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D01.01 Final Data Model

Collaborative Mapping of Innovation Supporting Actors

Specific Contract n° 373 under Framework Contract n° DI/07624 - ABCIV Lot 3

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Introduction

This deliverable provides the semantic data model of *Collaborative Mapping of Innovation Supporting Actors* (CMISA) as a vocabulary. The model can be used to share information on innovation supporting actors (technology centres, pilot lines, cluster organisations, alliances, innovation hubs, etc.) in an interoperable format and re-use datasets published using the data model.

The overall purpose of the document is to offer support to anyone with technical background to use the data model to share information on innovation supporting actors or reuse a dataset using this data model.

The document focuses on the data model and the context it is aimed to be used in.

Upon its elaboration, this document represents a part of an interoperable solution (data model – central database – online demonstrator website), and it will serve as a common data model to be used by the websites to share / publish their datasets in a standard and harmonised way.

During the lifetime of the project, it is aimed to keep the model up-to-date and aligned with the latest versions of the related vocabularies, taxonomies, as well as user feedback that will result into new releases of the document.

Context

The European Commission (EC) recognises that innovation plays a key role for the European Union (EU) industry competitiveness. In that regard, the EC has an important role in supporting Member States (MS) and regions to increase their potential for innovation, competitiveness and sustainable growth. The EC realises this mission via implementation of various initiatives and programmes that aim to support innovation development and access of MS and regions to the financing and technologies (e.g. Horizon 2020, ESIF European Structural Investment Funds, COSME Programme, and EIT KICs Knowledge Innovation Communities).

Thus, MS' public administrations and businesses already have access to various websites that provide information on advanced technologies, testing facilities, financing, etc. in the area of innovative solutions (e.g. the European Network for Pilot Production Facilities and Innovation Hubs). However, in practice, many of those websites provide only fragmented information rather than a comprehensive overview, implying authorities and businesses to visit many websites to obtain all needed data about innovation aspects. This fragmentation and lack of data interoperability represents burden and additional costs for the different interested stakeholders.

In this context, the EC plans to undertake more actions to achieve data interoperability and ease the exchange of information in the innovation area between MS and regions.

The data model represents one of the deliverables of a project that is developing and implementing a common sematic data model, a centrally federated database and an online demonstrator website, in order to ease exchange of data between various European and national websites and allow public administrations and enterprises to receive information faster and in a more efficient manner. This project was financed by the ISA² Programme[1].

The implementation of this data model also aims at increasing the data quality by elaborating a flexible common set of rules with the descriptions of the actors and instruments, as well as reducing effort for EU data providers by providing a central dataset that merges available information from the participating websites. On the long-term, this should allow policy makers to analyse more efficiently the innovation related datasets, enabling decision making based on more accurate evidences.

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[1] https://ec.europa.eu/isa2/home_en

ISA[2] Core Vocabularies

Both, the semantic data model and the vocabulary are based on recognised schemes and ontologies, such as the **ISA[2] Core Vocabularies[2]**, **W3C Organization[3] Ontology[4], FOAF Vocabulary[5]**, and follow good practices inspired by **ADMS[6], DCAT-AP[7]**, Publication Office's **MDR**[8] (Metadata Registry).

ISA² Core Vocabularies are simplified, reusable, and extensible data models that capture the fundamental characteristics of an entity, such as a person or a public organisation, a location or an address in a context-neutral manner. They can be used and extended to facilitate information exchange, data integration and publishing, providing a common format and also serving as a starting point for designing conceptual and logical data.

The W3C Organization Ontology is a core ontology for organisational structures, aimed at supporting linked data publishing of organisational information across a number of domains. It is designed to allow domain-specific extensions to add classification of organisations and roles, as well as extensions to support neighbouring information such as organisational activities.

Within the scope of this deliverable, the Core Vocabularies and the Organizational Ontology were analysed in order to reuse the most suitable classes and properties as much as possible in the context of the CMISA specification, in order to enable cross-border interoperability between platforms for data publication and exchange related to Innovation Supporting Actors.

The CMISA vocabulary is intended to facilitate data exchange, publication findability and reuse and, therefore, the vocabulary of classes and properties defined in this document is aimed for this; there are no requirements for participating platforms to implement specific technical environments.

Terminology used in CMISA Vocabulary

A **semantic data model** provides a way of structuring data in order to represent it in a conceptual level. It includes semantic information that adds a basic meaning to the data and the relationships that lie between them.

A **vocabulary** formally defines a common set of terms that are used to describe and represent a domain. It contains terms and the relationships among these terms. The various concepts of the domain described by the vocabulary are modelled with classes. The various features and attributes of the concepts are expressed by using a special group of terms: properties. These property terms, apart from encapsulating the features

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[2] https://joinup.ec.europa.eu/page/core-vocabularies
[3] Hereinafter, the naming is used according to the source and prevails the English UK spelling of the words
[4] https://www.w3.org/TR/vocab-org/
[5] http://xmlns.com/foaf/spec/
[6] https://joinup.ec.europa.eu/solution/asset-description-metadata-schema-adms/about
[7] https://joinup.ec.europa.eu/collection/semantic-interoperability-community-semic/solution/dcat-application-profile-data-portals-europe/release/201-0
[8] http://publications.europa.eu/mdr/authority/

and attributes of the concepts, they can also be used to associate different classes together.

The CMISA vocabulary presented in this deliverable is a specification that re-uses terms from base standards and open vocabularies, adding more specificity by identifying mandatory and optional elements to be used for a particular domain application.

An **Actor** corresponds to the "innovation supporting actor or instrument", for instance, it can be a Technology Centre, an Innovation Hub, a Pilot plant, a Participating Region (the administration participating in one of the platforms). An Actor is associated with the **Address**, **Location** and **Contact Point** classes that provide relevant information. The data model enables multiple ways to provide location information related to an Actor:

- Using the Address class to provide full address and regional information;
- Using the Location class to provide location information that can be associated with the address. Location information can also be provided as geospatial coordinates;
- Using the contact point vCard class to provide contact information of the Actor, including address information.

The **Aggregator Platform** represents the platform that aggregates information related to Actors, e.g. KET Technology Centres, KETs for clean production, European Pilot Production Network (EPPN) (including Open Innovation Test Beds and Industrial Infrastructures for Research and Innovation), Smart Specialisation Platform for Industrial Modernisation, Digital Innovation Hubs (DIH) catalogue, ECCP European Cluster Collaboration Platform. It is related to Actors via an **Aggregation** association class.

The **Organizational Collaboration class** models a collaboration between Actors using membership associations and properties that provide further information about the collaboration, i.e. name, description, type. An Organizational Collaboration can be a project, an endeavour, venture, consortium, etc.

The available information about Actors is stored in catalogs. The vocabulary offers a **Generic Catalog** to describe any kind of information related to an Actor (e.g. funding received, products, networks, etc.). There are also explicit catalogs for storing **Sector** and **Technology** information for each Actor, where available. Catalogs may use controlled vocabularies, such as the list of technologies, technology readiness levels, market sector hierarchical classification, etc. to provide the related information in a more structured and interoperable way.

In the following sections, classes and properties of the vocabulary are classified as 'mandatory' and 'optional', according to the following meaning:

Classes:

- **Mandatory**: the data model *must* contain information about instances of the class. Mandatory classes represent the entities that are available for all participating platforms;

- **Optional**: the data model may contain information about instances of the class. These classes encapsulate entities that *may* exist for some actors. Their absence does not impact interoperability, but their presence enriches the shared data.

Properties:

- **Mandatory**: the instances of classes *must* contain information for that property;
- **Optional**: the instances of classes *may* contain information for that property.

The meaning of the terms *must*, *should* and *may* in this document, is compliant with the specifications of RFC 2119[9]: *must* mean that the definition is an absolute requirement of the specification; *should*, or the adjective *recommended*, mean that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications must be understood and carefully weighed before choosing a different course; and *may*, or the adjective *optional*, mean that an item is truly optional.

The vocabulary reuses terms from various **recognised standard schemas and ontologies**. In order to simplify the notation, this specification will refer to **namespaces** that represent the following vocabularies and ontologies:

Prefix	Namespace	RDF Vocabulary
cmisa	https://joinup.ec.europa.eu/collection/cmisa/solution/cmisa	Common data Model for Innovation Supporting Actors
dct	http://purl.org/dc/terms/	Dublin Core Metadata Element Set, v1.1
foaf	http://xmlns.com/foaf/0.1/	FOAF Vocabulary
locn	http://www.w3.org/ns/locn#	ISA Programme Core Location Vocabulary
owl	http://www.w3.org/2002/07/owl#	OWL Web Ontology Language
org	https://www.w3.org/TR/vocab-org/#	Organization Ontology
rdf	http://www.w3.org/1999/02/22-rdf-syntax-ns#	Resource Description Framework (RDF): Concepts and Abstract Syntax
rdfs	http://www.w3.org/2000/01/rdf-schema#	RDF Vocabulary Description Language 1.0: RDF Schema
skos	http://www.w3.org/2004/02/skos/core#	SKOS Simple Knowledge Organization System - Reference
vann	http://purl.org/vocab/vann/	VANN: A vocabulary for annotating vocabulary descriptions
vcard	http://www.w3.org/2006/vcard/ns#	vCard Ontology
xsd	http://www.w3.org/2001/XMLSchema#	XML Schema Part 2: Datatypes Second Edition

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[9] https://www.ietf.org/rfc/rfc2119.txt

1. Overview of Classes and Properties
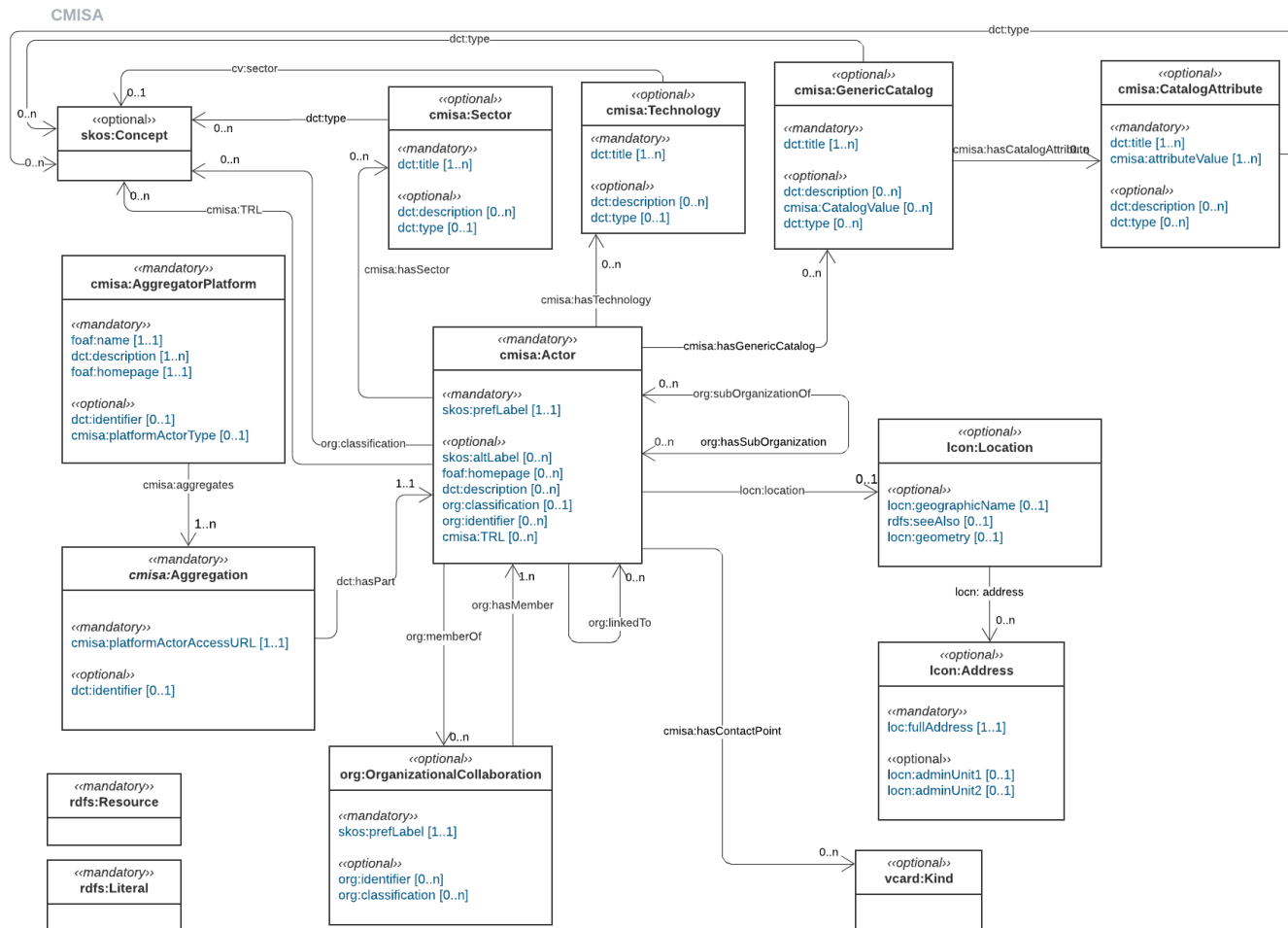
Figure 1 CMISA UML class diagram

2. CMISA Data Model Classes

Mandatory Classes

Class name	Usage note for the Data Model	URI	Reference
Actor	An entity representing the Innovation Supporting Actor, i.e. it can be a Technology Centre, an Innovation HUB, a Pilot Plant, a Participating Region (the administration participating in one of the platforms)	cmisa:Actor	https://joinup.ec.europa.eu/collection/cmisa/solution/cmisa
Aggregation	An association class for attaching additional information to the relationship between Aggregator Platform and Actor	cmisa:Aggregation	https://joinup.ec.europa.eu/collection/cmisa/solution/cmisa
Aggregator Platform	The platform that aggregates information about the Innovation Supporting Actors	cmisa:AggregatorPlatform	https://joinup.ec.europa.eu/collection/cmisa/solution/cmisa
Literal	A literal value, such as a text string or a integer; Literals may be typed, e.g. as a date according to xsd:date. Literals that contain human-readable text have an optional language tag as defined by BCP 47[10]	rdfs:Literal	https://www.w3.org/TR/rdf-schema/#ch_literal
Resource	Anything described by RDF	rdfs:Resource	http://www.w3.org/TR/rdf-schema/#ch_resource

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[10] http://www.rfc-editor.org/rfc/bcp/bcp47.txt

Optional Classes

Class name	Usage note for the Data Model	URI	Reference
Address	The Address representing a location	locn:Address	https://www.w3.org/ns/locn#locn:Address
Catalog Attribute	A class that could be associated with a Generic Catalog to describe the catalog attributes and their values	cmisa:CatalogAttribute	https://joinup.ec.europa.eu/collection/cmisa/solution/cmisa
Concept	A class representing an abstract idea or notion; a unit of thought	skos:Concept	http://www.w3.org/2004/02/skos/core#Concept
Generic Catalog	A generic catalog used to group available information related to the Actor	cmisa:GenericCatalog	https://joinup.ec.europa.eu/collection/cmisa/solution/cmisa
Kind	This class provides contact point information for the Actor, following the vCard specification, e.g. to provide telephone number and e-mail address for a contact point. Note that the class Kind is the parent class for the four explicit types of vCards (Individual, Organization, Location, Group)	vcard:Kind	http://www.w3.org/TR/2014/NOTE-vcard-rdf-20140522/#d4e181
Location	A spatial region or named place. It can be associated with an address	dct:Location	https://www.w3.org/ns/locn#dcterms:Location
Organizational Collaboration	A collaboration between two or more Actors such as a Project, a Venture, an Endeavour, a Consortium, Alliance, Cluster etc.	Org:OrganizationalCollaboration	https://www.w3.org/TR/vocab-org/#org:OrganizationalCollaboration
Sector	The sectors related to the Actor. Note that a single Actor can have multiple sectors	cmisa:Sector	https://joinup.ec.europa.eu/collection/cmisa/solution/cmisa
Technology	A technology related to the Actor	cmisa:Technology	https://joinup.ec.europa.eu/collection/cmisa/solution/cmisa

3. CMISA Data Model Properties per Class

The main mandatory classes of the CMISA data model that conceptualise the core semantic entities (Actor and Aggregator platform) are subclasses of the W3C Organization Ontology - Organization class and the FOAF Vocabulary - Actor class, respectively. The list of included properties is a selection of the properties on which CMISA expresses additional constraints or wants to emphasise their usage. A property which is not mentioned here but would be applicable for a class according to Organization Ontology or FOAF vocabulary is considered out of scope for CMISA data model. Other classes included in this specification are either reused from Core Vocabularies (e.g. Address and Location) or defined within the CMISA namespace. Most properties are reused from other open and well establish vocabularies (foaf, dcterms, etc.), but where not possible, new properties have been defined. Newly minted terms are specific to the concepts of the CMISA specification.

Actor

Actor is a subclass of org:Organization

Mandatory properties for Actor

Property	URI	Range	Usage note	Cardinality
name	skos:prefLabel	rdfs:Literal	The name of the Actor	1..1

Optional properties for Actor

Property	URI	Range	Usage note	Cardinality
alternative name	skos:altLabel	rdfs:Literal	The alternative name(s) of the Actor	0..n
classification	org:classification	skos:Concept	Indicates a classification within some classification scheme. This property classifies the Actor according to its type, which should be provided using a controlled vocabulary expressed as a SKOS concept	0..n
description	dct:description	rdfs:Literal	A textual description for the innovation supporting services offered by the Actor	0..1
has contact point	cmisa:hasContactPoint	vcard:Kind	This property associates the Actor with a contact point, modelled using vCard ontology to provide contact information	0..n
has generic catalog	cmisa:hasGenericCatalog	cmisa:GenericCatalog	This property links the Actor to a Generic Catalog that provides information related to the Actor	0..n
has sector	cmisa:hasSector	cmisa:Sector	This property associates the Actor with a Sector	0..n
has suborganization	org:hasSubOrganization	cmisa:Actor	This property represents hierarchical containment of Actors, and indicates an Actor which is a sub-part or child of this Actor	0..n

Property	URI	Range	Usage note	Cardinality
has technology	cmisa: hasTechnology	cmisa: Technology	This property links the Actor to activities that support technological innovation	0..n
homepage	foaf:homepage	rdfs:Resource	The URL of the homepage of the Actor. This property can have multiple values to allow for Actor's social links	0..n
identifier	org:identifier	rdfs:Literal	This property assigns an identifier for the Actor (a company registration number, a PIC number, etc.) that can be used to uniquely identify the Actor organization. The particular identifier scheme should be indicated by the datatype of the identifier value. Multiple identifiers are allowed for each Actor, if available	0..n
linked to	org:linkedTo	cmisa:Actor	This property links the Actor to another Actor, without specifying the type of relationship	0..n
location	locn:location	dct:Location	This property associates the Actor with its Location	0..1
member of	org:memberOf	cmisa:OrganizationalCollaboration	This property associates the Actor to an Organizational Collaboration he is a member of	0..n
suborganization of	org:subOrganizationOf	cmisa:Actor	This property represents hierarchical containment of Actors, indicates another Actor which contains this Actor	0..n
trl	cmisa:TRL	skos:Concept	The technology readiness level of the Actor. The possible values of this property are provided as a controlled vocabulary	0..n

Address

Mandatory properties for Address

Property	URI	Range	Usage note	Cardinality
full address	locn:fullAddress	rdfs:Literal	The complete address with or without formatting	1..1

Optional properties for Address

Property	URI	Range	Usage note	Cardinality
admit unit level 1	locn:adminUnitL1	rdfs:Literal	The region of the address, usually a county, state or other such area that typically encompasses several localities	0..1
admit unit level 2	locn:adminUnitL2	rdfs:Literal	The uppermost administrative unit for the address, almost always a country	0..1

Aggregation

Mandatory properties for Aggregation

Property	URI	Range	Usage note	Cardinality
has part	dct:hasPart	cmisa:Actor	This property associates the Aggregation with the Actor	1..1
platformActorAccessURL	cmisa:platformActorAccessURL	rdfs:Resource	This property is the URL to access the Actor information from the Aggregator Platform, e.g. the Actor "Antal Bejczy Center for Intelligent Robotics" KET Centre", has a foaf:homepage: http://irob.uni-obuda.hu/?q=en (URL of the actor itself) and cmisaplatformActorURL: https://ati.ec.europa.eu/technology-centre/antal-bejczy-center-intelligent-robotics, where more information about the actor can be found	1..1

Optional properties for Aggregation

Property	URI	Range	Usage note	Cardinality
identifier	dct:identifier	rdfs:Literal	A unique identifier assigned to the Actor by the Aggregator Platform	0..1

Aggregator Platform

Aggregator Platform is a sub-class of foaf:Agent.

Mandatory properties Aggregator Platform

Property	URI	Range	Usage note	Cardinality
aggregates	cmisa:aggregates	cmisa: Aggregation	This property associates the Aggregator Platform to the Aggregation class	1..n
description	dct:description	rdfs:Literal	A textual description of the Aggregator Platform. Multiple instances of this property can be used, i.e. one instance to provide the general description of the platform, another instance of the property to provide a description about the type of the Actors that are aggregated by the Aggregator Platform	1..n
name	foaf:name	rdfs:Literal	The name of the Aggregator Platform	1..n
platform URL	foaf:homepage	rdfs:Resource	This property refers to the URL of the Aggregator Platform	1..1

Optional properties for Aggregator Platform

Property	URI	Range	Usage note	Cardinality
identifier	dct:identifier	rdfs:Literal	This property specifies a unique identifier assigned to the Aggregator Platform	0..1

Property	URI	Range	Usage note	Cardinality
platform actor type	cmisa:platformActorType	rdfs:Literal	The type of the Actors that are aggregated by the Aggregator Platform	0..1

Catalog Attribute

Mandatory properties for Catalog Attribute

Property	URI	Range	Usage note	Cardinality
attribute value	cmisa:attributeValue	rfds:Literal	The value of the Catalog Attribute	1..1
name	dct:title	rdfs:Literal	The name of the Catalog Attribute	1..1

Optional properties for Catalog Attribute

Property	URI	Range	Usage note	Cardinality
description	dct:description	rdfs:Literal	The description of the Catalog Attribute	0..1
type	dct:type	Skos:Concept	The type of the Catalog Attribute, defined by a controlled vocabulary	0..1

Generic Catalog

Mandatory properties for Generic Catalog

Property	URI	Range	Usage note	Cardinality
name	dct:title	rdfs:Literal	The name of the Generic Catalog	1..n

Optional properties for Generic Catalog

Property	URI	Range	Usage note	Cardinality
description	dct:description	rdfs:Literal	The textual description of the Generic Catalog	0..n
has catalog attribute	cmisa:hasCatalogAttribute	cmisa:Catalog Attribute	This property associates the Generic Catalog with its attribute(s). A Generic Catalog may have multiple attributes	0..n
type	dct:type	skos:Concept	The type of the Generic Catalog provided by a controlled vocabulary (code list) modelled as a skos:Concept	0..n
value	cmisa:value	rdfs:Literal	The value of the Generic Catalog	0..n
Note: Although catalogValue and hasCatalogAttribute are both optional, one of the two should exist, otherwise there is no point of existence for the Generic Catalog				

Location

Optional properties for Location

Property	URI	Range	Usage note	Cardinality
address	locn:address	locn:Address	This property associates the Location with the address class	0..1

Property	URI	Range	Usage note	Cardinality
geographic identifier	rdfs:seeAlso	rdfs:Literal	This property allows a Location to be defined by a URI, such as a GeoNames or DBpedia URI	0..1
geographic name	locn:geographicName	rdfs:Literal	This property applies a proper noun to a spatial object, e.g. "DE", "Athens"	0..1
geometry	locn:geometry	rdfs:Literal	This property associates the Actor with the corresponding geometry	0..1
Note: Although all Location properties are optional, at least one should exist, otherwise there is no point of existence for the Location class				

Organizational Collaboration

This class is subclass of org:Organization.

Mandatory properties for Organizational Collaboration

Property	URI	Range	Usage note	Cardinality
has memebr	org:hasMember	cmisa:Actor	Indicates an Actor that is a member of the subject OrganizationalCollaboration. This is the inverse of org:memberOf	1..n
name	skos:prefLabel	rdfs:Literal	The name of the Organizational Collaboration	1..1

Optional properties for Organizational Collaboration

Property	URI	Range	Usage note	Cardinality
identifier	org:identifier	rdfs:Literal	This property provides an identifier for the Organizational Collaboration	0..n
classification	org:classification	skos:Concept	This property classifies the Organizational Collaboration according to its type, e.g. Project, Venture, Endeavour, Consortium, Alliance, Cluster, etc. (to be provided using a controlled vocabulary)	0..1

Sector

Mandatory properties for Sector

Property	URI	Range	Usage note	Cardinality
name	dct:title	rdfs:Literal	The name of the Sector	1..n

Optional properties for Sector

Property	URI	Range	Usage note	Cardinality
description	dct:description	rdfs:Literal	A textual description of the Sector	0..n

Property	URI	Range	Usage note	Cardinality
sector type	dct:type	skos:Concept	This property represents the industry or sector an Actor relates to or is intended for. For example: environment, safety, housing. The possible values for this property are provided as a controlled vocabulary. Several such vocabularies exist, however, the preferred choice for interoperability is NACE	0..1

Technology

Mandatory properties for Technology

Property	URI	Range	Usage note	Cardinality
name	dct:title	rdfs:Literal	The name of the Technology	1..n

Optional properties for Technology

Property	URI	Range	Usage note	Cardinality
description	dct:description	rdfs:Literal	A textual description of the Technology	0..n
technology type	dct:type	skos:Concept	The type of the Technology as described by a controlled vocabulary of the different technology fields	0..1

4. Controlled and Other Vocabularies

Descriptions of specific properties like the Actor classification, Sector type, Technology type, TRL, Generic Catalog type, Organizational Collaboration classification, etc., rely on controlled vocabularies.

Requirements for controlled vocabularies

The following is a list of requirements that were identified for the controlled vocabularies to be recommended or implemented for the CMISA specification.

Controlled vocabularies should:
- Be public and published under an open licence;
- Be maintained by an institution of the European Union, by a recognised standards organisation or another trusted organisation;
- Be properly documented;
- Have labels in multiple languages, ideally in all official languages of the European Union;
- Have terms that are identified by URIs with each URI resolving to documentation about the term;
- Have associated persistence and versioning policies.

Controlled vocabularies to be used

The use of the following controlled vocabularies for the properties listed in the specification is recommended. This will guarantee a minimum level of interoperability.

Property URI	Used in Class	Vocabulary name	Vocabulary URI	Usage note
org:classification	Actor	Generic Actor Categories - Multilevel List (GAC-ML), Direct Actor List (DAL)	http://data.europa.eu/cmisa/actor-types/multilevel http://data.europa.eu/cmisa/actor-types/direct	For instance, Research, Applied Research Supporting Actor, Industry, Business Association, etc. For Instance, Direct Actor, Parent organizations, etc.
org:classification	Organizational Collaboration	Actor Collaboration types	http://data.europa.eu.cmisa/Actor-Collaboration-types /1.0	Project, venture, endeavour, alliance, cluster
dct:type	Technology	The International Patent Classification (IPC)	https://www.wipo.int/classifications/ipc/ipcpub/?notion=scheme&version=20200101&symbol=A&menulang=en&lang=enfr&viewmode=h&fipcpc=no&showdeleted=no&indexes=yes&headings=yes&notes=no&direction=o2n&initial=A&cwid=none&tree=yes&searchmode=smart	ATI and DIH lists could be mapped to IPC taxonomy,
cmisa: TRL	Technology	TRL – List of Technology Readiness Levels	http://data.europa.eu/.cmisa/TRL/1.0	The Technology Readiness Level, as used by the H2020 programme: TRL 1 – basic principles observed TRL 2 – technology concept formulated TRL 3 – experimental proof of concept TRL 4 – technology validated in lab TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies) TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in case of key enabling technologies) TRL 7 – system prototype demonstration in operational environment TRL 8 – system complete and qualified TRL 9 – actual system proven in operational environment (competitive manufacturing in case of key enabling technologies; or in space)
dct:type	Sector	List of NACE codes	https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=LST_CLS_DLD&StrNom=NACE_REV2#l>	The list of NACE codes as provided by European Commission

Where a vocabulary is not already available as a SKOS concept scheme, best practice is to create one as part of the data set (or better still, use someone else's encoding of it). This should be considered, for instance, when a Generic Catalog is provided and its type needs to be specified.

In addition to the proposed vocabularies, which are mandatory to ensure minimal interoperability, users of the CMISA specification are encouraged to publish and to use further domain-specific vocabularies that are available online and serve to increase

interoperability across applications in the same domain. Examples are the EuroVoc[11], the CERIF standard vocabularies[12] and numerous other schemes.

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[11] http://eurovoc.europa.eu/
[12] https://www.eurocris.org/cerif/feature-tour/cerif-15

5. Future Considerations

The CMISA specification has evolved from its initial realisation during its pilot phase[13] to its current mature state within the scope of the *Collaborative Mapping of Innovation Supporting Actors* project. It is a robust semantic model that promotes Innovation Supporting Actors by facilitating data exchange, sharing and publishing.

Although the data model is considered final, there are some points for future consideration regarding the model extension, aiming to enrich the model usability and further improve discoverability of Innovation Supporting Actors. Such extensions are, but not limited to:

- addition of a property in Actor class to associate the actor to its visual identity, e.g logo;
- addition of explicit properties for social accounts of the Actors (they are currently supported by multiple instances of Actor's homepage);
- definition of new classes as explicit catalogs to accommodate specific information about the Actors (like the Sector and Technology classes that are currently available);
- identification or/and implementation of controlled vocabularies that will suit the scope of the CMISA data model and further ensure interoperability among its users.

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[13] https://ec.europa.eu/isa2/actions/improving-semantic-interoperability-european-egovernment-systems_en