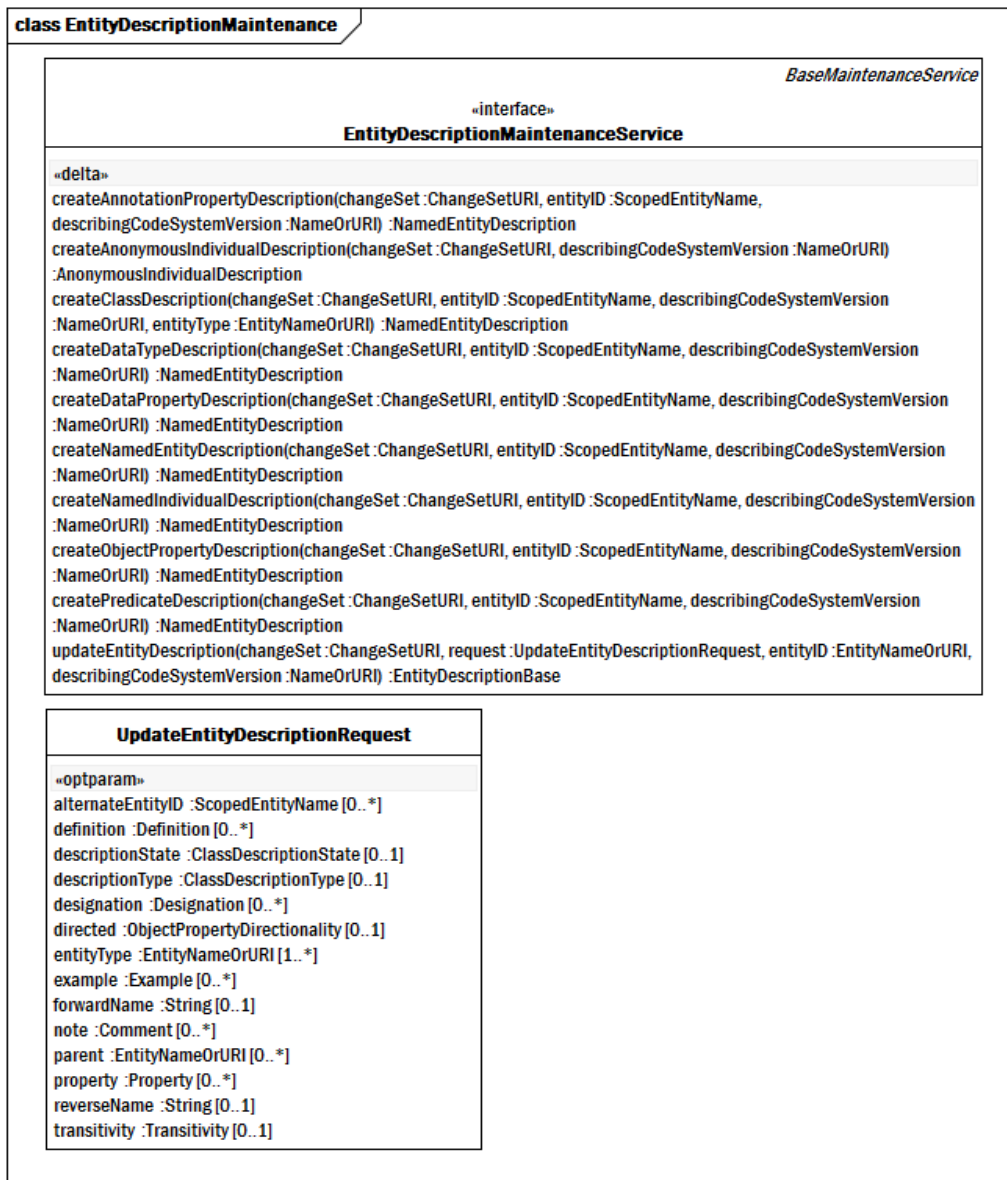


Figure 3.4 - Entity Description Maintenance Service

3.4.1 Interface **EntityDescriptionMaintenanceService**

Superclasses:

- Every instance of **EntityDescriptionMaintenanceService** is also an instance of **BaseMaintenanceService**.

3.4.1.1 Operation: **createAnnotationPropertyDescription**

Create a new **AnnotationPropertyDescription**.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an OPEN change set that will record the change (Type: **ChangeSetURI**).
- **entityID_{OPT}** - the entity code and/or namespace identifier of the entity to be created. The decision about whether this parameter has to (or can be) supplied is service specific. Some services may choose to manage both namespaces and codes themselves, others may require a namespace without a code or a code without a namespace. (Type: **ScopedEntityName**)
- **describingCodeSystemVersion** - the URI or local identifier of the code system version that this entity description is both described in and described by. The referenced code system version must be in an OPEN (vs. FINAL) state (Type: **NameOrURI**).

Return Type: NamedEntityDescription

Exceptions

- **EntityIDMustBeGeneratedByService** - The service expects to automatically generate the entityID for the supplied code system. It cannot be supplied in the API call.
- **EntityIDMustBeSupplied** - The service requires that the scoped entity name be provided.
- **UnknownCodeSystemVersion** - The referenced **CodeSystemVersion** is not recognized by the service.
- **ChangeSetIsNotOpen** - The **changeSetContext** is recognized by the service, but its state is not OPEN.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **EntityAlreadyExists** - A description of the named entity already exists in the code system version.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.

3.4.1.2 Operation: **createAnonymousIndividualDescription**

Create a new **AnonymousIndividualDescription**.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an OPEN change set that will record the change (Type: **ChangeSetURI**).

- **describingCodeSystemVersion** - the URI or local identifier of the code system version that this entity description is both described in and described by. The referenced code system version must be in an OPEN (vs. FINAL) state (Type: NameOrURI).

Return Type: Anonymous IndividualDescription

Exceptions

- **UnknownCodeSystemVersion** - The referenced CodeSystemVersion is not recognized by the service.
- **ResourceIsNotOpen** - The target resource version description has been finalized and cannot be updated.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.

3.4.1.3 Operation: createClassDescription

Create a new ClassDescription.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an OPEN change set that will record the change (Type: ChangeSetURI).
- **entityID_{OPT}** - the entity code and/or namespace identifier of the entity to be created. The decision about whether this parameter has to (or can be) supplied is service specific. Some services may choose to manage both namespaces and codes themselves, others may require a namespace without a code or a code without a namespace. (Type: ScopedEntityName)
- **describingCodeSystemVersion** - the URI or local identifier of the code system version that this entity description is both described in and described by. The referenced code system version must be in an OPEN (vs. FINAL) state. (Type: NameOrURI)
- **entityType_{OPT}** - the type (e.g., skos:concept, owl:class, rdf:property, owl:individual) of this entity. If not supplied the type will default to skos:concept. (Type: EntityNameOrURI)

Return Type: NamedEntityDescription

Exceptions

- **EntityIDMustBeGeneratedByService** - The service expects to automatically generate the entityID for the supplied code system. It cannot be supplied in the API call.
- **EntityIDMustBeSupplied** - The service requires that the scoped entity name be provided.
- **UnknownCodeSystemVersion** - The referenced CodeSystemVersion is not recognized by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **EntityAlreadyExists** - A description of the named entity already exists in the code system version.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.

3.4.1.4 Operation: createDataTypeDescription

Create a new `DataTypeDescription`.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an OPEN change set that will record the change (Type: `ChangeSetURI`).
- **entityID_{OPT}** - the entity code and/or namespace identifier of the entity to be created. The decision about whether this parameter has to (or can be) supplied is service specific. Some services may choose to manage both namespaces and codes themselves, others may require a namespace without a code or a code without a namespace. (Type: `ScopedEntityName`)
- **describingCodeSystemVersion** - the URI or local identifier of the code system version that this entity description is both described in and described by. The referenced code system version must be in an OPEN (vs. FINAL) state. (Type: `NameOrURI`)

Return Type: `NamedEntityDescription`

Exceptions

- **EntityIDMustBeGeneratedByService** - The service expects to automatically generate the entityID for the supplied code system. It cannot be supplied in the API call.
- **EntityIDMustBeSupplied** - The service requires that the scoped entity name be provided.
- **UnknownCodeSystemVersion** - The referenced `CodeSystemVersion` is not recognized by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **EntityAlreadyExists** - A description of the named entity already exists in the code system version.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.

3.4.1.5 Operation: createDataPropertyDescription

Create a new `DataPropertyDescription`.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an OPEN change set that will record the change (Type: `ChangeSetURI`).
- **entityID_{OPT}** - The entity code and/or namespace identifier of the entity to be created. The decision about whether this parameter has to (or can be) supplied is service specific. Some services may choose to manage both namespaces and codes themselves, others may require a namespace without a code or a code without a namespace. (Type: `ScopedEntityName`)
- **describingCodeSystemVersion** - the URI or local identifier of the code system version that this entity description is both described in and described by. The referenced code system version must be in an OPEN (vs. FINAL) state. (Type: `NameOrURI`)

Return Type: NamedEntityDescription

Exceptions

- **EntityIDMustBeGeneratedByService** - The service expects to automatically generate the entityID for the supplied code system. It cannot be supplied in the API call.
- **EntityIDMustBeSupplied** - The service requires that the scoped entity name be provided.
- **UnknownCodeSystemVersion** - The referenced CodeSystemVersion is not recognized by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **EntityAlreadyExists** - A description of the named entity already exists in the code system version.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.

3.4.1.6 Operation: createNamedEntityDescription

Create a new NamedEntityDescription.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an OPEN change set that will record the change (Type: ChangeSetURI).
- **entityID_{OPT}** - the entity code and/or namespace identifier of the entity to be created. The decision about whether this parameter has to (or can be) supplied is server specific. Some services may choose to manage both namespaces and codes themselves, others may require a namespace without a code or a code without a namespace. (Type: ScopedEntityName)
- **describingCodeSystemVersion** - the URI or local identifier of the code system version that this entity description is both described in and described by. The referenced code system version must be in an OPEN (vs. FINAL) state. (Type: NameOrURI)

Return Type: NamedEntityDescription

Exceptions

- **EntityIDMustBeGeneratedByService** - The service expects to automatically generate the entityID for the supplied code system. It cannot be supplied in the API call.
- **EntityIDMustBeSupplied** - The service requires that the scoped entity name be provided.
- **UnknownCodeSystemVersion** - The referenced CodeSystemVersion is not recognized by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **EntityAlreadyExists** - A description of the named entity already exists in the code system version.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.

3.4.1.7 Operation: createNamedIndividualDescription

Create a new `NamedIndividualDescription`.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an OPEN change set that will record the change (Type: `ChangeSetURI`).
- **entityID_{OPT}** - the entity code and/or namespace identifier of the entity to be created. The decision about whether this parameter has to (or can be) supplied is service specific. Some services may choose to manage both namespaces and codes themselves, others may require a namespace without a code or a code without a namespace. (Type: `ScopedEntityName`)
- **describingCodeSystemVersion** - the URI or local identifier of the code system version that this entity description is both described in and described by. The referenced code system version must be in an OPEN (vs. FINAL) state. (Type: `NameOrURI`)

Return Type: `NamedEntityDescription`

Exceptions

- **EntityIDMustBeGeneratedByService** - The service expects to automatically generate the entityID for the supplied code system. It cannot be supplied in the API call.
- **EntityIDMustBeSupplied** - The service requires that the scoped entity name be provided.
- **UnknownCodeSystemVersion** - The referenced `CodeSystemVersion` is not recognized by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **EntityAlreadyExists** - A description of the named entity already exists in the code system version.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.

3.4.1.8 Operation: createObjectPropertyDescription

Create a new `ObjectPropertyDescription`.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an OPEN change set that will record the change. (Type: `ChangeSetURI`)
- **entityID_{OPT}** - the entity code and/or namespace identifier of the entity to be created. The decision about whether this parameter has to (or can be) supplied is service specific. Some services may choose to manage both namespaces and codes themselves, others may require a namespace without a code or a code without a namespace. (Type: `ScopedEntityName`)
- **describingCodeSystemVersion** - the URI or local identifier of the code system version that this entity description is both described in and described by. The referenced code system version must be in an OPEN (vs. FINAL) state. (Type: `NameOrURI`)

Return Type: NamedEntityDescription

Exceptions

- **EntityIDMustBeGeneratedByService** - The service expects to automatically generate the entityID for the supplied code system. It cannot be supplied in the API call.
- **EntityIDMustBeSupplied** - The service requires that the scoped entity name be provided.
- **UnknownCodeSystemVersion** - The referenced CodeSystemVersion is not recognized by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **EntityAlreadyExists** - A description of the named entity already exists in the code system version.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.

3.4.1.9 Operation: createPredicateDescription

Create a new PredicateDescription.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an OPEN change set that will record the change. (Type: ChangeSetURI)
- **entityID_{OPT}** - The entity code and/or namespace identifier of the entity to be created. The decision about whether this parameter has to (or can be) supplied is service specific. Some services may choose to manage both namespaces and codes themselves, others may require a namespace without a code or a code without a namespace. (Type:ScopedEntityName)
- **describingCodeSystemVersion** - the URI or local identifier of the code system version that this entity description is both described in and described by. The referenced code system version must be in an OPEN (vs. FINAL) state. (Type:NameOrURI)

Return Type: NamedEntityDescription

Exceptions

- **EntityIDMustBeGeneratedByService** - The service expects to automatically generate the entityID for the supplied code system. It cannot be supplied in the API call.
- **EntityIDMustBeSupplied** - The service requires that the scoped entity name be provided.
- **UnknownCodeSystemVersion** - The referenced CodeSystemVersion is not recognized by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **EntityAlreadyExists** - A description of the named entity already exists in the code system version.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.

3.4.1.10 Operation: `updateEntityDescription`

Update an existing entity description of any type.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - The identifier of an OPEN change set that will record the change. (Type: `ChangeSetURI`)
- **request** - The set of fields to be changed. (Type: `UpdateEntityDescriptionRequest`)
- **entityID** - The namespace and name or URI of the referenced entity. (Type: `EntityNameOrURI`)
- **describingCodeSystemVersion** - The URI or local identifier of the code system version that this entity description is both described in and described by. The referenced code system version must be in an OPEN (vs. FINAL) state. (Type: `NameOrURI`)

Return Type: `EntityDescriptionBase`

Exceptions

- **UnsupportedCaseSignificance** - The case Significance indicator is not recognized by the service.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedDesignationFidelity** - The `designationFidelity` is not recognized by the service.
- **UnsupportedDesignationType** - The `designationType` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ResourceIsNotOpen** - The target resource version description has been finalized and cannot be updated.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

3.4.2 Class `UpdateEntityDescriptionRequest`

The set of attributes that can be changed in an `EntityDescription`. The `optparam` stereotype means that, if not supplied in the `UpdateEntityRequest`, the named attribute will not be changed. If a parameter is supplied, it can add an attribute where none existed before (original cardinality = 0, update cardinality > 0), can remove an attribute that was previously present (original cardinality > 0, update cardinality = 0), or can update an attribute if both the original and update cardinality > 0. Note that lists must be replaced as units - to add an element to a list (e.g., to add a new note), the entire new list must be supplied. Finer grained update capability can be recognized via. the `STATEMENT` service implementation.

Attributes

- **alternateEntityID** - an identifier that uniquely references the about entity in the context of the describing code system version.
- **definition** - an explanation of the intended meaning of a class or predicate.
- **descriptionState** - the specific role that a class description plays, if known.
- **descriptionType** - an indicator that states whether the class description contains only necessary assertions (PRIMITIVE) or both necessary and sufficient assertions (FULLY_DEFINED).
- **designation** - a label that represents the intended meaning in a natural language.
- **directed** - an indicator whether the predicate semantics are mono or bi-directional. This attribute only applies to entities of type PREDICATE.
- **entityType** - a type that the referenced entity is an instance of. All entity references must have at least one type. A service may add constraints about the allowed type transitions (e.g., from Class to Individual or Individual to Property).
- **example** - an example representing an instance or uses of the referenced entity.
- **forwardName** - a name assigned to a predicate when used in the source to target direction. Only applies to entities of type PREDICATE.
- **note** - a note or comment about the history, status, use, etc. of the referenced entity.
- **parent** - an asserted or direct “parent” of the entity.
- **property** - an additional “non-semantic” (annotation) assertion about the referenced entity.
- **reverseName** - a name assigned to a predicate when used in the target to source direction. Only applies to entities of type PREDICATE.
- **transitivity** - an indicator that states whether an object property is transitive. Only applies to entities of type OBJECT_PROPERTY.

3.5 Entity Description Transform Service

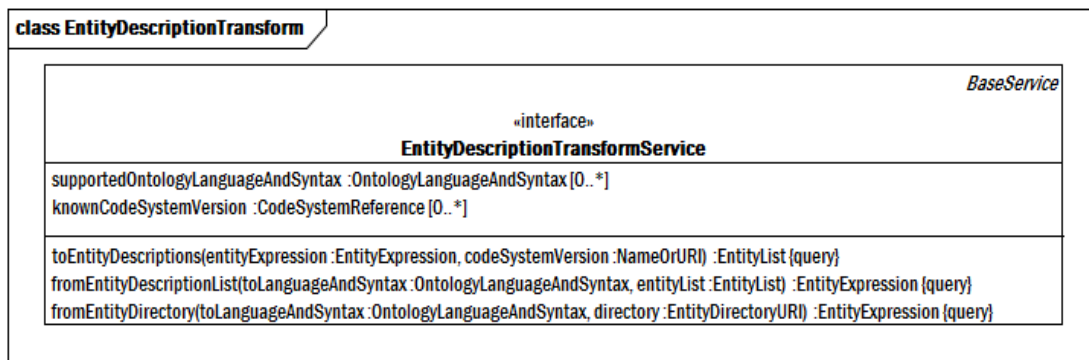


Figure 3.5 - Entity Description Transform Service

The `EntityDescriptionTransformService` transforms entity descriptions from external formats such as OWL/RDF, Manchester Syntax, SNOMED-CT Compositional Grammar, etc. into the corresponding `EntityDescriptions` without entering the descriptions into the service database. It also allows existing `EntityDescriptions` to be represented in external formats for viewing and portability.

3.5.1 Interface `EntityDescriptionTransformService`

A service that transforms various external formats into the CTS2 `EntityDescription` model and vice versa.

Superclasses

- Every instance of `EntityDescriptionTransformService` is also an instance of `BaseService`.

Attributes

- **`supportedOntologyLanguageAndSyntax`** - an ontology language and syntax that is supported by the transformation service.
- **`knownCodeSystemVersion`** - a URI and name of a code system version that can serve as the basis for a transformation by this service.

3.5.1.1 Operation: `toEntityDescriptions`

Transform `entityExpression` into a list of one or more `EntityDescriptions` in the context of the supplied `codeSystemVersion`.

Input Parameters

- **`entityExpression`** - the expression in the external language (Type: `EntityExpression`).
- **`codeSystemVersion`**_{OPT} - the name or URI of the code system version that supplies the surrounding context for the transformation, if any (Type: `NameOrURI`).

Return Type: `EntityList`

Exceptions

- **`UnknownCodeSystemVersion`** - The referenced `CodeSystemVersion` is not recognized by the service.
- **`EntityExpressionSyntaxError`** - The entity expression is syntactically incorrect and cannot be parsed.
- **`UnsupportedOntologySyntax`** - The supplied ontology syntax is not supported by the service.
- **`UnsupportedOntologyLanguage`** - The supplied ontology language is not supported by the service.

3.5.1.2 Operation: `fromEntityDescriptionList`

Transform the list of entity descriptions in `entityList` into the semantics and syntax specified in `toLanguageAndSyntax`.

Input Parameters

- **`toLanguageAndSyntax`** - the target language and syntax for the transformation (Type: `OntologyLanguageAndSyntax`).

- **entityList** - the list of entity descriptions to be transformed (Type: EntityList).

Return Type: EntityExpression

Exceptions

- **UnsupportedOntologyLanguage** - The supplied ontology language is not supported by the service.
- **UnsupportedOntologySyntax** - The supplied ontology syntax is not supported by the service.

3.5.1.3 Operation: fromEntityDirectory

Transform the list of entity descriptions referenced in `entityDirectory` into the semantics and syntax specified in `toLanguageAndSyntax`.

Input Parameters

- **toLanguageAndSyntax** - the target language and syntax for the transformation (Type: OntologyLanguageAndSyntax).
- **directory** - a URI that resolves to the set of EntityReferences to be transformed (Type: EntityDirectoryURI).

Return Type: EntityExpression

Exceptions

- **UnsupportedOntologyLanguage** - The supplied ontology language is not supported by the service.
- **UnsupportedOntologySyntax** - The supplied ontology syntax is not supported by the service.
- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.

4 Association Information Model

4.1 Association Model

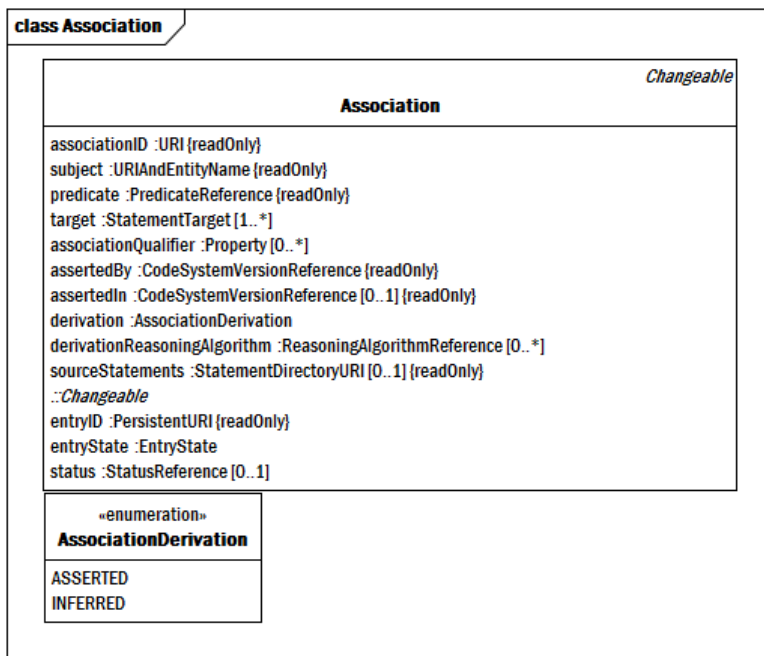


Figure 4.1 - Association Model

4.1.1 Class Association

A “semantic” assertion about a relationship between a subject entity and a target entity, literal or compound expression as represented by an unnamed blank node (“bnode”).

Superclasses

- Every instance of `Association` is also an instance of `Changeable`.

Attributes

- **associationID** - the unique identifier of the association instance. While the update mechanism of the CTS2 specifications requires that all `Changeable` elements have unique identifiers, the rules and mechanism for assigning unique identifiers to statements and associations are non-trivial. At the moment, the CTS2 specification remains silent when it comes to arriving at how this identifier is generated except to note that, if two service implementations do not generate the same unique identifier for the same assertion, then the `prevImage` element in `Changeable` becomes the only way to identify which `Association` instance is being updated or deleted.
- **subject** - the subject of the association statement. `subject` must reference an `Entity` - i.e., a class, predicate, and/or individual.
- **predicate** - the predicate of the association statement.

- **target** - the target (object) of the association statement. A target may be a reference to an entity, an external resource URI, a literal or a compound expression (bnode) or a set of targets.
- **associationQualifier** - additional tag/value attributes that qualify the association statement itself as opposed to the statement subject.
- **assertedBy** - the code system version that is making this assertion. A code system version makes an assertion when (a) it contains the assertion, (b) it imports a code system version that contains the assertion, or (c) the assertion is inferred from other assertions.
- **assertedIn** - the code system version that actually contains this assertion. If absent, it is the same resource as assertedBy.
- **derivation** - how this association was derived. ASSERTED takes precedence over DERIVED, meaning that an assertion that is both asserted and derived is marked as asserted.
- **derivationReasoningAlgorithm** - a reasoning algorithm that was used to derive an association of derivation INFERRED. Note that more than one reasoning algorithm may be present for the same association.
- **sourceStatements** - detail about the provenance and history of the statement(s) from which this particular association is derived. This attribute will only be present in CTS2 service implementations that support the statements model.

Invariants

1. The unique identifier of an `Association` element is the `associationId`.

4.1.1.1 Enum AssociationDerivation

The derivation of a given statement - whether it is directly asserted by the source, is derived by the application of a reasoner or is unknown because the reasoner or source does not supply such information.

Enumeration Types:

- **ASSERTED** - The statement was explicitly asserted by the asserting code system version.
- **INFERRED** - The statement was not asserted by the code system version, but was logically inferred by the application of one or more reasoning algorithms to other statements within the code system version.

4.2 Association Graph

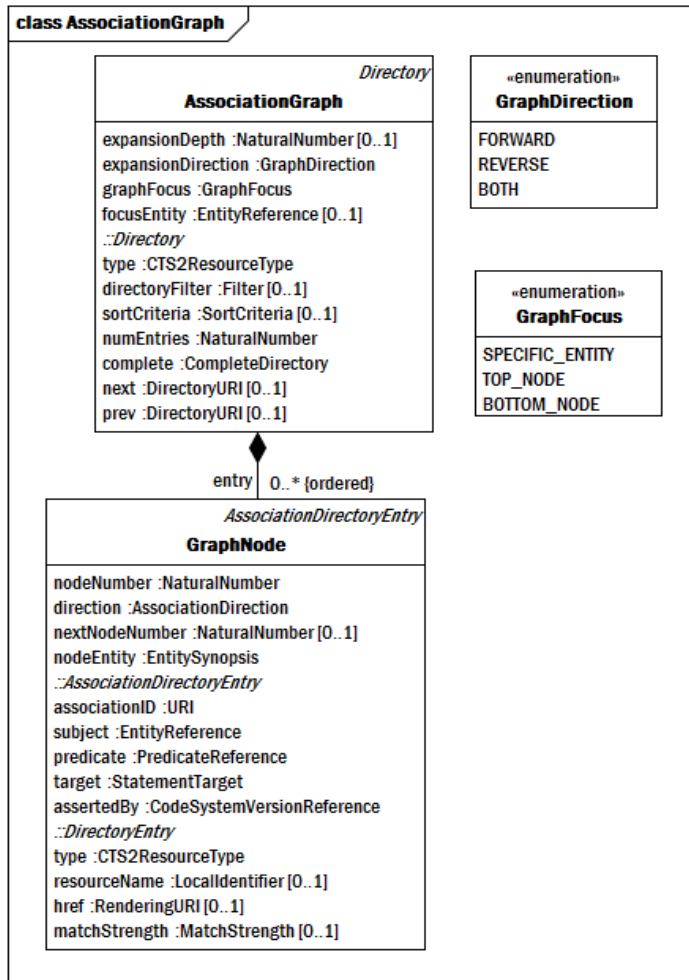


Figure 4.2 - Association Graph Model

AssociationGraph is an augmented rendering of a set of Associations where the linkage between subject and target nodes has been normalized for easier traversal. The challenge that is faced in the representation of graphs is that they can potentially be quite large and, as such, need to be able to be returned through the use of iterators, which are represented by the class *Directory* in the CTS2 model. This requirement, however, makes it very difficult to represent graphs hierarchically, as one graph may represent a single node with many thousands of direct descendents, another may represent a set of trees each 20 or more nodes deep and a third some other combination of these.

For this reason, the CTS2 model defines a flattened representation of the corresponding graph that is designed for manipulation and reassembly. To accomplish this, every *EntitySynopsis* that occurs in the set of associations is assigned a unique number. These numbers are assigned in depth first order and, when both forward and reverse association traversal is supported, in the order of forward first followed by reverse.

4.2.1 Class AssociationGraph

An augmented rendering of a set of `Associations` where the linkage between subject and target nodes has been normalized for easier traversal.

Superclasses

- Every instance of `AssociationGraph` is also an instance of `Directory`.

Attributes

- **expansionDepth** - the depth (one based) of the graph. This is a copy of the `resolveDepth` parameter of the `resolveAsGraph` method in the `AdvancedAssociationQueryService`.
- **expansionDirection** - the direction that the graph was expanded. This is a copy of the `resolveDirection` parameter from the `resolveAsGraph` method in the `AdvancedAssociationQueryService`.
- **graphFocus** - the focus of the graph.
- **focusEntity** - the focus entity of the graph, if any. This is a copy of the `focus` parameter from the `resolveAsGraph` method in the `AdvancedAssociationQueryService`.
- **entry** -

Invariants

1. The `graphFocus` can be on a `SPECIFIC_ENTITY` if and only if there is a `focusEntity` present.

4.2.1.1 Class GraphNode

The summary of an association as represented in a flattened graph structure.

Superclasses

- Every instance of `GraphNode` is also an instance of `AssociationDirectoryEntry`.

Attributes

- **nodeNumber** - an integer that corresponds to the particular `EntityReference` in `nodeEntity`. Every instance of the same `EntityReference` will be represented by the same `nodeNumber`. There will be graph node for every source predicate target combination in the association, with multiple `GraphNode`s being generated for targets that are of type set or `BNode`.
- **direction** - an indicator whether `nodeEntity` plays a source or a target role in the accompanying `AssociationDirectory` instance.
- **nextNodeNumber** - an integer that represents the next graph node that is reached by traversing the specified predicate in the specified direction. This number will only be present if the result of traversing predicate results in an `EntityReference`. Target nodes of type `ResourceReference` or `Literal` will not be assigned node numbers. Note that each `EntityReference` target of a nested `BNode` will be represented by a different `GraphNode`.
- **nodeEntity** - the URI, name and a designation for the `EntityReference` represented by this node. `nodeEntity` represents the association subject when `direction` is `SOURCE_TO_TARGET` and (one of the) targets when `direction` is `TARGET_TO_SOURCE`.

Invariants

1. A graph node does not have a local identifier.

4.2.1.2 Enum GraphDirection

An indicator that states whether the graph represents a graph at which the focus is in the subject role, the target role, or both.

Enumeration Types:

- **FORWARD** - Indicates that graph is based the graph focus in the source role - the graph is drawn from source to target with the source at the root.
- **REVERSE** - Indicates that graph is based the graph focus in the target role - the graph is drawn from target source with the source at the bottom.
- **BOTH** - Indicates that graph is based the graph focus in both the source and the target role - the graph represents all associations in which the focus is either in the source or target role.

4.2.1.3 Enum GraphFocus

Identifies the root of an association graph.

Enumeration Types:

- **SPECIFIC_ENTITY** - The focus on the graph is contained in `focusEntity`.
- **TOP_NODE** - The focus of the graph is on the TOP or “universe” node.
- **BOTTOM_NODE** - The focus of the graph is on the BOTTOM or empty node.

4.3 Association Directories

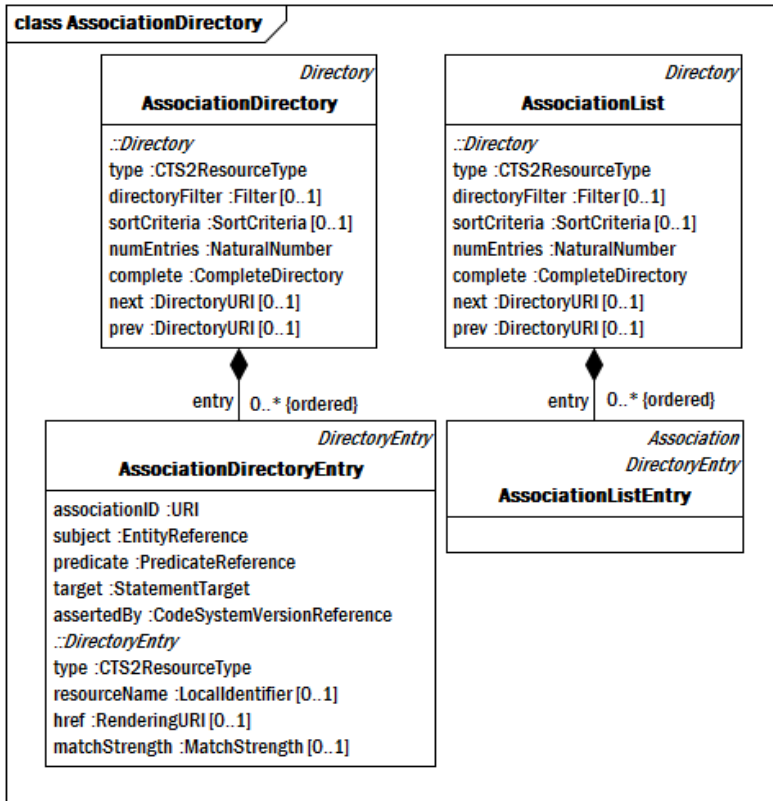


Figure 4.3 - Association Directory

4.3.1 Class AssociationDirectory

A directory of Association resources that meet a specified criteria.

Superclasses

- Every instance of AssociationDirectory is also an instance of Directory.

Attributes

- **entry** - an entry in an association directory

Invariants

1. The type of an AssociationDirectory is ASSOCIATION.

4.3.2 Class AssociationDirectoryEntry

A synopsis of an Association along with information about how to access the complete resource.

Superclasses

- Every instance of `AssociationDirectoryEntry` is also an instance of `DirectoryEntry`.

Attributes

- **associationID** - the unique identifier of the association instance.
- **subject** - the subject of the association statement.
- **predicate** - the predicate of the association statement.
- **target** - the target (object) of the association statement.
- **assertedBy** - the code system version that is making this assertion.

Invariants

1. The type of an `AssociationDirectoryEntry` is `ASSOCIATION`.
2. `AssociationDirectoryEntry` does not have a `resourceName`.

4.3.3 Class AssociationList

A collection of complete `Association` resources that meet a specified criteria.

Superclasses

- Every instance of `AssociationList` is also an instance of `Directory`.

Attributes

- **entry** -

Invariants

1. The type of an `AssociationList` is `ASSOCIATION`.

4.3.4 Class AssociationListEntry

An instance of `Association` that meets a specified filter criteria.

Superclasses

- Every instance of `AssociationListEntry` is also an instance of `Association`.
- Every instance of `AssociationListEntry` is also an instance of `DirectoryEntry`.

Invariants

1. The type of an `AssociationListEntry` is `ASSOCIATION`.

5 Association and Reasoning Services

5.1 Base Association Services

5.1.1 Association Read Service

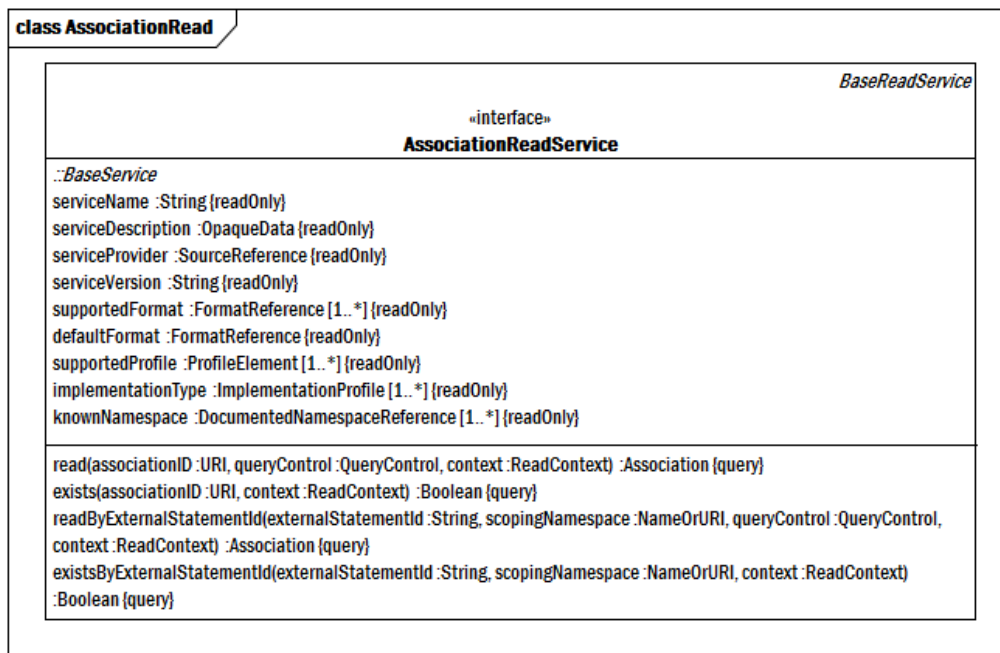


Figure 5.1 - Association Read Service

AssociationReadService provides direct access to association instances in a CTS2 service implementation. Instances may be retrieved by URI or by an external identifier associated with them in the context of a scoping namespace. Note that currently there is no widely accepted scheme for assigning “universal” URIs to association instances, meaning that the mechanism is left to the specific service implementation. This does mean, however, that associations pretty much have to be exchanged and addressed by value instead of URI.

In the case that Association instances have been given external identifiers, it is strongly recommended that the association URI be constructed from a combination of the namespace and external identifier. As an example, the International Health Standards Terminology Development Organization (IHTSDO)¹³ assigns a unique “SctId” to every row in the relationship table. The combination of this external identifier and an appropriate namespace could be combined giving something in the form `http://id.ihtsdo.org/2537148029`. Note that the service also supports direct access to Associations by external identifier, meaning that the above example could be accessed by `scopingNamespace` “`http://id.ihtsdo.org/`” and an external identifier of 2537148029.

13. <http://www.ihtsdo.org/>

5.1.1.1 Interface AssociationReadService

A service that provides direct read access to associations.

Superclasses

- Every instance of `AssociationReadService` is also an instance of `BaseReadService`.

5.1.1.2 Operation: read

Retrieve the association instance identified by the `entryID` URI.

Input Parameters

- **associationID** - the URI that uniquely identifies the association instance (Type: `URI`).
- **queryControl**_{OPT} - parameters that control the ordering, format, timeout, and query behavior (Type: `QueryControl`).
- **context**_{OPT} - parameters that control the language, date and time, and other contextual variables (Type: `ReadContext`).

Return Type: Association

Exceptions

- **UnknownAssociation** - The referenced `Association` is not recognized by the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not `OPEN`.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.
- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The `format` is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.

5.1.1.3 Operation: exists

Determine whether an association identified by the `entryID` URI is accessible from the service in the specified (optional) context.

Input Parameters

- **associationID** - the URI that uniquely identifies the association instance (Type: URI).
- **context_{OPT}** - parameters that control the language, date and time, and other contextual variables (Type: ReadContext).

Return Type: Boolean

Exceptions

- **UnsupportedLanguage** - The referenceLanguage is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more changeSetContext is not supported by the service.

5.1.1.4 Operation: readByExternalStatementId

Retrieve the association identified by the identifierNamespace and externalStatementId.

Input Parameters

- **externalStatementId** - the identifier assigned to the association instance in the context of the scoping namespace (Type: String).
- **scopingNamespace** - the name or URI of the namespace that contextualizes externalStatementId (Type: NameOrURI).
- **queryControl_{OPT}** - parameters that control the ordering, format, timeout, and query behavior (Type: QueryControl).
- **context_{OPT}** - parameters that control the language, date and time, and other contextual variables (Type: ReadContext).

Return Type: Association

Exceptions

- **UnknownAssociation** - The referenced Association is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedLanguage** - The referenceLanguage is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more changeSetContext is not supported by the service.
- **UnsupportedMatchAlgorithm** - The matchAlgorithm is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.

- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The `format` is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.

5.1.1.5 Operation: **existsByExternalStatementId**

Determine whether the association identified by the `identifierNamespace` and `externalStatementId` is accessible from the service in the specified (optional) context.

Input Parameters

- **externalStatementId** - the identifier assigned to the association instance in the context of the scoping namespace (Type: `String`).
- **scopingNamespace** - the name or URI of the namespace that contextualizes `externalStatementId` (Type: `NameOrURI`).
- **context_{OPT}** - parameters that control the language, date and time, and other contextual variables (Type: `ReadContext`).

Return Type: Boolean Exceptions

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not `OPEN`.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.

5.1.2 Association Query Service

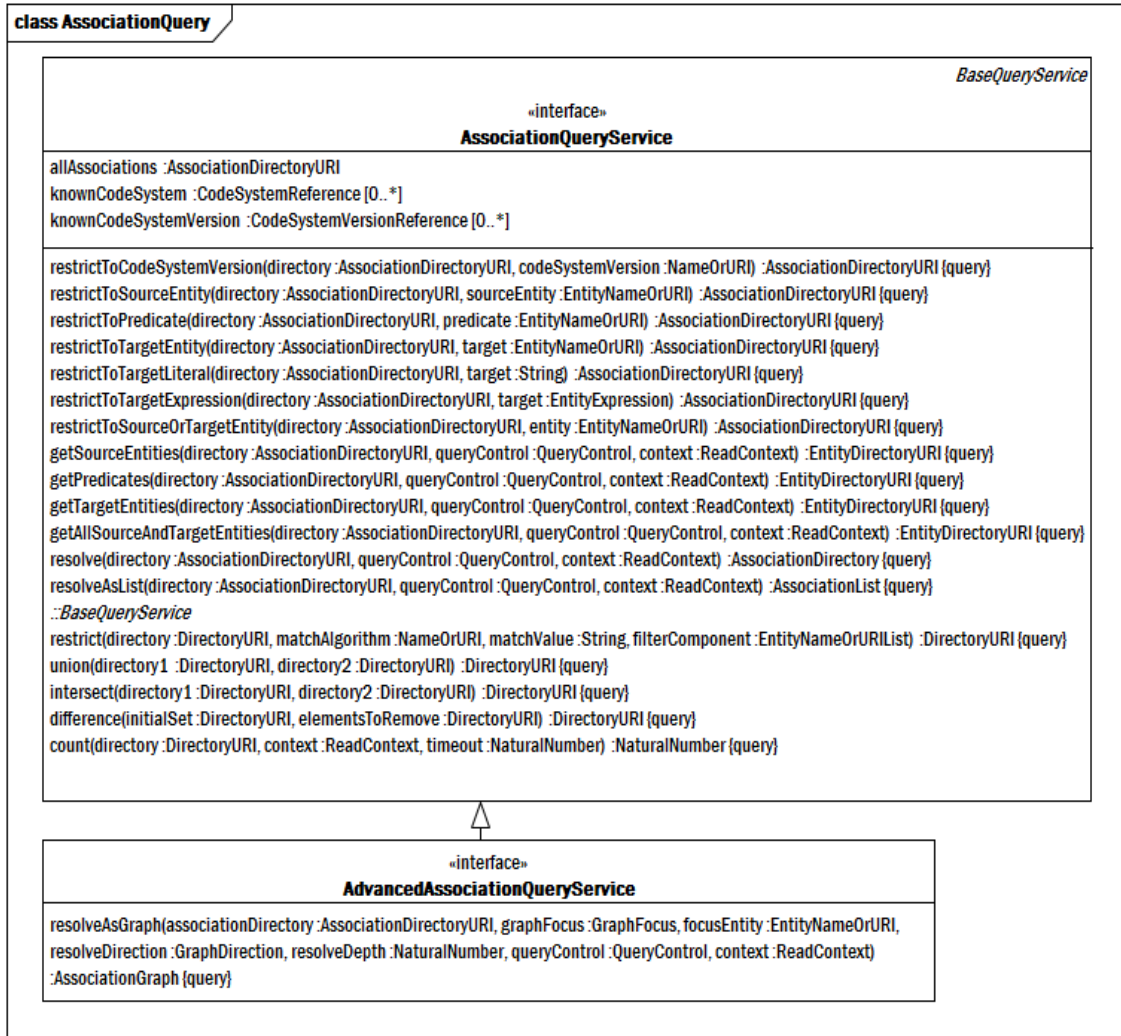


Figure 5.2 - Association Query Service

AssociationQueryService provides an ability that is in some ways similar to that provided by the SPARQL query language - it enables the creation of association subsets via various restriction criteria, the intersection, union, and difference of these sets and the ability to render the result of these queries in useful fashions. The primary difference between AssociationQueryService and SPARQL is that the AssociationQueryService works in the context of the Association structure defined by the CTS2 specification. This structure includes built-in provenance, direct representation of dependent BNODES and mechanisms for representing the output of the queries in ways that allow easy and direct RESTful manipulation.

5.1.2.1 Interface AdvancedAssociationQueryService

An optional extension to the AssociationQueryService that allows AssociationDirectoryURIs to be resolved as graphs.

Superclasses

- Every instance of `Advanced AssociationQueryService` is also an instance of `AssociationQueryService`.

5.1.2.2 Operation: `resolveAsGraph`

Resolve the set of associations referenced by `associationDirectory` as a graph.

Input Parameters

- **associationDirectory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **graphFocus_{OPT}** - the focus (level 0) node of the graph. The focus node may either be the (potentially virtual) topmost node in the graph, the bottommost node in the graph or any valid node that is a member of the resolution of `associationDirectory`. (Type: `GraphFocus`)
- **focusEntity_{OPT}** - the specific entity to focus on if `graphFocus` is `SPECIFIC_ENTITY` (Type: `EntityNameOrURI`).
- **resolveDirection** - the direction that the resolution occurs - “downwards” (in a forward direction) or “upwards” (in a reverse direction) or both (Type: `GraphDirection`).
- **resolveDepth_{OPT}** - the number of levels to resolve. If omitted, the closure of the graph is resolved. (Type: `NaturalNumber`).
- **queryControl_{OPT}** - parameters that control the ordering, format, timeout, and query behavior (Type: `QueryControl`).
- **context_{OPT}** - parameters that control the language, date and time, and other contextual variables (Type: `ReadContext`).

Return Type: `AssociationGraph`

Exceptions

- **UnknownFocusEntity** - either (a) the `focusEntity` is not reachable in `associationDirectory` or (b) `graphFocus` was not set to `SPECIFIC_ENTITY` but `focusEntity` was supplied.
- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.
- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.

- **UnsupportedFormat** - The format is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

5.1.2.3 Interface **AssociationQueryService**

A service that allows the specification and rendering of useful subsets of associations. **AssociationQueryService** allows associations to be restricted by subject, predicate, target, asserting ontology, etc. It also provides set operations that allow the results of restrictions to be combined.

Superclasses

- Every instance of **AssociationQueryService** is also an instance of **BaseQueryService**.

Attributes

- **allAssociations** - A **DirectoryURI** that resolves to all Associations known to the service.
- **knownCodeSystem** - a code system that is known to this service.
- **knownCodeSystemVersion** - a code system version that is known to this service.

5.1.2.4 Operation: **restrictToCodeSystemVersion**

Return a **DirectoryURI** that represents the subset of the associations in `directory` that were assertedBy the named code system version.

Input Parameters

- **directory** - a **DirectoryURI** that resolves to a set of associations (Type: **AssociationDirectoryURI**).
- **codeSystemVersion** - the name or URI of a code system version that constrains the output associations to those assertedBy this version (Type: **NameOrURI**).

Return Type: AssociationDirectoryURI

Exceptions

- **UnknownCodeSystemVersion** - The referenced **CodeSystemVersion** is not recognized by the service.
- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.

5.1.2.5 Operation: restrictToSourceEntity

Return a `DirectoryURI` that represents the subset of the associations in `directory` whose subject is `sourceEntity`.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **sourceEntity** - the namespace/name or URI of the entity that must occur as the source of every association in the output set (Type: `EntityNameOrURI`).

Return Type: `AssociationDirectoryURI`

Exceptions

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.
- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.

5.1.2.6 Operation: restrictToPredicate

Return a `DirectoryURI` that represents the subset of the associations in `directory` whose predicate is `predicate`.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **predicate** - the namespace/name or URI of the entity that must occur as the predicate of every association in the output set (Type: `EntityNameOrURI`).

Return Type: `AssociationDirectoryURI`

Exceptions

- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

5.1.2.7 Operation: restrictToTargetEntity

Return a `DirectoryURI` that represents the subset of the associations in `directory` having a target directly matching target or containing one or more bnodes who reference target.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).

- **target** - the namespace/name or URI of an entity that occurs either (a) in the target position or (b) as the target of a BNODE in the target position (Type: `EntityNameOrURI`).

Return Type: `AssociationDirectoryURI`

Exceptions

- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

5.1.2.8 Operation: `restrictToTargetLiteral`

Return a `DirectoryURI` that represents the subset of the associations in directory having a string literal that matches target.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **target** - the target literal to search for (Type: `String`).

Return Type: `AssociationDirectoryURI`

Exceptions

- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.

5.1.2.9 Operation: `restrictToTargetExpression`

Return a `DirectoryURI` that represents the subset of the associations in directory whose target matches the supplied expression.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **target** - an expression in an external grammar that represents a `StatementTarget` (Type: `EntityExpression`).

Return Type: `AssociationDirectoryURI`

Exceptions

- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.

- **EntityExpressionSyntaxError** - The entity expression is syntactically incorrect and cannot be parsed.
- **UnsupportedOntologySyntax** - The supplied ontology syntax is not supported by the service.
- **UnsupportedOntologyLanguage** - The supplied ontology language is not supported by the service.

5.1.2.10 Operation: restrictToSourceOrTargetEntity

Return a `DirectoryURI` that represents the subset of the associations having either a source or a target matching the supplied entity. This is equivalent to the union of `restrictToSourceEntity` and `restrictToTargetEntity` with source and target being the same.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **entity** - the namespace/name or URI of the filter entity (Type: `EntityNameOrURI`).

Return Type: `AssociationDirectoryURI`

Exceptions

- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnknownEntity** - The `EntityNameOrURI` is not known to the service.

5.1.2.11 Operation: getSourceEntities

Return a `DirectoryURI` that resolves to the set of entities that occur in the source position of the resolution of the supplied association directory.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **queryControl_{OPT}** - parameters that control the ordering, timeout, and query behavior (Type: `QueryControl`).
- **context_{OPT}** - parameters that control the language, date and time, and other contextual variables (Type: `ReadContext`).

Return Type: `EntityDirectoryURI`

Exceptions

- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.
- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.

- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The format is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.

5.1.2.12 Operation: `getPredicates`

Return a `DirectoryURI` that resolves to the set of entities that occur in the predicate position of the resolution of the supplied association directory.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **queryControl**_{OPT} - parameters that control the ordering, timeout, and query behavior (Type: `QueryControl`).
- **context**_{OPT} - parameters that control the language, date and time, and other contextual variables (Type: `ReadContext`).

Return Type: `EntityDirectoryURI`

Exceptions

- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.
- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The format is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.

- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.

5.1.2.13 Operation: **getTargetEntities**

Return a `DirectoryURI` that resolves to the set of entities that occur in the target position or as the target of a `BNode` in the resolution of the supplied association directory.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **queryControl_{OPT}** - parameters that control the ordering, timeout, and query behavior (Type: `QueryControl`).
- **context_{OPT}** - parameters that control the language, date and time, and other contextual variables (Type: `ReadContext`).

Return Type: `EntityDirectoryURI`

Exceptions

- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.
- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.
- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The `format` is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.

5.1.2.14 Operation: **getAllSourceAndTargetEntities**

Return a `DirectoryURI` that resolves to the set of entities that occur in either the source or the target position of the resolution of the supplied association directory.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **queryControl**_{OPT} - parameters that control the ordering, timeout, and query behavior (Type: `QueryControl`).
- **context**_{OPT} - parameters that control the language, date and time, and other contextual variables (Type: `ReadContext`).

Return Type: `EntityDirectoryURI`

Exceptions

- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The format is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.
- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.

5.1.2.15 Operation: **resolve**

Return a directory that summarizes the resolution of the supplied association directory URI.

Input Parameters

- **directory** - a `DirectoryURI` that resolves to a set of associations (Type: `AssociationDirectoryURI`).
- **queryControl**_{OPT} - parameters that control the ordering, timeout, and query behavior (Type: `QueryControl`).

- **context_{OPT}** - parameters that control the language, date and time, and other contextual variables (Type: ReadContext).

Return Type: AssociationDirectory

Exceptions

- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.
- **UnsupportedLanguage** - The referenceLanguage is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The changeSetContext is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more changeSetContext is not supported by the service.
- **UnsupportedMatchAlgorithm** - The matchAlgorithm is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The format is not supported by the service implementation.
- **QueryTimeout** - The timeLimit was exceeded by the service.

5.1.2.16 Operation: resolveAsList

Return the set of associations that are referenced by the supplied directory URI.

Input Parameters

- **directory** - a DirectoryURI that resolves to a set of associations (Type: AssociationDirectoryURI).
- **queryControl_{OPT}** - parameters that control the ordering, timeout, and query behavior (Type: QueryControl).
- **context_{OPT}** - parameters that control the language, date and time, and other contextual variables (Type: ReadContext).

Return Type: AssociationList

Exceptions

- **UnsupportedMatchAlgorithm** - The matchAlgorithm is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.

- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The format is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.
- **InvalidDirectoryURI** - The supplied directory URI is not valid.
- **InvalidDirectoryType** - The type represented by the supplied directory URI is not the one required by the service invocation.

5.1.3 Association History Service

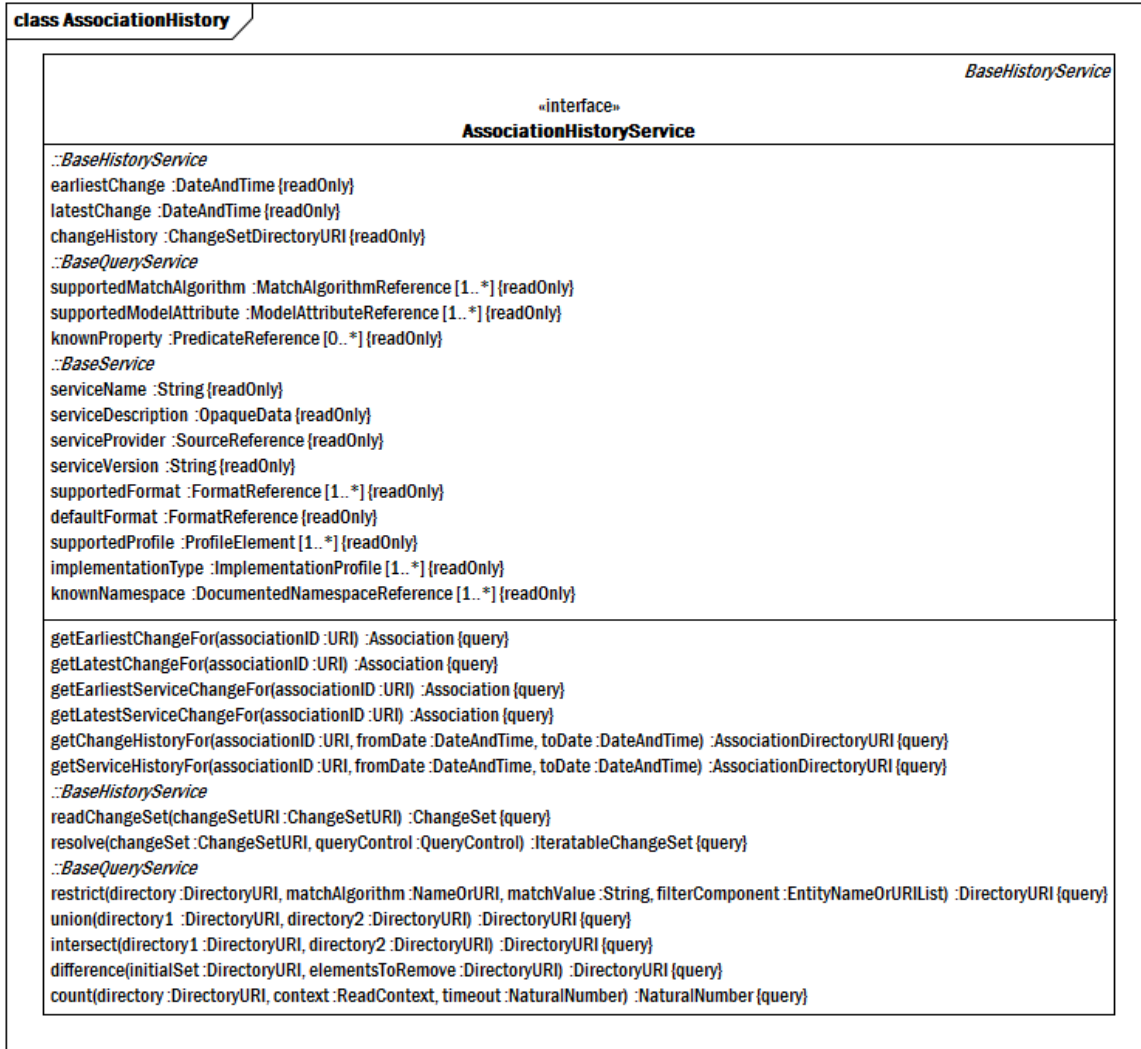


Figure 5.3 - Association History

The **AssociationHistoryService** allows the client to find the first change, last change, and the set of changes that occurred to an **Association** in a particular range of time. Changes can be viewed either from the perspective of the service - determining when a change became visible to the service clients or from the perspective of the publisher - determining when the author of the change stated that it was to become active.

5.1.3.1 Interface AssociationHistoryService

A service that provides a historical perspective on what changes occurred to a given **Association**.

- Every instance of **AssociationHistoryService** is also an instance of **BaseHistoryService**.

5.1.3.2 Operation: **getEarliestChangeFor**

Select the Association instance in the `ChangeSet` that has the earliest `officialEffectiveDate` and return the first change for the referenced Association in the set. The return value represents the earliest known published state of the Association.

Input Parameters

- **associationID** - an association identifier (Type: URI).

Return Type: `Association`

Exceptions

- **UnknownAssociation** - The referenced Association is not recognized by the service.

5.1.3.3 Operation: **getLatestChangeFor**

Select the Association instance in the `ChangeSet` that has the latest `officialEffectiveDate` and return the last change for the referenced Association in the set. The return value represents the most recent known published state of the Association.

Input Parameters

- **associationID** - an association identifier (Type: URI).

Return Type: `Association`

Exceptions

- **UnknownAssociation** - The referenced Association is not recognized by the service.

5.1.3.4 Operation: **getEarliestServiceChangeFor**

Get the first change that was applied to the named entity from the perspective of the service instance.

Input Parameters

- **associationID** - an association identifier (Type: URI).

Return Type: `Association`

Exceptions

- **UnknownAssociation** - The referenced Association is not recognized by the service.

5.1.3.5 Operation: **getLatestServiceChangeFor**

Get the last change that was applied to the named entity from the perspective of the service instance.

Input Parameters

- **associationID** - an association identifier (Type: URI).

Return Type: Association

Exceptions

- **UnknownAssociation** - The referenced Association is not recognized by the service.

5.1.3.6 Operation: getChangeHistoryFor

Return a directory of Associations with the supplied URI whose ChangeSet officialEffectiveDate falls between fromDate and toDate. The order of the dates controls the return order - if fromDate is later than toDate the return order is latest to earliest, otherwise it is earliest to latest.

Input Parameters

- **associationID** - an association identifier (Type: URI).
- **fromDate_{OPT}** - the starting date. If later than toDate, the return order is latest to earliest, otherwise it is earliest to latest. If not supplied, it is treated as the earliest possible date. (Type: DateTime)
- **toDate_{OPT}** - the end date. If later than fromDate, the return order is earliest to latest otherwise it is latest to earliest. (Type: DateTime)

Return Type: AssociationDirectoryURI

Exceptions

- **UnknownAssociation** - The referenced Association is not recognized by the service.

5.1.3.7 Operation: getServiceHistoryFor

Return a directory of Associations with the supplied URI whose changes became visible in the service between fromDate and toDate. The order of the dates controls the return order - if fromDate is later than toDate the return order is latest to earliest, otherwise it is earliest to latest.

Input Parameters

- **associationID** - an association identifier (Type: URI).
- **fromDate_{OPT}** - the starting date. If later than toDate, the return order is latest to earliest, otherwise it is earliest to latest. If not supplied, it is treated as the earliest possible date. (Type: DateTime)
- **toDate_{OPT}** - the end date. If later than fromDate, the return order is earliest to latest otherwise it is latest to earliest. (Type: DateTime)

Return Type: AssociationDirectoryURI

Exceptions

- **UnknownAssociation** - The referenced Association is not recognized by the service.

5.1.4 Association Maintenance Service

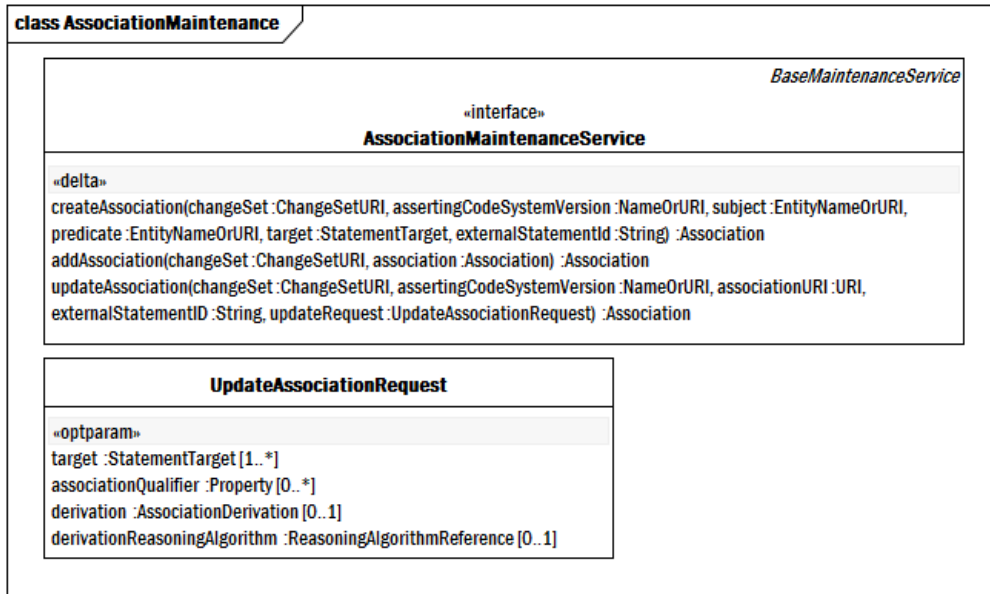


Figure 5.4 - Association Maintenance

The **AssociationMaintenanceService** provides the ability to create, update, or remove associations from the set of assertions.

5.1.4.1 Interface **AssociationMaintenanceService**

A service that allows the creation and modification of semantic assertions made by an ontology or code system.

Superclasses

- Every instance of **AssociationMaintenanceService** is also an instance of **BaseMaintenanceService**.

5.1.4.2 Operation: **createAssociation**

Create a new **Association**.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an OPEN change set that will record the change (Type: **ChangeSetURI**).
- **assertingCodeSystemVersion** - the local identifier or URI of the code system version that is making this assertion. If the service supports the **CodeSystemVersion** authoring profile, the version must exist and be OPEN (not FINAL) (Type: **NameOrURI**).
- **subject** - the namespace/name or URI of the subject of the association (Type: **EntityNameOrURI**).
- **predicate** - the namespace/name or URI of the association predicate (Type: **EntityNameOrURI**).

- **target** - the statement target (Type: `StatementTarget`).
- **externalStatementId**_{OPT} - An optional statement identifier that is assigned to this statement from an outside organization (Type: `String`).

Return Type: `Association`

Exceptions

- **UnknownAssociationQualifierNamespaceName** - The namespace in the predicate identifier is not known to or supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **UnknownTargetEntity** - The target `EntityNameOrURI` is not known to the service.
- **UnsupportedAssociationQualifier** - The predicate of an association qualifier is not recognized by the service or is not considered to be a valid association qualifier.
- **UnknownPredicateNamespaceName** - The namespace in the predicate identifier is not known to or supported by the service.
- **UnsupportedSubjectNamespaceName** - The namespace in the subject identifier is not known to or supported by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not `OPEN`.
- **UnknownSubjectEntity** - The `EntityNameOrURI` is not known to the service.
- **UnknownTargetNamespaceName** - The namespace in a target entity identifier is not known to or supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.

5.1.4.3 Operation: `addAssociation`

Add the input association to the service.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - the identifier of an `OPEN` change set that will record the change. (Type: `ChangeSetURI`)
- **association** - the new association to be added to the service. (Type: `Association`)

Return Type: `Association`

Exceptions

- **UnknownAssociationQualifierNamespaceName** - The namespace in the predicate identifier is not known to or supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **UnknownTargetEntity** - The target `EntityNameOrURI` is not known to the service.

- **UnsupportedAssociationQualifier** - The predicate of an association qualifier is not recognized by the service or is not considered to be a valid association qualifier.
- **UnknownPredicateNamespaceName** - The namespace in the predicate identifier is not known to or supported by the service.
- **UnsupportedSubjectNamespaceName** - The namespace in the subject identifier is not known to or supported by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnknownSubjectEntity** - The `EntityNameOrURI` is not known to the service.
- **UnknownTargetNamespaceName** - The namespace in a target entity identifier is not known to or supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.

5.1.4.4 Operation: **updateAssociation**

Update an existing Association resource.

This operation may alter the state of the service.

Input Parameters

- **changeSet** - (Type: `ChangeSetURI`)
- **assertingCodeSystemVersion** - (Type: `NameOrURI`)
- **associationURI**_{OPT} - (Type: `URI`)
- **externalStatementID**_{OPT} - (Type: `String`)
- **updateRequest** - (Type: `UpdateAssociationRequest`)

Return Type: **Association**

Exceptions

- **UnknownAssociationQualifierNamespaceName** - The namespace in the predicate identifier is not known to or supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **UnknownTargetEntity** - The target `EntityNameOrURI` is not known to the service.
- **UnsupportedAssociationQualifier** - The predicate of an association qualifier is not recognized by the service or is not considered to be a valid association qualifier.
- **UnknownPredicateNamespaceName** - The namespace in the predicate identifier is not known to or supported by the service.
- **UnsupportedSubjectNamespaceName** - The namespace in the subject identifier is not known to or supported by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.

- **UnknownSubjectEntity** - The `EntityNameOrURI` is not known to the service.
- **UnknownTargetNamespaceName** - The namespace in a target entity identifier is not known to or supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.

5.1.4.5 Class `UpdateAssociationRequest`

The set of elements that can be changed in an existing association. Association identity has always been an interesting issue, and the CTS2 specification has chosen to say that, while identity is undoubtedly more than just the subject and the predicated, we can't really draw a clean line in the target / qualifier range. The basic CTS2 specification allows updates on any part of the target or any qualifier, although we anticipate that service implementations may choose more strict interpretations.

Attributes

- **target** - the new or modified association target.
- **associationQualifier** - a qualifier whose subject is that association itself.
- **derivation** - the new or modified derivation.
- **derivationReasoningAlgorithm** - the new or modified derivation reasoning algorithm.

5.1.5 Association Transform Service

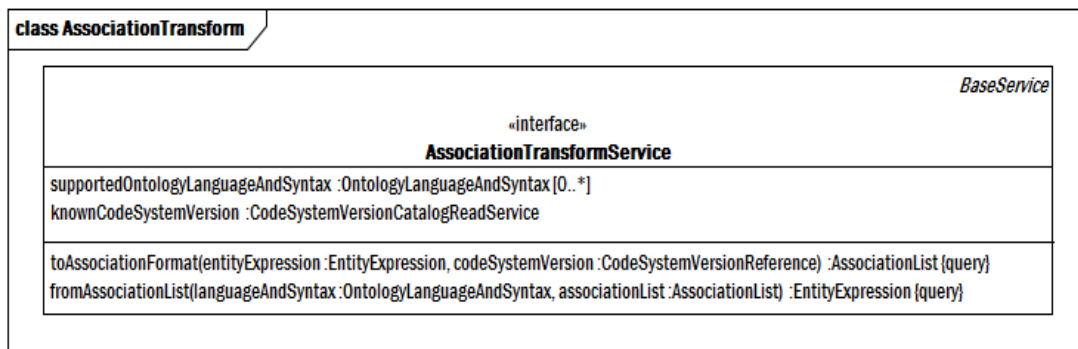


Figure 5.5 - Association Transform

The `AssociationTransformService` transforms association statements from external formats such as OWL/RDF, Manchester Syntax, SNOMED-CT Compositional Grammar, etc. into the corresponding `Associations` without entering the descriptions into the server database. It also allows existing `Associations` to be represented in external formats for viewing and portability.

5.1.5.1 Interface `AssociationTransformService`

A service that transforms various external formats into the CTS2 `Association` model and visa versa.

Superclasses

- Every instance of `AssociationTransformService` is also an instance of `BaseService`.

Attributes

- **supportedOntologyLanguageAndSyntax** - an ontology language / syntax combination that is supported by this transformation service.
- **knownCodeSystemVersion** - the URI and name of a code system version that can serve as the basis for a transformation by this service.

5.1.5.2 Operation: toAssociationFormat

Transform `entityExpression` into a lot of one or more `Associations` in the context of the supplied `codeSystemVersion`.

Input Parameters

- **entityExpression** - the expression of a set of associations in a named ontology language and syntax. (Type: `EntityExpression`)
- **codeSystemVersion** - the name and URI of the code system version that supplies for the surrounding context for the transformation. (Type: `CodeSystemVersionReference`)

Return Type: `AssociationList`

Exceptions

- **EntityExpressionSyntaxError** - The entity expression is syntactically incorrect and cannot be parsed.
- **UnknownCodeSystemVersion** - The referenced `CodeSystemVersion` is not recognized by the service.
- **UnsupportedOntologySyntax** - The supplied ontology syntax is not supported by the service.
- **UnsupportedOntologyLanguage** - The supplied ontology language is not supported by the service.

5.1.5.3 Operation: fromAssociationList

Return an expression that represents `associationList` in the named `languageAndSyntax`.

Input Parameters

- **languageAndSyntax** - the target ontology language and syntax (Type: `OntologyLanguageAndSyntax`).
- **associationList** - a list of one or more CTS2 format associations (Type: `AssociationList`).

Return Type: `EntityExpression`

Exceptions

- **UnsupportedOntologySyntax** - The supplied ontology syntax is not supported by the service.
- **UnsupportedOntologyLanguage** - The supplied ontology language is not supported by the service.

5.2 Reasoning Service

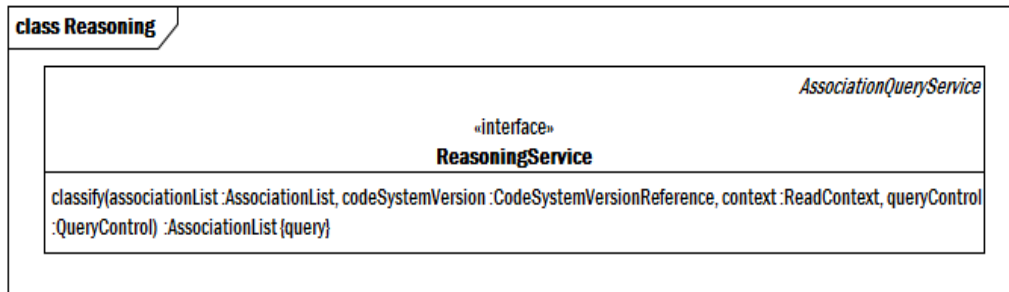


Figure 5.6 - Reasoning Service

The **ReasoningService** allows the posing of “what if” questions. Whenever a new **Association** (i.e., semantic assertion) is written into the service database, a service implementation that supports inference and reasoning would be expected to automatically derive the logical consequences of the change. As an example, if **ChangeSet** is imported into a service that asserts that **Class X** is a subclass of **Class Y**, and **Class Y** has an assertion that **Y hasPart some H**, **Class X**, when retrieved from the service will include an assertion that **Class X hasPart some H**, with an indicator that this was derived through the application of a reasoning algorithm.

One approach to doing “what if” reasoning would be to take advantage of the **UPDATE** and **AUTHORING** services. One could create a new change set, add whatever “what if” inferences they wanted tested, analyze the result in the context of the change set and then roll it back. This is, effectively, what many of the current ontology authoring tool kits do - you import an ontology source file, create new assertions, classify those assertions and evaluate the results. Once complete, the new assertions are then discarded.

This is less than an ideal approach, however, for a CTS2 compliant service as requiring services that provide a reasoning interface should not be required to support the authoring interface. Furthermore, the authoring architecture was intended for submissions that had a high likelihood of becoming accepted, with the roll back function intended to be the exception rather than the rule. The **ReasoningService**, as described below, is intended to be a “lighter weight” alternative.

The `classify` interface described above takes a set of assertions, combines it with the set of active assertions that are assertedBy the named `codeSystemVersion` and invokes the reasoner(s) that are considered appropriate by the service implementation. It then returns the resulting set of assertions that result from the combination of the input and the application of the reasoner that are not already asserted by the referenced code system version.

5.2.1 Interface ReasoningService

An extension to the **AssociationQueryService** that allows the posing of “what if” questions.

Superclasses

- Every instance of **ReasoningService** is also an instance of **AssociationQueryService**.

5.2.1.1 Operation: classify

The set of new assertions that can be inferred from the combination of the assertions in `associationList` and the set that are assertedBy `codeSystemVersion`.

Input Parameters

- **associationList** - the set of assertions about one or more subjects to be classified (Type: `AssociationList`).
- **codeSystemVersion** - the name or URI of a code system version that is used to establish the base set of axioms against which the reasoning will be performed. All active associations that are assertedBy the referenced `codeSystemVersion` will be considered to be in the base set (Type: `CodeSystemVersionReference`).
- **context_{OPT}** - parameters that control the language, date and time, and other contextual variables (Type: `ReadContext`).
- **queryControl_{OPT}** - parameters that control the ordering, format, timeout, and query behavior (Type: `QueryControl`).

Return Type: `AssociationList`

Exceptions

- **UnknownCodeSystemVersion** - The referenced `CodeSystemVersion` is not recognized by the service.
- **InferenceNotSupported** - Inference is not supported for the supplied `codeSystemVersion`.
- **UnsupportedMatchAlgorithm** - The `matchAlgorithm` is not supported by the service.
- **UnsupportedPredicate** - The predicate name or URI is not recognized by the service.
- **UnsupportedNamespaceName** - The supplied namespace name is not one that is known to the service.
- **UnsupportedModelAttribute** - The name or URI of a CTS2 model attribute is not recognized and/or supported by the service implementation.
- **MatchValueFormatException** - The match value does not meet the format or syntax required or the supplied match algorithm.
- **UnsupportedFormat** - The format is not supported by the service implementation.
- **QueryTimeout** - The `timeLimit` was exceeded by the service.
- **UnsupportedLanguage** - The `referenceLanguage` is not supported by the service.
- **UnknownChangeSet** - The change set specified could either not be read or located by the service.
- **ChangeSetIsNotOpen** - The `changeSetContext` is recognized by the service, but its state is not OPEN.
- **UnsupportedContext** - One or more `changeSetContext` is not supported by the service.

