CAMSS - Solutions
ONTOLOGY

Specification

CHANGE CONTROL

Modification	Details
Version 1.1.0	

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INTRODUCTION

1. INTRODUCTION

This document contains version 1.0.0 of the CAMSS Ontology.

1.1. General Context

CAMSS stands for the Common Assessment Method for Standards and Specifications. It is a development of the ISA[2] Programme Action "*Achieving a modern ICT standardisation policy*[1]" aimed at "assessing and selecting standards and specifications for an eGovernment project, a reference when building an architecture and an enabler for justifying the choice of standards and specifications in terms of interoperability needs and requirements. It is fully aligned with the European Standardisation Regulation 1025/2012"[2].

The CAMSS concepts need a formally agreed upon definition. The current CAMSS assessments do not contain conveniently structured and machine-readable data. Hence the proposal to develop a CAMSS Ontology.

This CAMSS Ontology will be key for the agreement on the meaning of the CAMSS concepts, roles, and axioms. The interpretation of the resulting ontology will present a clear idea of the method defined in CAMSS to assess standards and specifications. Examples of identified benefits would be the following.

- On one side, it would formalise the reference terminology for the different concepts used in CAMSS. The terminology is definitorial because it contains clear and atomic name symbols that are defined based on other atomic symbols. The terminology is therefore "acyclic", thus providing a way to agree on the meaning of concepts such as scenario, assessment, criterion, purpose, among others. This will ease the promotion, understanding, and adoption of the method and its components at the pan-European and international levels.

- On the other side, a CAMSS machine-readable ontology would allow for the discoverability, reuse, interoperability, integration, and processing (e.g. automated evaluation, comparison, production of reports, etc.) of the CAMSS assessments as Linked Open Data.

- Finally, the availability of a machine-readable CAMSS Ontology would provide Member States (MS) and European Institutions with the capability of developing tools for the creation and maintenance of new scenarios and the production of assessments that may be exchanged cross-border and cross-domain.

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[1] Achieving a modern standard ICT standardisation policy; CAMSS Action 2016.27: https://ec.europa.eu/isa2/actions/achieving-modern-ict-standardisation-policy_en.
[2] See CAMSS Joinup Community for additional details: https://joinup.ec.europa.eu/collection/common-assessment-method-standards-and-specifications-camss/about.

1.2.   Objective and Scope of the document

The objective of this document is to provide an interoperability-oriented solution for the expression and exchange of CAMSS Assessments. The solution proposed is an Ontology.

The scope of this document encompasses:

- conceptual data models used for the CAMSS Vocabulary;

- constraints and rules specific to the CAMSS domain;

- a reference implementation of the Ontology as an OWL Turtle[1] syntax v1.1.

1.3.   Methodological approach

The approach followed for the development of the CAMSS Ontology follows three fundamental principles.

1. Sharing and reuse (i.e. do not reinvent the wheel).

2. Do not betray the knowledge and experience of the domain, nor the terminology and interpretation of the concepts (i.e. do not invent new terms when they exist in the communities of practice or generic domains).

3. Isolate technical and business constraints and rules as much as possible (i.e. externalise them into separate artefacts, e.g. graph and data shapes for the control and validation of the data). This has a large impact on the quality and cost of the implementation and maintenance of the ontology.

One way of facilitating the semantic interoperability consists of reusing existing generic ontologies and vocabularies. This way, the semantics of common concepts and properties are agreed upon without having to re-discuss them. When concepts or properties have not been identified nor defined for the purposes pursued, they have to be proposed either as extensions or from scratch.

The methodological approach followed for the development of the CAMSS Ontology reuses the following ontologies and vocabularies:

- Friend of a Friend (FOAF)

- Core Person Vocabulary (CPV), only Natural Person

- The Organisation Ontology

- Core Criterion and Core Evidence Vocabulary (CCCEV)

Additionally, other concepts and properties needed in the CAMSS Ontology had to be defined in new vocabularies, which use common terms and definitions agreed upon with experts and users from the CAMSS domain (namely the Member States and EU Public Administrations, EU Working Groups, and Stakeholders[1]):

- Core Standards and Specifications Vocabulary (CSSV)[2]
- Core Assessment Vocabulary (CAV)[3]

The rationale for defining these two new vocabularies goes as follows. See examples in the sections *¡Error! No se encuentra el origen de la referencia. ¡Error! No se encuentra el origen de la referencia.* and *¡Error! No se encuentra el origen de la referencia. ¡Error! No se encuentra el origen de la referencia.*.

1. No generic ontologies or vocabularies have been found defining what a Specification and Assessment are that fulfil the purposes of CAMSS, partially or totally (e.g. There is not an ontology covering both specifications and assessments. Some initiatives define the concept standard as a generic concept, e.g. Dublin Core[4], W3C Profile[5]; or define methodologies for assessment, but not ontologies or vocabularies).

2. Existing concepts in other ontologies did not cover all the information requirements needed in CAMSS and therefore had to be reused or specialised by new classes (e.g. both CSSV and CAV benefit greatly from the existence of the ADMS Asset concept).

3. Concepts and properties existing in other ontologies have different semantics to the ones needed in CAMSS (e.g. Dublin Core definition for Standard provides a partial semantic field. The CAV extends this definition).

4. Concepts required in CAMSS have not been identified in any other existing ontologies and therefore needed to be defined as new (e.g. the concepts of Family of Standards in the CSSV or Scenario in the CAV).

5. Given these are "core" vocabularies a key goal is to make them as flexible as possible. This means that predicates are set with optional and multiple cardinality (0 … n) unless there is a strong reason to further restrict.

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[1] Examples of Working Groups and Stakeholders are the European Multi-Stakeholder Platform on ICT Standardisation (MSP Working Group) and Standard Development Organisations such as UN/CEFACT, OASIS, W3C and private sector representatives, which also participate in the regular MSP sessions.

[2] The Core Standards and Specifications Vocabulary (CSSV): https://joinup.ec.europa.eu/collection/common-assessment-method-standards-and-specifications-camss/solution/core-standards-and-specifications-vocabulary-cssv

[3] The Core Assessment Vocabulary (CAV): https://joinup.ec.europa.eu/collection/common-assessment-method-standards-and-specifications-camss/solution/core-assessment-vocabulary-cav

[4] Dublin Core Metadata Initiative: https://www.dublincore.org/specifications/dublin-core/dcmi-terms/

[5] The Profiles Vocabulary. W3C Working Draft 02 April 2019: https://www.w3.org/TR/dx-prof/

1.4. Structure of this document

This document consists of the following sections.

- Section 2 explains the analysis performed on the tools that could be used for the development of the CAMSS Ontology.

- Section 3 explains the CAMSS Ontology simplified view, and identifies the classes and properties defined for the vocabulary.

- Section 4 explains the CAV model, and identifies the classes and properties defined for the vocabulary.

- Section 5 explains the CSSV model, and identifies the classes and properties defined for the vocabulary.

- Section 6 presents the CAMSS Knowledge Graph in a detailed overview (Ontology design, T-Box and A-Box).

- Section 7 exposes the conclusions of the CAMSS Ontology.

- Section 8 lists the different acronyms used in the whole document.

- Section 9 contains related references.

2

THE CAMSS ONTOLOGY

2.   THE CAMSS ONTOLOGY (simplified overview)

The *Figure 1 CAMSS Ontology* shows the classes and properties used or defined in the CAMSS Ontology. This ontology, which has its own namespace, reuses two classes and one property from two different vocabularies (CAV and CSSV). What is specific to the CAMSS Ontology is the fact that its domain is "the assessment of specifications".
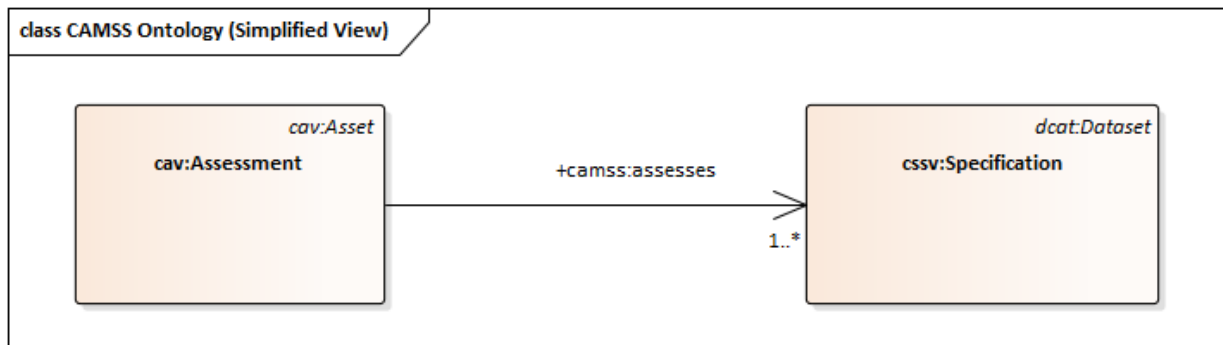
Figure 1 CAMSS Ontology (simplified overview)

Hence, the implementation of the CAMSS Ontology as a Knowledge Base (KB) would amount to stating these facts.

- The terminology[1] (or T-Box[2]) is defined by the CAV and the CSSV vocabularies. A graphic representation as UML is provided for both vocabularies in this document, jointly with their symbol names, definitions, and properties.

- The assertions[9] (in the A-Box) would encompass all the opinions and facts expressed in each existing CAMSS Assessments, once transposed into triples and stores in the KB.

- The fact that CAMSS assess only specifications (and all its descendants) is the specific constraint that makes the CAMSS Ontology a domain of its own, with a unique namespace. For this release of the CAMSS Ontology, SHACL shapes have been created to represent the CAMSS Ontology constraints. See Annex 5.

In order to fully understand how the CAMSS Ontology is to be interpreted and used, the following two sections describe the CAV and the CSSV vocabularies.

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[1] The Description Logic Handbook: Theory, Implementation, and Applications. Chapter 2. January 2007. Cambridge University Press, 2nd Edition.
https://www.researchgate.net/publication/230745455_The_Description_Logic_Handbook_Theory_Implementation_and_Applications
[2] See CAMSS Ontoloyg T-Box in Annex 4

2.1. CAMSS Ontology Prefixes

The following table list the different prefixes and the corresponding namespaces used in the CAMSS Ontology.

Prefix	Namespace
CAMSS	https://data.europa.eu/2sa/ontology
CAV	https://data.europa.eu/2sa/cav/
RDFS	http://www.w3.org/2000/01/rdf-schema
CSSV	https://data.europa.eu2sa/cssv/
SKOS	http://www.w3.org/2004/02/skos/core
DCAT	http://www.w3.org/ns/dcat
FOAF	http://xmlns.com/foaf/0.1/
CCCEV	https://data.europe.eu/semanticassets/ns/cv/cccev_v2.0.0

Table 1 CAMSS Ontology prefixes

3

CORE ASSESSMENT VOCABULARY (CAV)

3. CORE ASSESSMENT VOCABULARY (CAV)

The Core Assessment Vocabulary represents and defines what an "Assessment" of an "Asset" is and how to perform an Assessment using scenario-based "Criteria". It is a domain-agnostic vocabulary, meaning that it can be used to assess any type of assets. Hence, the CAV is at the very core of the CAMSS Ontology.

In other words, the CAMSS Ontology reuses 100% the CAV.

The CAV is depicted in *Figure 2 The Core Assessment Vocabulary*. The figure shows the classes and properties used or defined in the vocabulary.

3.1. Data Modem for the CAV

The following data model results from these actions and feedback.

- The analysis performed by the CAMSS Team.

- The review of the comments issued by the open community in the public GitHub.

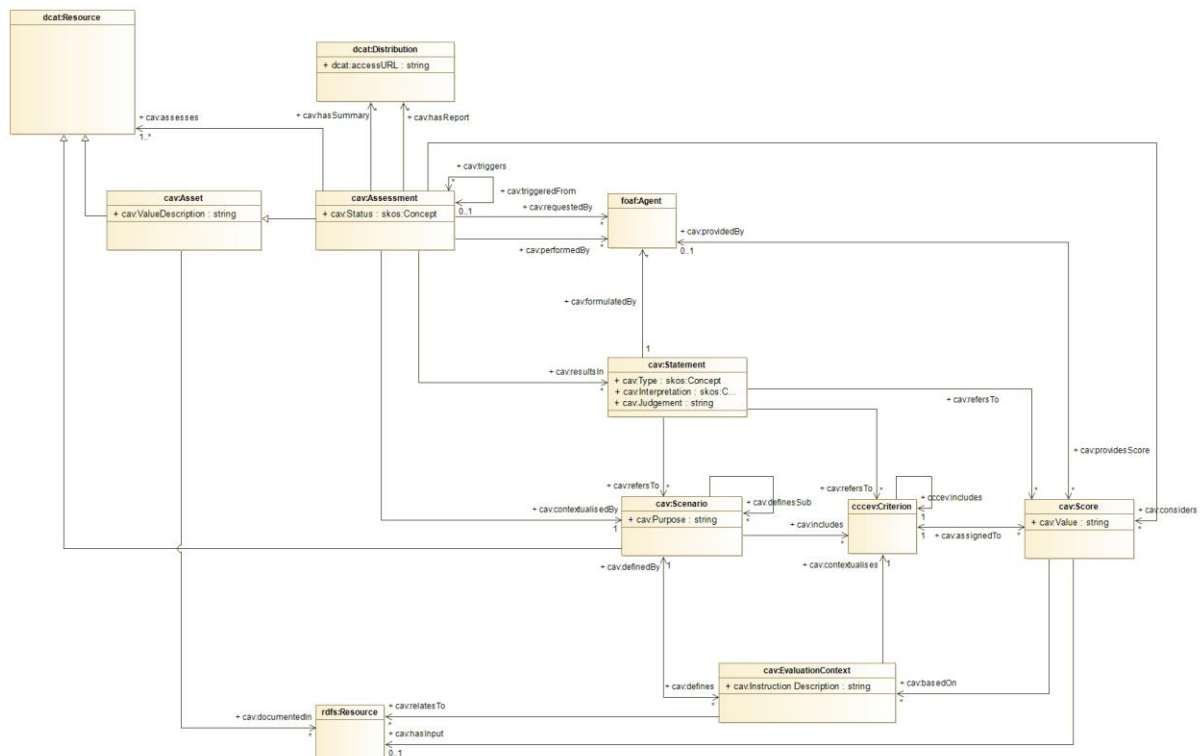- The comments issued by external experts during the review of the Core Assessment Vocabulary (CAV).

Figure 2 The Core Assessment Vocabulary

3.1.1. Interpretation

A CAV **Assessment** is a specialisation of an Asset, which is itself also a specialisation of the *dcat:Resource*. As with any asset, it can be identified and described, and has individuals, distributions, publishers, etc. In addition to these properties the CAV class Assessment needs to specify the identity of the requestors and evaluators of the Assessments. These can be anything represented by a FOAF[1] Agent, such as a natural person or an organisation. Notice that the objects assessed are also Resources meaning that the CAV may be used to assess anything considered a valuable resource. Examples of such resources could be products, services, or in the case of CAMSS, standards and specifications.

An Assessment results in **Statements** capturing the produced knowledge and providing value judgments. These can refer to the Assessment as a whole or a specific section, even being as detailed as to refer to individual evaluated criteria.

A **Criterion** is typically derived from a Reference Framework, which is to be understood as a series of "agreed and descriptive reference requirements" coming from one or more sources (e.g. legislation, specifications and standards, ICT policy-related works like the EIF within the EIS, etc.). Throughout the Assessment each Criterion is assigned a **Score** (in principle by human users, but potentially also by systems) as the value output considered when formulating the resulting Statement(s). The **Score** can take into consideration any resource input (e.g. when the score is calculated based on different input parameters, algorithms and formulae).

All Assessment is performed in the context of a **Scenario**. The Scenario defines the purpose of the Assessment and the set of Criteria to be scored by one or more Agents. Scenarios can be defined with a flexible structure including nested sections (represented as sub-Scenarios) that serve to provide additional context, group thematically Criteria, and be referred to by the assessment's resulting Statement(s). Criteria can themselves be simple or complex and originate from various reference sources. The overall context for the evaluation of the Criteria is provided by the Scenario, however in case certain Criteria require additional contextualisation or evaluation instructions, these can exceptionally be provided by means of **EvaluationContext** which is related to a resource.

Finally, an Assessment might trigger another related Assessment of different content which has its own Scenario and Criteria. Note that it is also possible to model work in progress, expressed by having the Assessment defining optional links to Scores, Statements, reports, and summaries.

3.2. Class: cav:Asset

OWL Class	cav:Asset
Label	Asset
Definition	A resource, probably resulting from a work, with purpose and value.

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[1] FOAF Vocabulary Specification http://xmlns.com/foaf/spec/

	Additional information:
	This definition considers "resource" as a res available for use". (See the definition of res in the IFLA FRBR/LRM specifications).
Subclass of	dcat:Dataset

3.2.1. Property: cav:documentedIn

OWL Property	cav:documentedIn
OWL type	owl:ObjectProperty
Label	Documented in
Definition	A link to any information supporting the value of the asset and any other related relevant details.
	Additional information:
	A good choice to implement instances of resources supporting the value of the asset can be the use of the cccev:Evidence class from the Core Criterion and Core Evidence Vocabulary.
Domain	*cav:Asset*
Range	*Rdfs:Resource*
Cardinality:	0..n

3.3. Class: cav:Assessement

OWL Class	cav:Assessment
Label	Assessment
Definition	The intellectual work to evaluate an asset against the criteria of a given scenario.
Subclass of	cav:Asset

3.3.1. Property: cav:hasStatus

OWL Property	cav:hasStatus
OWL type	owl:DataProperty
Label	hasStatus
Definition	The current situation of the assessment. Additional Information: A list with different status codes is to be provided by context/domain-specific application profiles to identify the statuses that make sense for that context or domain.
Domain	*cav:Assessment*
Property Type	skos:Concept

3.3.2. Property: cav:hasReport

OWL Property	cav:hasReport
OWL type	owl:ObjectProperty
Label	hasReport
Definition	A manifestation[1] of all the information related to and resulting from an assessment. Additional Information: The included information usually contains everything about the assessment, e.g. the purpose of the assessment, the criteria defined in the scenario, the responses and the scoring provided by the evaluator. The report may be manifested in one or multiple ways (distributed as different formats) e.g. as OWL triples, as an HTML, as a narrative text (pdf, doc, ods, etc.).
Domain	cav:Assessment
Range	dcat:Distribution
Cardinality:	0..n

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[1] The term "manifestation" is used herein as defined in the IFLA Library Reference Model (IFLA LRM): https://www.ifla.org/publications/node/11412

3.3.3.   Property: cav:hasSummary

OWL Property	cav:hasSummary
OWL type	owl:ObjectProperty
Label	hasSummary
Definition	An abbreviated manifestation of the performed assessment.
Domain	cav:Assessment
Range	dcat:Distribution
Cardinality:	0..n

3.3.4.   Property: cav:assesses

OWL Property	cav:assesses
OWL type	owl:ObjectProperty
Label	assesses
Definition	The reference to the asset(s) that are the object of the assessment.
Domain	cav:Assessment
Range	dcat:Resource
Cardinality:	1..n

3.3.5.   Property: cav:performedBy

OWL Property	cav:performedBy
OWL type	owl:ObjectProperty
Label	performedBy
Definition	The agent(s) that carry out the assessment.

Domain	cav:Assessment
Range	foaf:Agent
Cardinality:	0..n

3.3.6. Property: cav:requestedBy

OWL Property	cav:requestedBy
OWL type	owl:ObjectProperty
Label	requestedBy
Definition	The agent(s) requesting the assessment of an asset.
Domain	cav:Assessment
Range	foaf:Agent
Cardinality:	0..n

3.3.7. Property: cav:contextualisedBy

OWL Property	cav:contextualisedBy
OWL type	owl:ObjectProperty
Label	contextualisedBy
Definition	The assignment of the scenario for the current assessment providing its context, purpose, and criteria.
Domain	cav:Assessment
Range	cav:Scenario
Cardinality:	1

3.3.8.   Property: cav:resultsIn

OWL Property	cav:resultsIn
OWL type	owl:ObjectProperty
Label	resultsIn
Definition	The creation of the statement(s) resulting from the assessment. Additional Information: The cardinality allows for optional associations to express an Assessment that is typically a work in progress.
Domain	cav:Assessment
Range	cav:Statement
Cardinality:	0..n

3.3.9.   Property: cav:considers

OWL Property	cav:considers
OWL type	owl:ObjectProperty
Label	considers
Definition	The evaluation of a criterion score in the context of the current assessment as input to issue one or more statements.
Domain	cav:Assessment
Range	cav:Score
Cardinality:	0..n

3.3.10.   Property: cav:triggeredFrom

OWL Property	cav:triggeredFrom
OWL type	owl:ObjectProperty
Label	triggeredFrom
Definition	The event causing the current assessment as the result of another related assessment.

Domain	cav:Assessment
Range	cav:Assessment
Cardinality:	0..1

3.3.11. Property: cav:triggers

OWL Property	cav:triggers
OWL type	owl:ObjectProperty
Label	triggers
Definition	The event causing further related assessment(s) due to the current one.
Domain	cav:Assessment
Range	cav:Assessment
Cardinality:	0..n

3.4. Class: cav:Scenario

OWL Class	cav:Scenario
Label	Scenario
Definition	The context of the assessment establishing its purpose, the organisation of criteria being evaluated, and its reference Framework(s). Additional Information: A scenario can be used to include criteria sourced from various reference frameworks and organised in a flexible structure including nested parts (expressed as sub-scenarios each with a further specified context). A scenario with no included criteria is considered as high-level or informal.
Subclass of	dcat:Dataset

3.4.1. Property: cav:includes

OWL Property	cav:includes
OWL type	owl:ObjectProperty
Label	includes
Definition	The aggregation of criteria to one scenario or parts of it. Additional Information: This aggregation may be contextualised at different granularity levels, scenario, parts of the scenario or specific criteria. The cardinality is 0 ... * to allow assessments that are very high-level, informal or subjective without criteria and scoring.
Domain	cav:Scenario
Range	cccev:Criterion
Cardinality:	0..n

3.4.2. Property: cav:definesSub

OWL Property	cav:definesSub
OWL type	owl:ObjectProperty
Label	definesSub
Definition	The definition of nested scenarios grouped based on different sub-purposes, commonalities or particularities of the sub-sets of criteria.
Domain	cav:Scenario
Range	cav:Scenario
Cardinality:	0..n

3.4.3. Property: cav:defines

OWL Property	cav:defines
OWL type	owl:ObjectProperty

Label	defines
Definition	The link to the evaluation contexts for specific criteria provided by the given scenario.
Domain	cav:Scenario
Range	cav:EvaluationContext
Cardinality:	0..n

3.4.4. Property: cav:Purpose

OWL Property	cav:Purpose
OWL type	owl:DataProperty
Label	Purpose
Definition	The reason for which the assessment is done.
Property Type	xsd:String

3.5. Class: cav:Statement

OWL Class	cav:Statement
Label	Statement
Definition	A value judgement, resulting from the assessment, pertinent to its entirety or to one or more of its specific parts.

3.5.1. Property: cav:Judgement

OWL Property	cav:Judgement
OWL type	owl:DataProperty
Label	Judgement
Definition	The text expressing the statement's resulting value judgement.
Property Type	xsd:String

3.5.2. Property: cav:Type

OWL Property	cav:Type
OWL type	owl:DataProperty
Label	Type
Definition	The categorisation of the statement. Additional Information: This code needs a context/domain-specific application profile codelist. An example of what this code can be used for is when there is need for signalling whether the statement is totally subjective, a judgement based on comparative actions performed upon several score inputs, a sentence picked-up from a database and as a result of an automated calculation, etc.
Property Type	skos:Concept

3.5.3. Property: cav:Interpretation

OWL Property	cav:Interpretation
OWL type	owl:DataProperty
Label	Interpretation
Definition	The favourability perception of the statement (e.g. positive, negative, or neutral).
Property Type	skos:Concept

3.5.4. Property: cav:formulatedBy

OWL Property	cav:formulatedBy
OWL type	owl:ObjectProperty
Label	formulatedBy
Definition	The reference to the agent(s) responsible for issuing the current statement.
Domain	cav:Statement

Range	foaf:Agent
Cardinality:	0..n

3.5.5. Property: cav:refersTo

OWL Property	cav:refersTo
OWL type	owl:ObjectProperty
Label	refersTo
Definition	The provision of a value judgement on one or more elements of the assessment.
Domain	cav:Statement
Range	cav:Scenario
Cardinality:	0..n

3.5.6. Property: cav:refersTo

OWL Property	cav:refersTo
OWL type	owl:ObjectProperty
Label	refersTo
Definition	The provision of a value judgement on one or more elements of the assessment.
Domain	cav:Statement
Range	cccev:Criterion
Cardinality:	0..n

3.5.7. Property: cav:refersTo

OWL Property	cav:refersTo
OWL type	owl:ObjectProperty
Label	refersTo

Definition	The provision of a value judgement on one or more elements of the assessment.
Domain	cav:Statement
Range	cav:Score
Cardinality:	0..n

3.6.   Class: cavEvaluationContext

OWL Class	cav:EvaluationContext
Label	Evaluation Context
Definition	The context for a criterion providing guidance on its evaluation considering the given scenario. This is used exceptionally to extend the context offered by the scenario when it is not sufficient for the evaluation of a given criterion. A criterion's evaluation produces an objective output that will then be considered to form value judgments expressed as the assessment's statements.

3.6.1.   Property: cav:InstructionDescription

OWL Property	cav:Judgement
OWL type	cav:InstructionDescription
Label	owl:DataProperty
Definition	Instruction Description
Property Type	Guideline or description that needs to followed during the evaluation of one particular criterion.

3.6.2.   Property: cav:definedBy

OWL Property	cav:definedBy
OWL type	owl:ObjectProperty
Label	definedBy

Definition	The link to the scenario that provides the evaluation context for one or more criteria.
Domain	cav:EvaluationContext
Range	cav:Scenario
Cardinality:	1

3.6.3. Property: cav:contextualises

OWL Property	**cav:contextualises**
OWL type	owl:ObjectProperty
Label	contextualises
Definition	The provision of context for the evaluation of the criterion.
Domain	cav:EvaluationContext
Range	cccev:Criterion
Cardinality:	1

3.6.4. Property: cav:relatesTo

OWL Property	**cav:relatesTo**
OWL type	owl:ObjectProperty
Label	relates To
Definition	The context for a criterion related to a resource.
Domain	cav:EvaluationContext
Range	rdfs:Resource

3.7. Class: cav:Score

OWL Class	**cav:Score**
Label	Score
Definition	The value output assigned to the criterion as part of the assessment.

3.7.1. Property: cav:providedBy

OWL Property	cav:providedBy
OWL type	owl:ObjectProperty
Label	providedBy
Definition	The agent responsible to provide score.
Domain	cav:Score
Range	foaf:Agent
Cardinality:	0..1

3.7.2. Property: cav:Value

OWL Property	cav:Value
OWL type	owl:DataProperty
Label	Value
Definition	The literal representing the final score assigned to one criterion. Additional Information: This literal is normally a number, generally a decimal. Be aware that one criterion may have multiple scores assigned, especially when there is the need of identifying who the agent is providing the score.
Property Type	rdfs:Literal

3.7.3. Property: cav:hasInput

OWL Property	cav:hasInput
OWL type	owl:ObjectProperty
Label	hasInput
Definition	The different resources provided to feed the context for the evaluation of a criterion.

	Additional Information: For example, the assessment of the quality of a criterion that is answered by a multiple respondents, as the cases of an exam question answered by multiple students, or the case of multiple evaluators evaluating the same quality aspect, etc.
Domain	cav:Score
Range	rdfs:Resource
Cardinality:	0..1

3.7.4.   Property: cav:basedOn

OWL Property	**cav:basedOn**
OWL type	owl:ObjectProperty
Label	basedOn
Definition	The consideration of a specific evaluation context when assigning the score to a criterion.
Domain	cav:Score
Range	cav:CriterionEvaluationContext
Cardinality:	0..n

3.7.5.   Property: cav:assignedTo

OWL Property	**cav:assignedTo**
OWL type	owl:ObjectProperty
Label	assignedTo
Definition	The assignment of a value output to the criterion.
Domain	cav:Score
Range	cccev:Criterion
Cardinality:	1

4

CORE STANDARDS AND SPECIFICATIONS VOCABULARY (CSSV)

4. CORE STANDARDS AND SPECIFICATIONS VOCABULARY (CSSV)

The Core Standards and Specifications Vocabulary is depicted in Figure 8 CSSV Data model. The figure shows the classes and properties used or defined in the CSSV.

4.1. 4.1. Data Model for the CSSV

The following data model results from these actions.

- The analysis performed by the CAMSS Team.
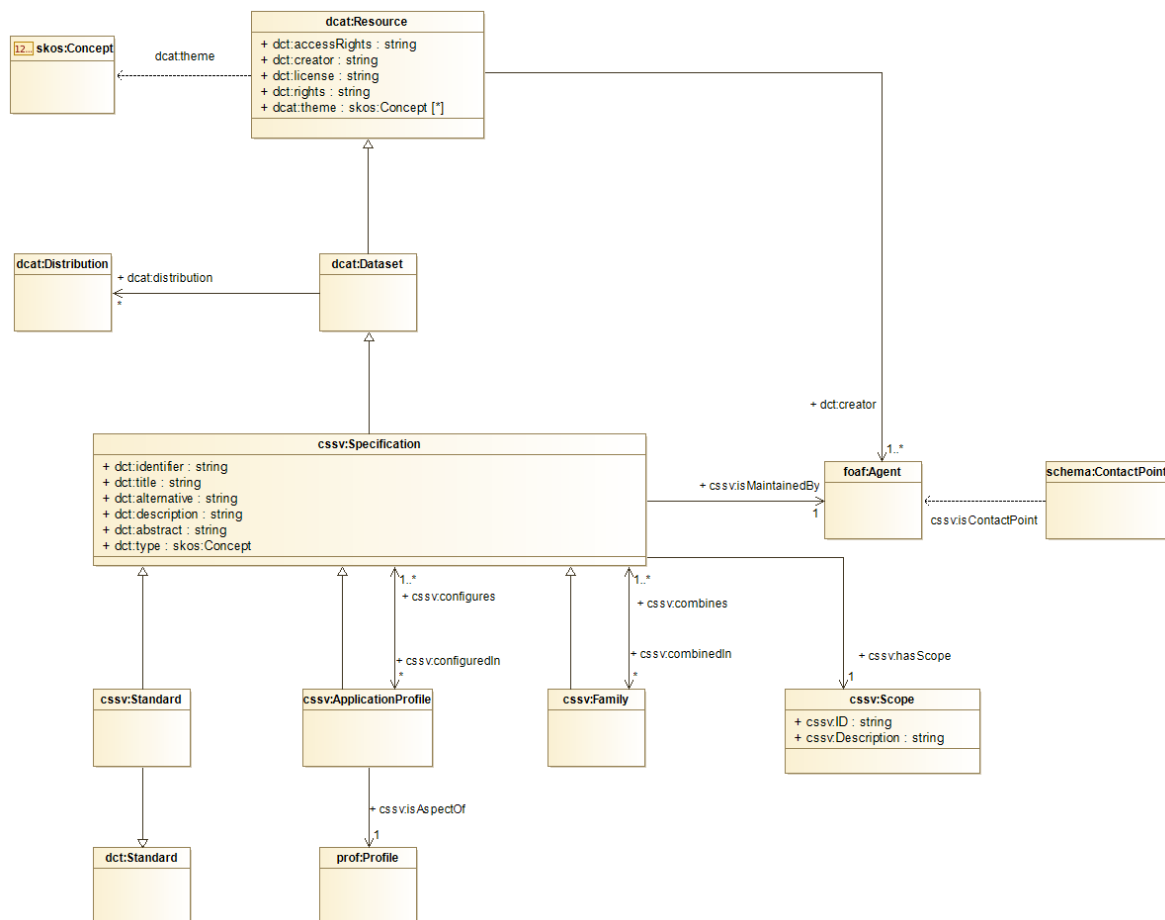- The review of the comments issued by the open community in the public GitHub.

Figure 3 The Core Standards and Specifications Vocabulary

4.1.1. Interpretation

The main class of the CSSV model is the "Specification". A Specification is an asset, as it inherits from the *dcat:Dataset*, which inherits from the *dcat:Resource*.

A Specification can additionally be a Standard, an ApplicationProfile, and/or a Family or a collection of other specifications.

The CSSV model defines the following.

- A **Specification** as a set of agreed, descriptive, and normative statements about how a specification should be designed or made.

- A **Standard** as a specification that is largely adopted and possibly endorsed.

- An **ApplicationProfile** as customisation of one or more existing specifications potentially for a given use case or a policy domain adding an end-to-end narrative describing and ensuring the interoperability of its underlying specification(s). By customisation, we understand the "addition of more specificity by identifying mandatory, recommended, and optional elements, as well as by defining controlled vocabularies to be employed".

- A **Family** as a collection of interrelated and/or complementary specifications, standards or application profiles and the explanation of how they are combined, used, or both.

A collection of Specifications differs from a Family of Specifications in that their interrelationship is not explicit. In the CSSV model, a collection of Specifications is an Asset related to other Assets and that is realised as an individual of a Specification. In other words, a Specification that reuses the *dct:relation* property of its base class *dcat:Dataset*.

There are occasions where collections of Specifications are applied to a context or a domain in a specific "configuration". Thus, application profiles may conform sets of "themed" specifications. For this, the CSSV model uses the property "configures/includedIn" and the *dcat:theme* property, pointing at a *skos:Concept* (i.e. a code, see the DCAT model above).

It is important to note that the descendants of the specifications are all "disjoint". For this reason, ApplicationProfiles and Families are Specifications that refer to, or put together with, other Specifications and/or Standards, but cannot themselves be considered Standards.

In time, a Specification may become a Standard. In these cases, the authority (author) that defined the Specification may be different from the authority that creates and maintains artefacts out of the Standard. Think for example of the artefacts produced, maintained, and distributed by the Publications Office of the European Union (OP) in its site EU Vocabularies[1]; all these artefacts are defined by other authorities (e.g. the ISO) whilst the artefacts (e.g. the controlled vocabularies expressed in SKOS, XML, GeneriCode, XML, etc.) are supplied by the OP. For this, the CSSV uses the properties *dct:creator* and *cssv:isMaintainedBy*. Additionally, the *dcat:Dataset* has the property *dct:type* which can be used to state that the Specification is of type "definition, artefact, or other". The DCAT vocabulary also provides the possibility to express who is responsible for the publication of the definition or the artefacts via the property *dct:publisher* (see the DCAT model).

The maintainer or publisher of a Specification is a *foaf:Agent* which allows for great flexibility of the CSSV model, as *foaf:Agent* is the base class in many ontologies. The CSSV puts forward the reuse of the Core Person Vocabulary (ISA2 CPV) and the Organisation Ontology (W3C Org) for this purpose. Additionally, the *foaf:Agent* also provides the contact point of the specification.

In terms of reusability, the class *cssv:Scope* allows for the reuse of the Specification. It refers to the area of requirements addressed by the specification.

---

[1] EU Vocabularies: https://publications.europa.eu/en/web/eu-vocabularies/controlled-vocabularies

Concerning the Intellectual Property Rights, they are covered by the fact that a specification is a *dcat:Resource* and it allows for the definition of the *dct:license* and *dct:rights*.

Finally, note that all the descendants of the *ccsv:Specification* are disjoint. This entails that an individual of an application profile or family cannot be a standard, but does not preclude that, in time, the application profile or the family can become standards. If this is the case then individuals of *ccsv:Standard* would be created to represent the standardisation of those specifications that are application profiles and families.

4.2.   Class:Specification

OWL Class	cssv:Specification
Label	Specification
Definition	Set of agreed, descriptive, and normative statements about how a specification should be designed or made.
Subclass of	dcat:dataset

The sections below list the data properties (class attributes) inherited from DCAT that are of particular interest to the class Specification:

4.2.1.   Property : dct :identifier

OWL Property	dct :identifier
OWL type	owl:DataProperty
Label	identifier
Definition	The main identifier for the specification, e.g. the URI or another unique identifier.
Property Type	xsd:AnyURI

Examples	Any URI pointing at an instance of an Asset. An example of this could be:
	
	- DCAT (W3C)
	
	- URI: http://www.w3.org/ns/dcat#
	
	- Expression in CSSV:
	
	`@prefix                                    cssv: <http://data.europa.eu/xyz/cssv#> .`
	
	`@prefix dct: <http://purl.org/dc/terms/> .`

🌐 ✉	`<http://www.w3.org/ns/dcat#>`
	
	    a `<cssv:Specification>` ;
	
	                    `dct:identifier` "`http://www.w3.org/ns/dcat#`" .

4.2.2. Property: dct :title

OWL Property	dct:title
OWL type	owl:DataProperty
Label	title
Definition	The name given to the Specification.
Property Type	xsd:String
Examples	Core Standards and Specifications Vocabulary, Core Assessment Vocabulary, Core Public Service Vocabulary, Core Criterion and Core Evidence Vocabulary, etc.

4.2.3. Property: dct:alternative

OWL Property	dct:alternative
OWL type	owl:DataProperty
Label	alternativeTitle
Definition	The alternative name of the specification.
Property Type	xsd:String
Examples	CSSV, CAV, CPSV, CCCEV, etc.

4.2.4. Property: dct:description

OWL Property	dct:description
OWL type	owl:DataProperty
Label	description

Definition	Free-text account of the Specification. This property can be repeated for parallel language versions of the description.
Property Type	xsd:String
Examples	A free-text account of the Specification.

4.2.5. Property: dct:abstract

OWL Property	dct:abstract
OWL type	owl:DataProperty
Label	abstract
Definition	A summary of the specification.
Property Type	xsd:String
Examples	To define the main concepts and characteristics related to specifications, standards, and their combinations and relationships.

4.2.6. Property: dct:type

OWL Property	dct:type
OWL type	owl:ObjectProperty
Label	type
Definition	One or more categorisations of the Specification. No controlled vocabulary are provided, since they can be very particular of the context and usage. A proposal is provided in the examples below, though.
Property Type	skos:Concept
Domain	dcat:Resource
Range	skos:Concept
Examples	Definition, Artefact, Summary.

4.2.7. Property: dct:accessRights

OWL Property	dct:accessRights

OWL type	owl:DataProperty
Label	accessRights
Definition	Information about who can access the resource or an indication of its security status.
Property Type	xsd:AnyURI
Examples	Read, write, modify, and delete rights.

4.2.8. Property: dct:license

OWL Property	dct:license
OWL type	owl:DataProperty
Label	license
Definition	A legal document under which the resource is made available.
Property Type	xsd:AnyURI
Examples	Creative commons license.

4.2.9. Property:dct:rights

OWL Property	dct:rights
OWL type	owl:DataProperty
Label	rights
Definition	A statement that concerns all rights not addressed with dct:license or dct:accessRights, such as copyright statements.
Property Type	xsd:AnyURI

4.2.10. Property: cssv:configuredIn

OWL Property	cssv:configuredIn
OWL type	owl:ObjectProperty
Label	configuredIn

Definition	A set of Specifications potentially for a given use case or policy domain that are aggregated in an ApplicationProfile.
Domain	cssv:Specification
Range	cssv:ApplicationProfile
Examples	Instance classes representing application profiles, such as DCAT-AP, ADMS-AP, others.

4.2.11.   Property: cssv:combinedIn

OWL Property	**cssv:combinedIn**
OWL type	owl:ObjectProperty
Label	combinedIn
Definition	A set of Specifications that are complementary and interrelated, forming a Family of Specifications.
Domain	cssv:Specification
Range	cssv:Family
Examples	OASIS UBL XML-based family (XML, XML Schema Definition, ISO Schematron, OASIS Genericode, Context Value Association (CVA), UN/CEFACT unqualified data types); OASIS JSON-based family; CEN TC 440 families; UN/CEFACT CII eInvoice family; other.

4.2.12.   Property :cssv :isMaintainedBy

OWL Property	**cssv:isMaintainedBy**
OWL type	owl:ObjectProperty
Label	isMaintainedBy
Definition	The Person, or Organisation responsible for updating and maintaining the specification.
Domain	cssv:Specification
Range	foaf:Agent
Examples	CAMSS Team, SEMIC, W3C, OASIS, others.

4.2.13. Property: cssv:hasScope

OWL Property	cssv:hasScope
OWL type	owl:ObjectProperty
Label	hasScope
Definition	Area of requirements that the specification addresses.
Domain	cssv:Specification
Range	cssv:Scope
Examples	Metadata, machine to machine interface, others.

4.3. Class: cssv:Standard

OWL Class	cssv:Standard
Label	Standard
Definition	Specification that is largely adopted and possibly endorsed.
Subclass of	cssv:Specification

At the present stage all the properties of the *cssv:Standard* class are those inherited from *cssv:Specification* and *dcat:Data* set.

4.4. Class: cssv:ApplicationProfile

OWL Class	cssv:ApplicationProfile
Label	ApplicationProfile
Definition	An application profile "customises one or more existing specifications potentially for a given use case or a policy domain adding an end to end narrative describing and ensuring the interoperability of its underlying specification(s)".
Subclass of	cssv:Specification

4.4.1. Property: cssv:configures

OWL Property	cssv:configures
OWL type	owl:ObjectProperty

⊕ ec.europa.eu/isa2

✉ isa2@ec.europa.eu

Label	configures
Definition	Whether an Application Profile design or adapts a Specification for a specific purpose.
Domain	cssv:ApplicationProfile
Range	cssv:Specification
Examples	DCAT-AP configuring DCAT for its use in the context of the EU Public Administrations; Any NATO profile configuring a set of interoperability Specifications for a specific context of use; other.

4.4.2. Property: cssv:isAspectOf

OWL Property	cssv:configures
OWL type	owl:ObjectProperty
Label	isAspectOf
Definition	ApplicationProfile is a part of a Profile.
Domain	cssv:ApplicationProfile
Range	prof:Profile
Examples	DCAT-AP.

4.5. Class: cssv:Family

OWL Class	cssv:Family
Label	Family
Definition	A collection of interrelated and/or complementary specifications, standards, or application profiles and the explanation of how they are combined, used, or both.
Subclass of	cssv:Specification

4.5.1. Property: cssv:combines

OWL Property	cssv:combines

OWL type	owl:ObjectProperty
Label	Combines
Definition	Whether a Family is a union of more than one Specifications.
Domain	cssv:Family
Range	cssv:Specification
Examples	One or more Specifications that are part of a family, e.g. OASIS UBL XML-based family (XML, XML Schema Definition, ISO Schematron, OASIS Genericode, Context Value Association (CVA), UN/CEFACT unqualified data types); OASIS JSON-based family; CEN TC 440 families; UN/CEFACT CII eInvoice family; other. Conformance Statement.

4.6.   Class: cssv:Scope

OWL Class	cssv:Scope
Label	Scope
Definition	Area of requirements addressed by the specification.

4.6.1.   Property:cssv:ID

OWL Property	cssv:ID
OWL type	owl:DataProperty
Label	identifier
Definition	The main identifier for the scope, e.g. the URI or another unique identifier.
Domain	xsd:AnyURI
Examples	Any URI pointing at an instance of the Scope.

4.6.2.   Property: cssv:Description

OWL Property	cssv:Description
OWL type	owl:DataProperty

Label	description
Definition	A free-text account of the Scope. This property can be repeated for parallel language versions of the description.
Domain	xsd:String
Examples	A free-text account of the Scope.

This section describes two essential aspects of the CAMSS Ontology and how the CAMSS A-Box has been implemented:

- **The CAMSS Ontology Vocabulary**: On one side, a graphic representation and textual descriptions of the CAMSS Ontology Vocabulary are provided. This vocabulary is to be taken as the basis for the building of a Knowledge Base T-Box ("T" standing for terminology).

- **The CAMSS Ontology Facts**: On the other side, the Ontology is to be completed with assertions, thus providing facts to populate the A-Box of the Knowledge Base ("A" standing for assertions). For this, the A-Box has been populated with the existing CAMSS Assessments once transformed into an OWL2 Syntax, and conformant to the axioms defined in the T-Box.

- **Implementation of the CAMSS A-Box**: Finally, this new release of the CAMSS Ontology is accompanied with the implementation of a first CAMSS A-Box.

4.7. The CAMSS Ontology Vocabulary

The figure below shows the main entities and relations of the CAMSS Ontology Vocabulary needed for the building of the Knowledge Base T-Box.
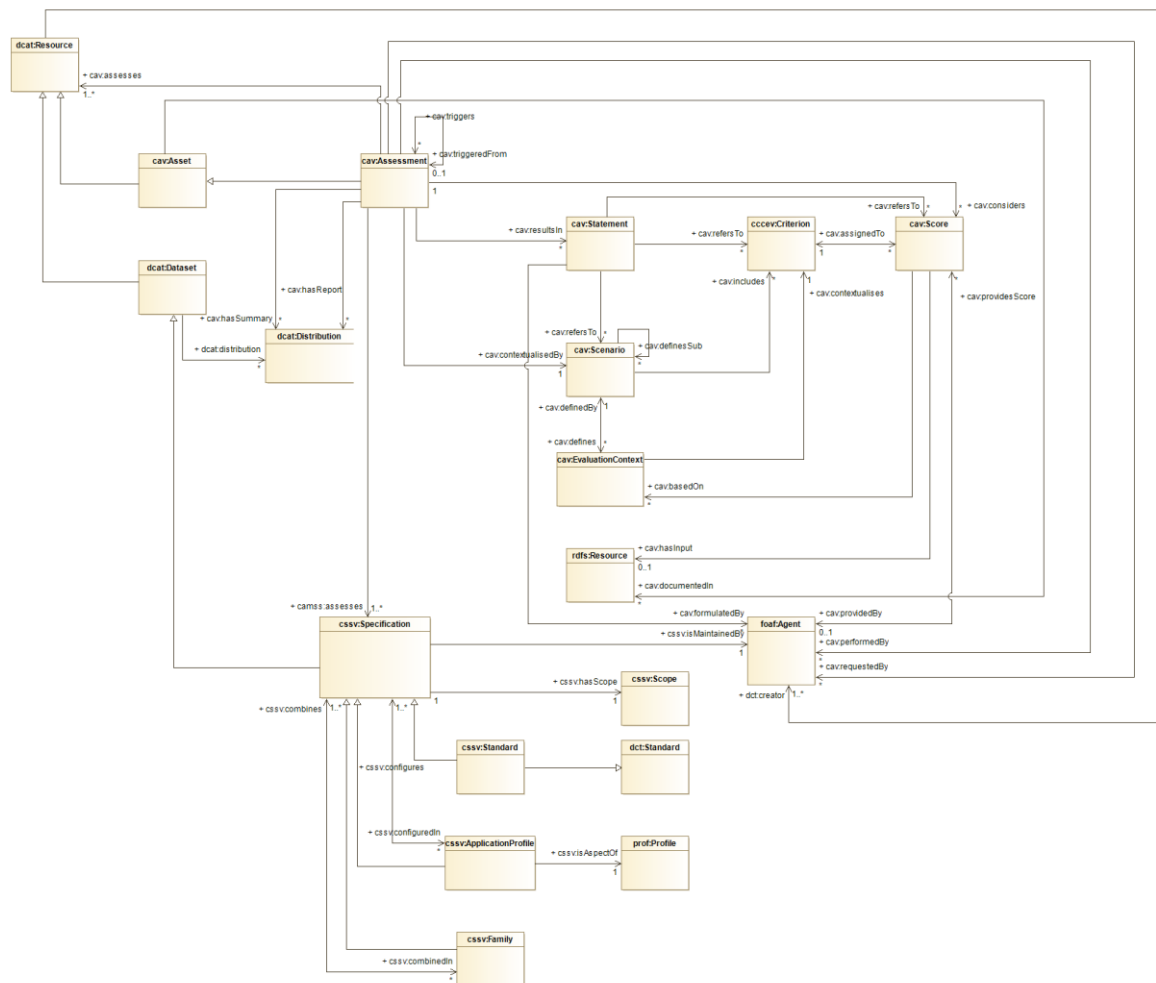
Figure 4 The CAMSS Ontology Vocabulary

The figure above provides a more detailed view of how the two vocabularies (CSSV and CAV) are connected in the context of the CAMSS Ontology. The important observation is that whilst a CAV Assessment assesses a DCAT Resource, the CAMSS Ontology Assessment assesses CSSV Specifications, which are also DCAT Resource.

The CAMSS Ontology is different from the CAV in two senses.

1. The CAMSS Ontology profiles the assessments to one specific type of asset, the specification (and its descendants).

2. The CAMSS Ontology limits the assessments to one or more specification. Beware that application profiles and families are descendants of one specification.

4.8. The CAMSS Ontology Facts

The CAMSS Ontology Vocabulary links the two domains of CAMSS, Assessments and Specifications. For the time being, the Assessments and Specifications performed in the context of CAMSS have not yet been expressed according to the CAMSS Ontology Vocabulary

described in the section above. This is on-going work, since the Ontology has dependencies on other vocabularies currently under development.

Because of this, the population of the A-Box will be done in next releases of the CAMSS Ontology, once the dependencies stability is greater or solved.

Nonetheless, this section aims to illustrate the Physical Instantiation of the CAMSS Ontology into a CAMSS Knowledge Graph, composed of a T-Box (Terminology) and A-Box (Assertions, the set of facts expressed as triples).
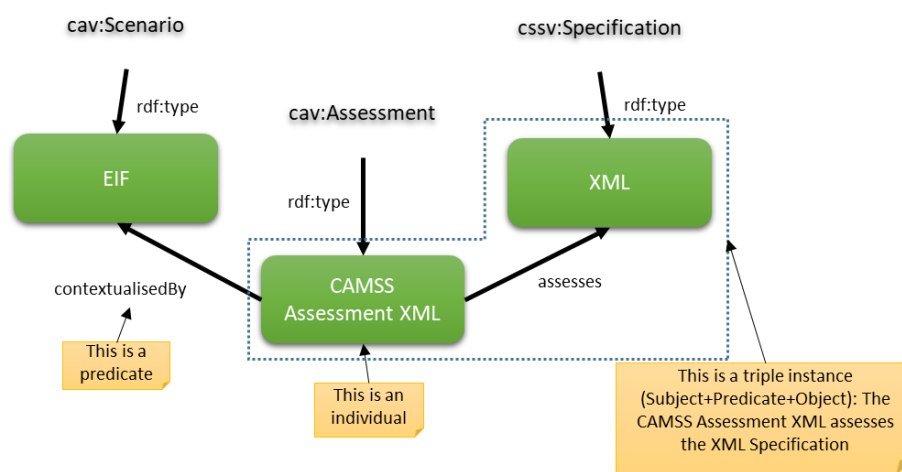
Figure 5 Example of CAMSS Facts

For the 'population' and maintenance of the A-Box with facts, some artefacts and developments have been performed. The next section provides more details on these.

4.9.   Implementation of the CAMSS A-Box

This new release of the CAMSS Ontology is accompanied with the implementation of a first CAMSS A-Box. The A-Box is composed of three Graphs:

URL	Description
http://data.europa.eu/2sa/assessments	All the CAMSS Assessments, it includes the answers to the criteria (which are individuals of the CCCEV created in the CAMSS namespace)
http://data.europa.eu/2sa/scenarios	The scenarios and criteria defined for their use in Assessments

http://data.europa.eu/2sa/cssv/rsc	All the specifications and standards identified via CAMSS Assessments and ELIS

Each graph can be obtained as a separate file (an OWL Turtle file). A test Graph Store was also set-up for the loading and testing of the A-Box from a SPARQL endpoint.

All these files, as well as the developments used to produce them, can be downloaded from the public CAMSS GitHub1. They can be used freely under the EUPL2 Licensing conditions. Moreover, the CAMSS Ontology will be available through the OP's CELLAR SPARQL endpoint: http://publications.europa.eu/webapi/rdf/sparql .

A set of SPARQL queries can be found in the Annex 2. This queries can be executed in the endpoint to retrieve data from the CAMSS Ontology Knowledge Graphs.

These utilities can be used for the maintenance of the CAMSS Knowledge Graph; e.g. for the addition of new Assessments, scenarios, and criteria, as well as standards and specifications.

4.9.1. Artefacts

For a better understanding of how the A-Box of the CAMSS Knowledge Graph is produced, a distinction needs to be done, first, between 'input' artefacts (needed for running a process) and 'output' artefacts (the outcome of the process).

- **Input artefacts**

    o **Specifications**: In CAMSS, the identification of specifications is done with two main purposes: either for their Assessment (via the CAMSS tools), or to associate them to EIRA ABBs (via ELIS). Specifications extracted from these two types or artefacts are instantiated once and saved into a GraphStore. For the unique and unambiguous identification of the specification, the official URL of the specification3 is taken as the input for the generation of a SHA-256 hexadecimal number, which is added to the CSSV namespace reserved for resources; e.g.:

    http://data.europa.eu/2sa/cssv/rsc/c0e30aa2cfbfa6220770e859721947eb65bfd1 f30c280053ea14861a66a06824 ;

    o **Criteria**: In principle, each Scenario and CAMSS Toolkit defines its own criteria. However some criteria are reused in different combinations of Scenario + ToolKit Version (e.g. EIF-3.0.0 and EIF-3.01). Since each CAMSS assessment specifies one Scenario and its criteria, randomly chosen assessments are picked to extract the different scenarios and criteria, and to save them into separate CSV files. For examples and more details, see the CSV files4 in the CAMSS GitHub. The identifiers of the criteria are also generated hashing the text of the criteria as a SHA-256 string.

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[1] See CAMSS GitHub, folder 'util': https://github.com/isa-camss/CAMSS-Ontology/tree/master/util
[2] https://joinup.ec.europa.eu/collection/eupl/about
[3] Including the version whenever it is available in the URL.
[4] See folder https://github.com/isa-camss/CAMSS-Ontology/tree/master/util/py/out/ass/csv

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✉ isa2@ec.europa.eu

- o **Mappings**: Two means are provided for the generation of the CAMSS A-Box, a Python script and RML mappers1 (RDF Mapping Language (RML) is a generic mapping language defined to express customised mapping rules from heterogeneous data structures and serialisations to the RDF data model. RML is defined as a superset of the W3C-standardised mapping language R2RML2). The RML mappers are provided as one example of reference implementation, but the actual CAMSS A-Box was generated using the Python utility3.

- **Output artefacts:**

  - o **'Flattened' CSV files**: Each CAMSS assessment spread-sheet book is converted to a CSV (one CSV per assessment).

  - o **Turtle (TTL) files**: Each flattened CSV file is converted into one RDF-OWL Turtle file. The 'camss.py' script can be used to merge the individual TTL files into one single TTL file containing all the CAMSS Assessments expressed as OWL. These graphs use the namespace http://data.europa.eu/2sa/assessments.

  - o **Scenarios and criteria**: The combinations of the three scenarios and toolkit versions (EIF-3.0.0, EIF-3.1.0, and MSP-3.0.0), together with their criteria, are captured from the flattened CSV files and converted into RDF-OWL Turtle files. The 'camss.py' script can be used to merge the three TTL files containing scenarios and criteria into one single TTL file. These graphs are created in the namespace http://data.europa.eu/2sa/scenarios.

  - o **Specifications**: The flattened CSV is also used to convert all the specifications identified therein into one single TTL file. The namespace used for this graph is http://data.europa.eu/2sa/cssv/rsc.

  - o **List of Assessments**: A CSV containing a basic set of metadata of all CAMSS Assessments being extracted and converted: the Assessment ID, Scenario ID, the tool version used to perform the Assessment, the Assessment title, and the date of the Assessment.

4.9.2.   Software

- **camss.py**: Given the input artefacts mentioned above, this script provides classes and functions to generate the outputs enumerated in the previous section. If you clone the GitHub repository, you need a folder containing the CAMSS Assessments (as spread-sheets) and the **camss.py** module4.

  Make sure that all the dependencies (third party-dependencies) are correctly installed in your Python's virtual environment (a 'requirements.txt' file is provided with these dependencies).

To see which parameters to use, see the file 'parameters.txt', or just run 'python camss.py' or 'python camss.py --help'. These show how to invoke the different functionalities from a command-line environment.

Alternatively, a Jupyter Notebook1 is provided to show and document each one of these functionalities from a Python interpreter console. The figure below shows how to execute some of these entries from a Jupyter Lab notebook:
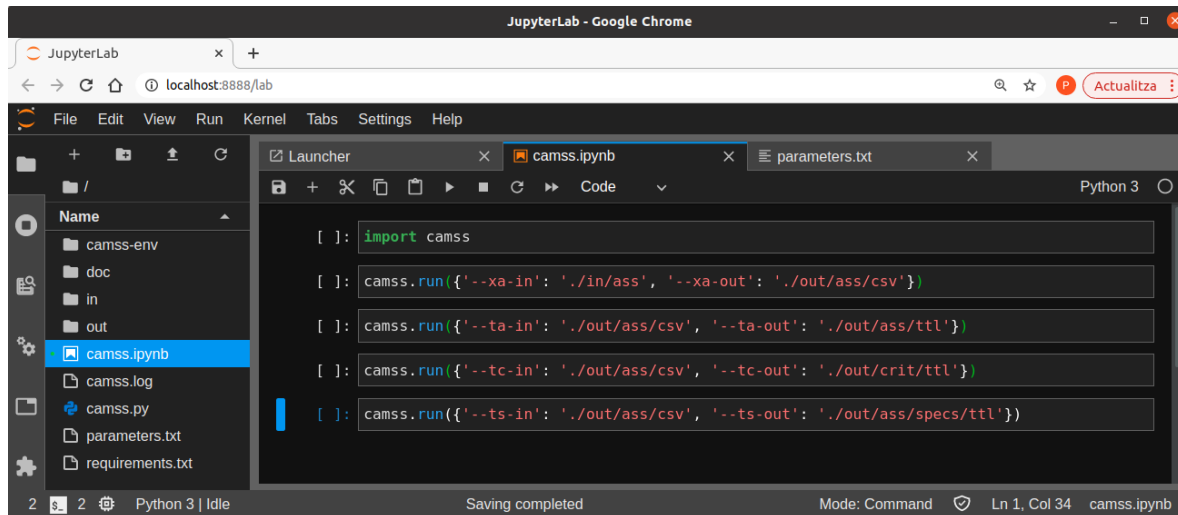

Figure 6 Running 'camss.py' utilities from a Jupyter Lab notebook

The examples provided in the 'parameters.txt' file or when running 'python camss.py –help', should produce a structure of directories and files like these:
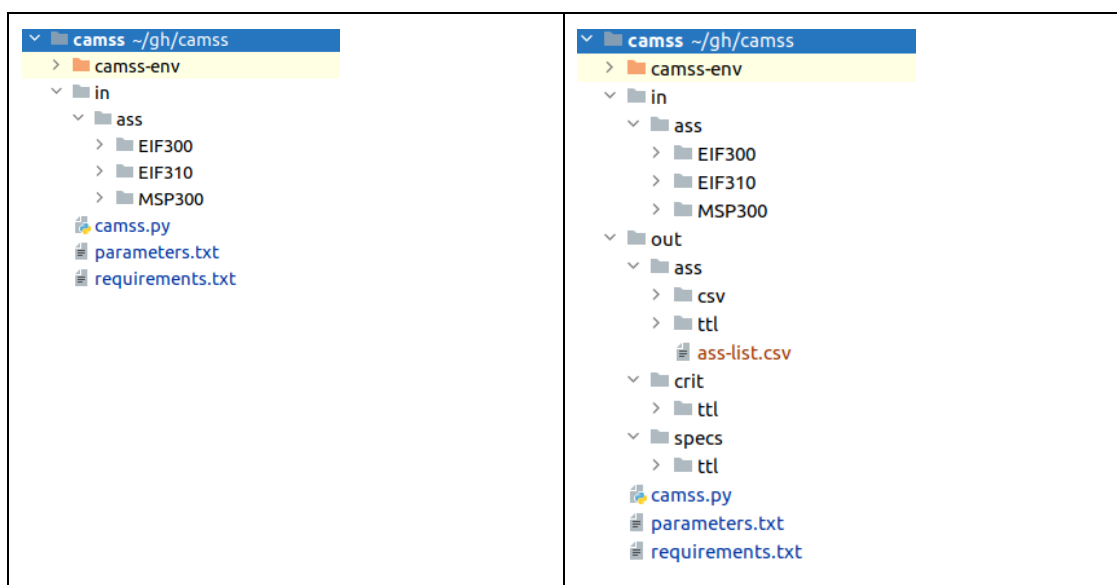
Figure 7 Directory structure 'before' and 'after' executing the examples of 'camss.py -help'

- **RMLMapper:** Some RML files are also provided to illustrate how the conversion from CSV files can be mapped into RDF using the RML.io specification and the RMLMapper Java tool. This implies that a JVM must be installed for the RMLMapper to run properly. For this version of the CAMSS utilities, Java 1.8 was successfully used. Accompanying

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[1] Jupyter notebook: https://github.com/isa-camss/CAMSS-Ontology/blob/master/util/py/camss.ipynb

these RML files, Jupyter Notebooks are provided to show how to invoke the RMLMapper Java jar from Python.

All the software developed in the context of this project is available under the EUPL Licence1 conditions. Before reusing it make sure that any other dependency of this development from other software reused therein is duly respected2.

1 EUPL Licence in Joinup: https://joinup.ec.europa.eu/collection/eupl/about
2 Check licences of RMLMapper, Pandas, other (a 'Requirements.txt' file is provided so dependencies with third-party libraries can be easily checked).

5

CONCLUSIONS

5. CONCLUSIONS

1. No ontologies or vocabularies were identified that fully covered the needs of the CAMSS domain. Hence the decision of developing a new CAMSS Ontology was made.

2. The CAMSS Ontology does not provide any new entity per se; it is a very simple model that reuses existing vocabularies and restricts their properties.

6

ACRONYMS

6.   ACRONYMS

Acronym	Description
ADMS	Asset Description Metadata Schema
CAMSS	Common Assessment Methods for Standards and Specifications
CAV	Core Assessment Vocabulary
CCCEV	Core Criterion and Core Evidence Vocabulary
CPV	Core Person Vocabulary
CSSV	Core Standards and Specifications Vocabulary
EIF	European Interoperability Framework
ELIS	EIRA Library of Interoperability Specifications
ESPD	European Single Procurement Document
FOAF	Friend of a Friend
IMAPS	Interoperability Maturity Assessments of a Public Service
IQAT	Interoperability Quick Assessment Toolkit
MSP	Multi-Stakeholder Platform
OWL	The W3C Web Ontology Language

7

REFERENCES

7. REFERENCES

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ANNEX 1 – Ontology basis

ANNEX 1 – ONTOLOGY BASIS

An Ontology, also known as T-Box, is a set of logical axioms that conceptualise a domain of interest by defining concepts and the semantics of relations among concepts.

The following picture depicts the T-Box of the CAMSS Ontology:

CAMSS Vocabulary (Terms)
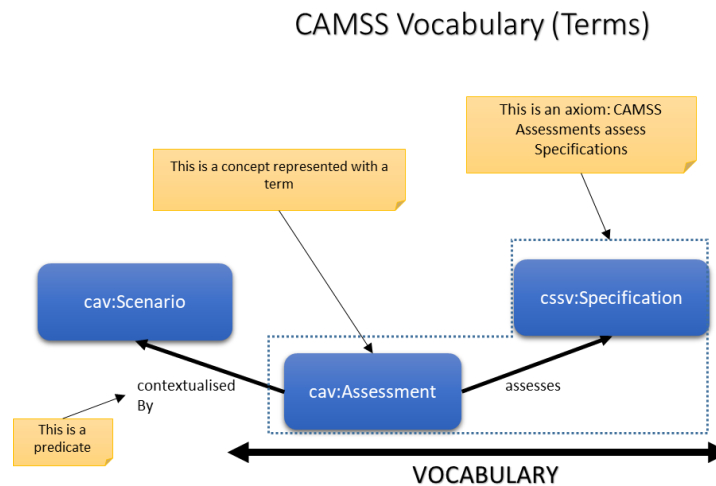
Figure 8 CAMSS Ontology (T-Box)

It is also worth when talking about ontologies to explain the meaning of the linked data concept or A-Box. Linked data are a set of assertions on individuals belonging to a domain of interest. Namely, assertions are facts associated with a conceptual model (i.e. the ontology) within a knowledge graph.

The following picture depicts an example of an A-Box:
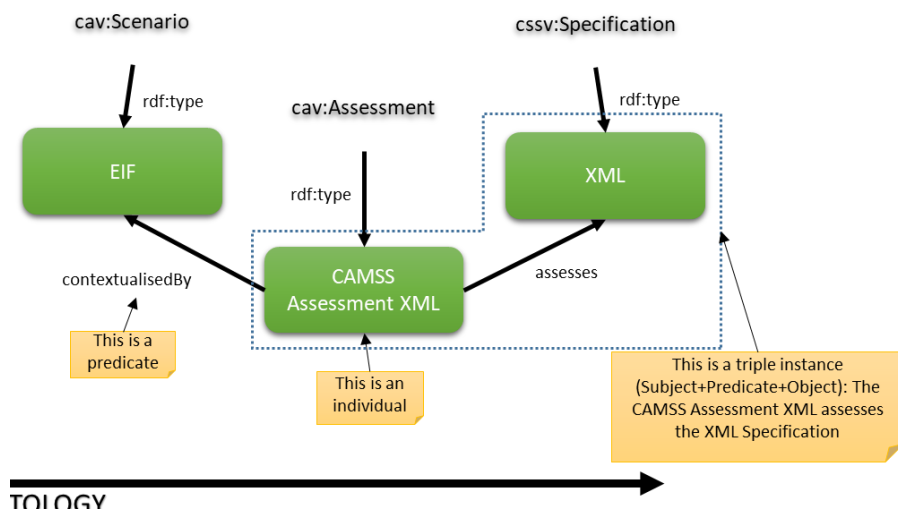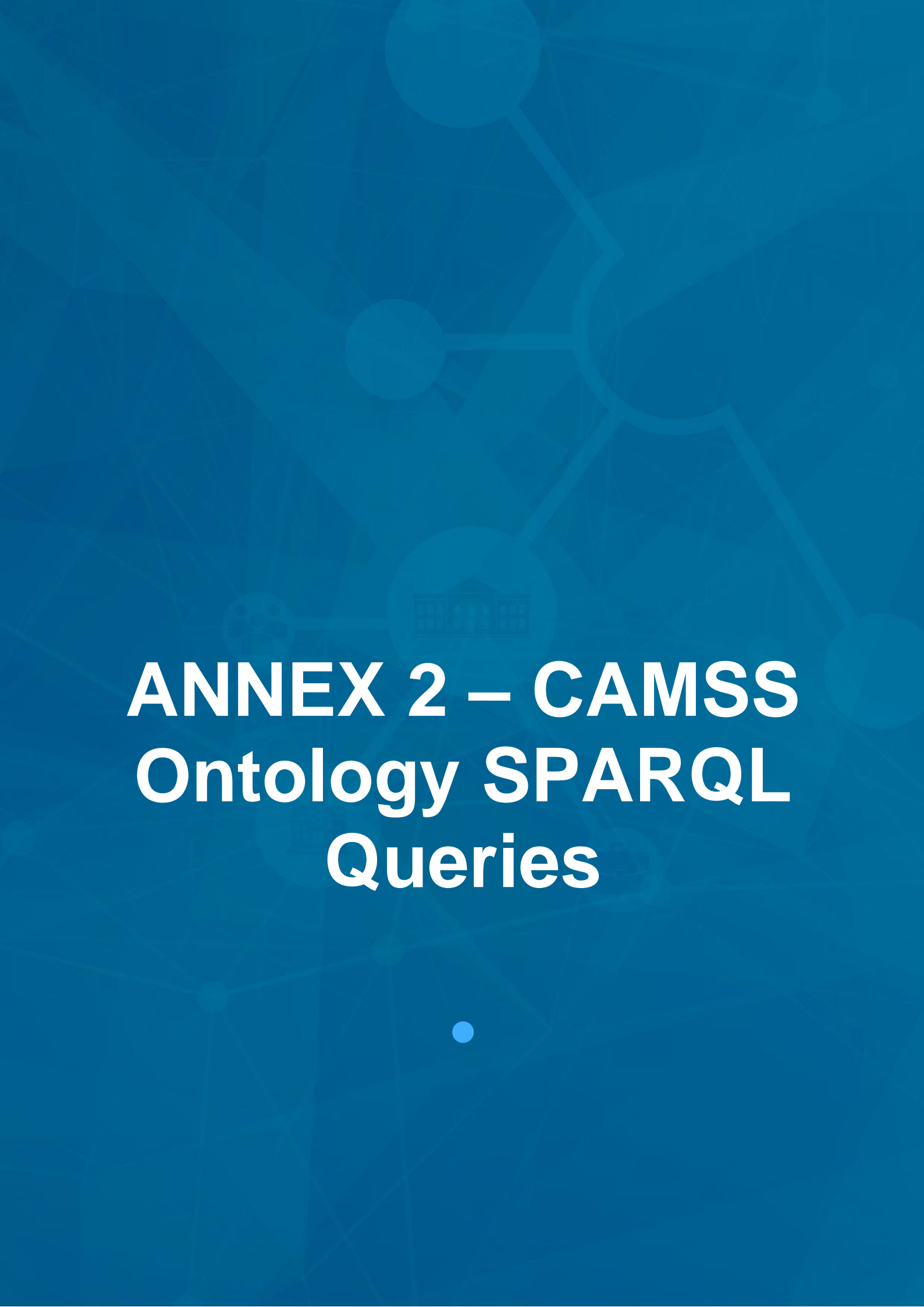
Figure 9 Linked Data (A-Box)

The grouping of the T-Box and the A-Box constitute the knowledge graph. The knowledge graph represents a collection of interlinked descriptions of entities – real-world objects and events, or abstract concepts (e.g. documents) – where the following statements are true.

- Descriptions have formal semantics that allows both people and computers to process them in an efficient and unambiguous manner.
- Entity descriptions to one another, forming a network, where each entity represents part of the description of the entities, related to it, and provides context for their interpretation.
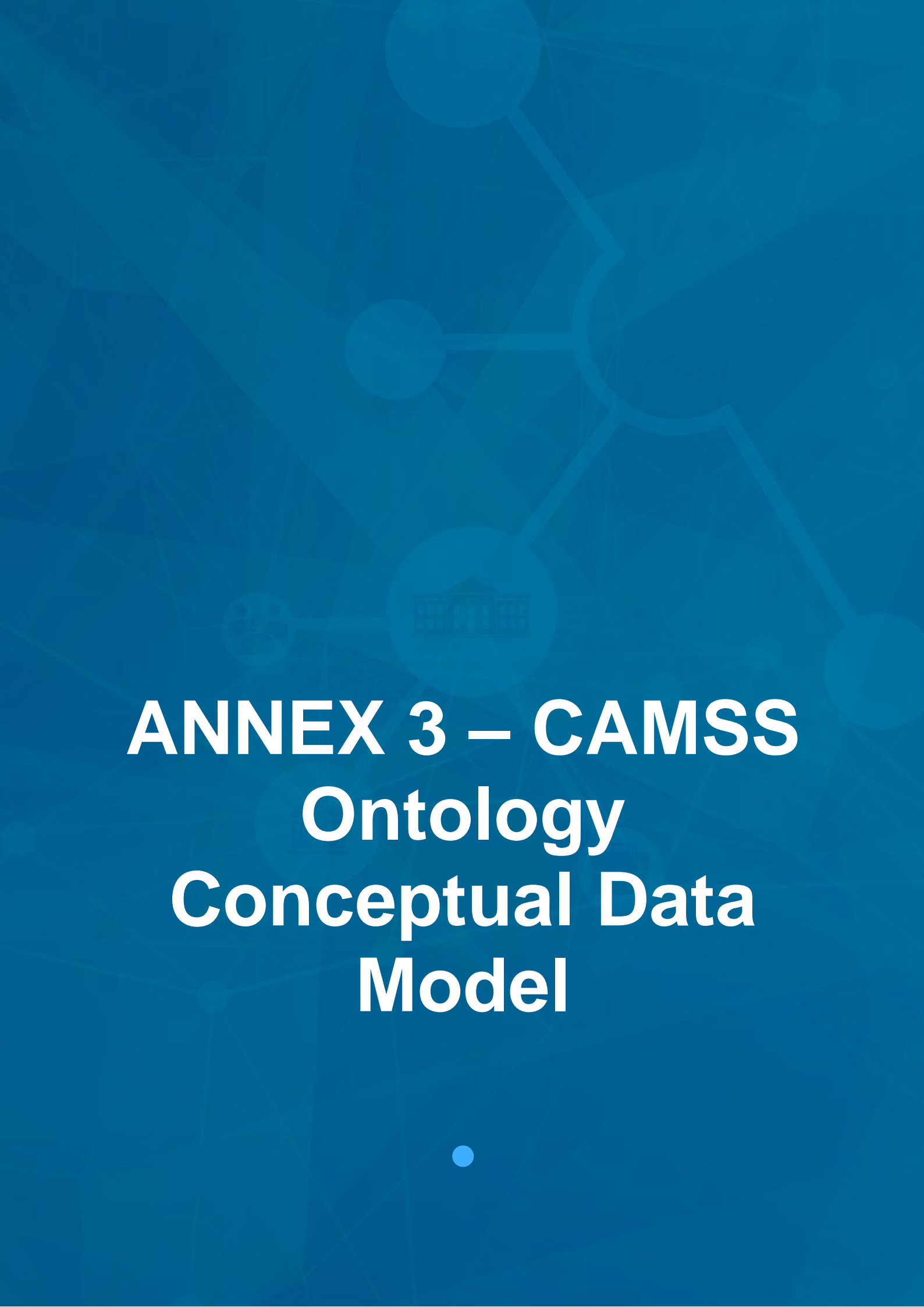
ANNEX 2 – CAMSS Ontology SPARQL Queries

ANNEX 2 – CAMSS ONTOLOGY SPARQL QUERIES

Access to the document here : https://github.com/isa-camss/CAMSS-Ontology/blob/master/doc/sparql.zip

ANNEX 3 – CAMSS Ontology Conceptual Data Model

ANNEX 3 – CAMSS Ontology Conceptual Data Model

Disclaimer

In order to open the files embedded in the annex, please use Modelio editor.

Access to the document here: https://joinup.ec.europa.eu/collection/common-assessment-method-standards-and-specifications-camss/solution/camss-ontology/distribution/cams-ontology-100-uml
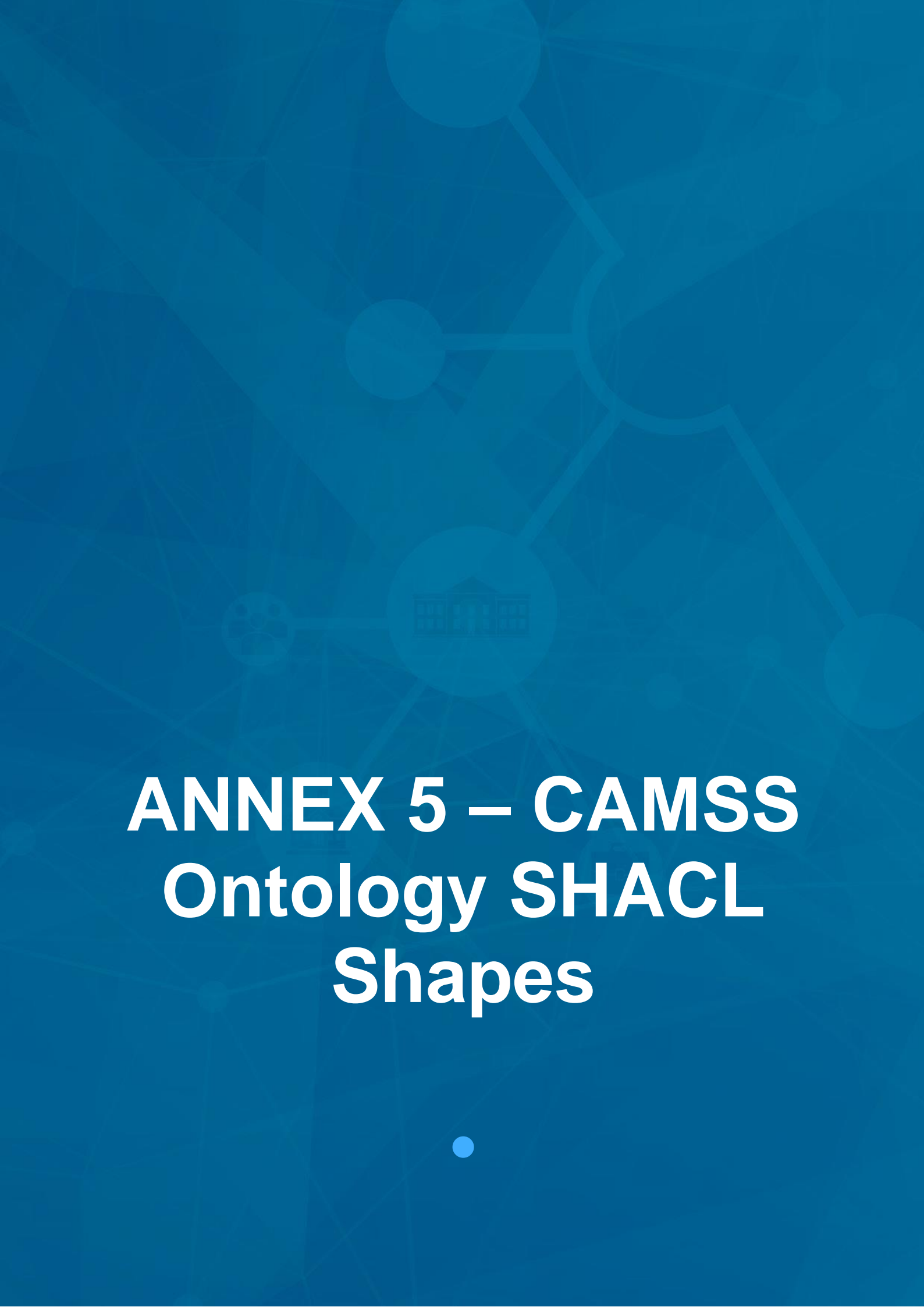
ANNEX 4 – CAMSS Ontology T-Box

ANNEX 4 - CAMSS ONTOLOGY T-BOX

Access to the document here: https://joinup.ec.europa.eu/collection/common-assessment-method-standards-and-specifications-camss/solution/camss-ontology/distribution/cams-ontology-v100ttl

ANNEX 5 – CAMSS Ontology SHACL Shapes

ANNEX 5 – CAMSS ONTOLOGY SHACL SHAPES

Access to the document here: https://joinup.ec.europa.eu/collection/common-assessment-method-standards-and-specifications-camss/solution/camss-ontology/distribution/cams-ontology-shacl-shapes-v100rdf

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