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ONTO-DESIDE

DELIVERABLE

FAIR integrated ontology network - v.2

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PROJECT INFORMATION

Project summary

Circular economy aims at reducing value loss and avoiding waste, by circulating materials or product parts before they become waste. Today, lack of support for sharing data in a secure, quality assured, and automated way is one of the main obstacles that industry actors point to when creating new circular value networks. Together with using different terminologies and not having explicit definitions of the concepts that appear in data, this makes it very difficult to create new ecosystems of actors in Europe today. This project will address the core challenges of making decentralized data and information understandable and usable for humans as well as machines. The project will leverage open standards for semantic data interoperability in establishing a shared vocabulary (ontology network) for data documentation, as well as a decentralized digital platform that enables collaboration in a secure and privacy-preserving manner.

The project addresses several open research problems, including the development of ontologies that need to model a wide range of different materials and products, not only providing vertical interoperability but also horizontal interoperability, for cross-industry value networks. As well as transdisciplinary research on methods to find, analyze and assess new circular value chain configurations opened by considering resource, information, value and energy flows as an integral part of the same complex system. Three industry use cases, from radically different industry domains, act as drivers for the research and development activities, as well as test beds and demonstrators for the cross-industry applicability of the results. The developed solutions will allow for automation of planning, management, and execution of circular value networks, at a European scale, and beyond. The project thereby supports acceleration of the digital and green transitions, automating the discovery and formation of new collaborations in the circular economy.

Project start date and duration

1st of June 2022, 36 months

Project consortium

No	Partner	Abbreviation	Country
1	Linköping University	LIU	Sweden
2	Interuniversitair Micro-Electronica Centrum	IMEC	Belgium
3	Concular Ug Haftungsbeschrankt	CON	Germany
4	+Impakt Luxembourg Sarl	POS	Luxembourg
5	Circularise Bv	CIRC	The Netherlands
6	Universitaet Hamburg	UHAM	Germany
7	Circular.Fashion Ug (Haftungsbeschrankt)	FAS	Germany
8	Lindner Group Kg	LIN	Germany
9	Ragn-Sells Recycling Ab	RS	Sweden
10	Texon Italia Srl	TEXON	Italy
11	Rare Earths Industry Association	REIA	Belgium

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Abbreviations

Abbreviation	Explanation
CE	Circular Economy
CVN	Circular Value Network
Dx.x	Deliverable x.x
EMMO	Elementary Multiperspective Material Ontology
FAIR	Findability, Accessibility, Interoperability, and Reusability
ODP	Ontology Design Pattern
OGC	Open Geospatial Consortium
OWL	Web Ontology Language
URI	Uniform Resource Identifier
WP	Work Package
W3C	World Wide Web Consortium
XD	eXtreme Design Methodology

Summary

This deliverable describes the second prototype of the Onto-DESIDE ontology network, earlier introduced and motivated in D3.1 and first released in D3.3. The deliverable itself is the online ontology network[1], however, this short report summarises the main content, and contains the documentation and respective files of the network (v0.2 for any updated modules) in the appendix, for archival and review purposes.

The ontology network prototype consists of 9 ontology modules, i.e. small ontologies, that are connected through `owl:imports` or by referencing concepts from other modules. The work on preparing external alignments has been started, and in this release we include some initial alignment candidates to provide an overview of the landscape and alignment opportunities, while curated reusable alignments will be included in the following versions. For testing the core ontology network the modules have also been specialised to cover the domain-specific user stories of our three industry use cases, and evaluated with end-users and domain experts, which is the basis of some of the updates in v0.2.

[1] Available at https://w3id.org/CEON/

1 Introduction

Ontologies are a key enabler for semantic interoperability since they can provide formal definitions of concepts and their relations, for describing the data to be exchanged. The Onto-DESIDE project will develop a technology for allowing data sharing about materials, components, and products, as well as actors, capabilities and processes, as part of circular value networks (CVNs), at a global scale and across industry domains. Metadata and structures for transforming data into information (semantic descriptions, vocabularies) will be open, and comply with FAIR principles (Findability, Accessibility, Interoperability, and Reusability), to enable the highest possible degree of semantic interoperability and automation in data sharing.

This document describes the ontology deliverable D3.4 (deliverable type OTHER, second version of D3.3), which is published publicly on GitHub[2], and that provides the foundations of the necessary core ontologies to enable semantic interoperability. This document describes the second version of the deliverable, presenting the second prototype versions of the ontologies, that will be evaluated and tested in the remainder of the second project iteration, while the following version (D3.5, and further releases) will present further changes, updates and extensions to this ontology network. This concretely means that the deliverable reports ongoing work in our second project iteration, and that both ontology requirements and ontology modules themselves are to be considered as preliminary, since they are not fully validated by end-users and domain experts yet, and not fully aligned with emerging standards and external ontologies. The focus is also primarily on the core modules, i.e. general cross-domain concepts, rather than on concrete concepts for our use cases. The latter will be developed in the context of WP6, but are to be seen as test cases for verifying the usability and applicability of the ontology network.

2 Ontology Network

The main content of this deliverable is the ontology network itself, but here we give a brief textual overview of the outline and content of the network.

2.1 Methodology

As presented in D3.1, we rely on an agile ontology development methodology, inspired by eXtreme Design (XD) [1]. This methodology supports an agile work process, suitable for the three iterations of the project, where requirements and solutions will evolve and emerge incrementally. The basis of the ontology development, is a set of stories, exemplifying and detailing the intended use of the ontologies. These are then transformed into ontology requirements, e.g. Competency Questions (CQs) [7] and other requirements, and thereafter formally represented in an ontology language, in our case OWL[3]. This methodology emphasizes highly modular ontologies, i.e. both for separation of concerns but also as a way to allow for modelling certain aspects without having the full picture of the requirements at hand, which is the case in our project. Further, the notion of Ontology Design Patterns (ODP) [2, 5] is used to here denote small, highly generic, ontology modules, that will be reusable across all industry domain, and which constitute the shared core design decisions of the ontology network. For further methodological details, and the full list of requirements, see D3.1 and subsequent versions of that deliverable.

2.2 Outline of the Ontology Network

The requirements analysis presented in D3.1 resulted in a quite extensive set of ontological requirements, i.e. 55 ontology stories resulting from the analysis of D2.1 (and D6.1) and 17 stories resulting from the analysis of the circular value network (CVN) concept itself and its definitions in standards and usage in D6.1 and D2.1. Many of

[2]With the permanent URI https://w3id.org/CEON/
[3]https://www.w3.org/OWL/

them are use case-specific, in terms of involving specific concepts of an industry domain. Still, many of them can also be generalised, and we note that there are many parallels between the three project use cases. Consider that all these requirements still have to be validated with the end-user partners of the project, e.g. in the context of the next version of the deliverable and in general in WP6, hence also the set of requirements is to be considered preliminary.

In the first and second project iteration we have focused on identifying the core topics that need to be covered by ontology modules, using this set of initial requirements, and to update the models based on initial feedback from the use cases. An overview of the included topics (refined version of the initial image in D3.1), in the form of an informal conceptual model is displayed in Figure 1. Note that the boxes do not represent single concepts in an ontology, but rather areas, i.e. topics, that should be covered by some ontology module. The dark blue boxes and ovals represent the 9 modules that are included in this release (i.e. D3.4), in some form. The lines between the boxes represent some common sense relations between the topics, and are in the actual implementation of the ontology network replaced by formal relations between modules, e.g. in some cases `owl:imports`, as well as some other alignments, reuse of concepts between modules, or specific object properties connecting concepts inside the modules. The light blue box with the text "location" represents an important notion that is present in many of the requirement stories, namely spatial locations of things, e.g., resources or actors. However, for this specific topic, we do not release our own module, but rather rely on reusing concepts from standard geographical ontologies, such as W3C standards and the OGC standard GeoSPARQL.

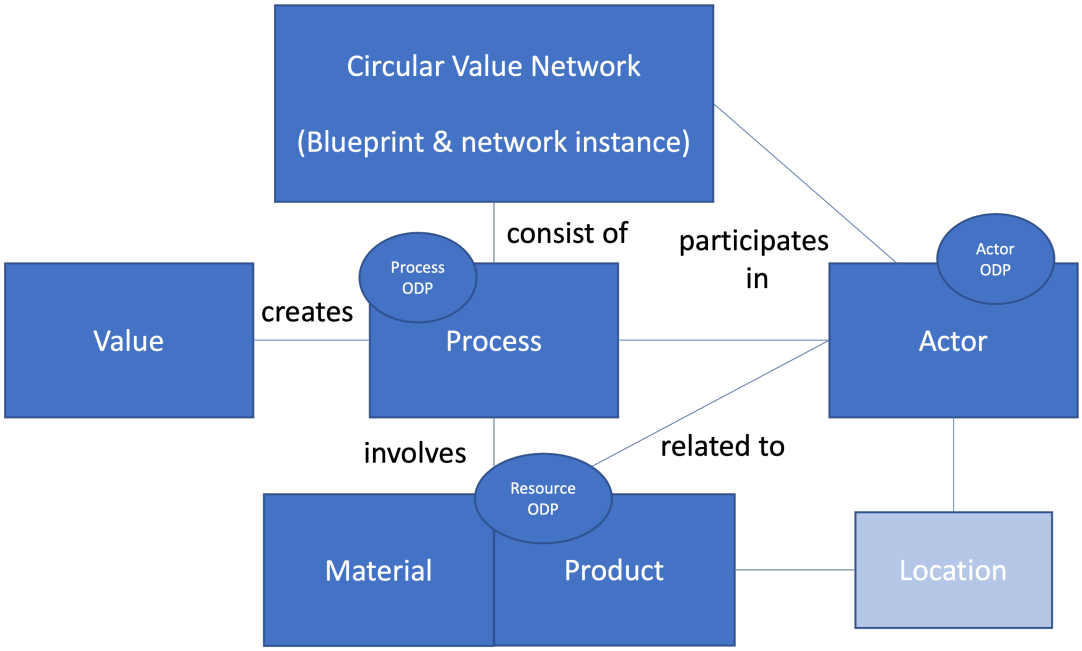

Figure 1: Informal illustration of the core topics of the ontology network.

2.3 Core Cross-Domain Topics

In this section we provide a brief description of the set of core modules, already identified for D3.3, that have been created, as generic reusable ontology building blocks, as illustrated in Figure 1. The actual modules can be found in our GitHub repository[4] and in the appendix of this document. The topics include:

- Circular Value Network
- Value

[4] http://w3id.org/CEON

- Actor
- Process
- Resource

2.3.1 Circular Value Network

This topic is in the current version of the network represented by one module, which details the core concept of the ontology network, i.e. the Circular Value Network (CVN) itself. The value network works according to a blueprint, which describes the planned setup, with needed functions in the network possible to fill by certain actor types, types of circular strategies targeted (e.g. refurbishment of a product), and relations to typical value propositions and goals. However, we also want to be able to model the concrete instance of the blueprint, i.e. an actual value network where the roles are filled by various actors of the appropriate types, with a specific goal, and specific value proposition (and value created) in mind.

Our starting point for this module was an analysis of several terminologies, ontologies, and emerging standards, c.f. D3.1, including the emerging standards in ISO 59004, the Circularity Thinking methodology, as well as a generalisation over the project use cases and requirements in D6.1 and D2.1. The CVN module refers to concepts both in the actor, process and resources modules.

2.3.2 Value

Although value is a very central concept in the Circular Economy (CE), and closely related to the circular value network through its value proposition, value is also a very hard concept to define. Following the discussions on the value concept that is currently ongoing in other fora, e.g. including standardisation bodies and our WP5, the concept will for now be left as a "stub" for further definition and extension in later versions of our ontology network. Hence, we reserve a specific module for this concept, but it is not further detailed in this version of the ontology network.

2.3.3 Actor

A circular value network is in essence composed of a set of actors filling certain roles in different phases of the network's flows, and in relation to certain resources. Hence, the actors are the ones that actually realise the value network, and perform the work to transform materials, components, and products in the various steps in the value network phases. Similar to the value network itself, also actors can be modelled at two levels, i.e. as actor types that can fill certain typical roles in a network, such as a "recycler" or "manufacturer", and the concrete actors, that are usually organisations, that take on those roles in a specific network instantiation. Actors are also related to their capabilities and competencies, which determines if they are able to fulfil a certain role in a network or not. Further, actors take on various roles in relation to resources, e.g. holding certain resources, owning them, selling them, buying them etc.

The modeling of this topic is done at two levels in the ontology network, i.e. one actor ODP, which holds the most general concepts that are essentially independent of any industry domain, or circular strategy, and an actor module that specialises that ODP and includes CVN-specific concepts, as well as specific roles in relation to circular strategies. These modules refer to concepts in the process and resource ODPs.

2.3.4 Process

Each circular value network realises one or more circular value flows, which can be seen as a process of transforming some resource, e.g. from materials, to components, into products, and then potentially back again. Such processes have different phases, e.g. the phase that takes something from materials to components, or the phase of

deconstructing a product into its material composition, and each phase can further be subdivided into smaller steps (pieces of work), which can be performed by different actors. However, at this point we chose to simply model all this at the level of processes and sub-processes. Each step may then also have inputs and outputs, both in terms of resources, but also work, energy, and information, for instance, and may result in some waste, i.e. transforming something for a certain state of affairs (situation) to another state of affairs (situation). Steps can be performed by actors, i.e. participants in the value network, with the right capabilities. For these aspects, many existing ontologies exist, and the module(s) for this topic will mainly act as a bridge, for in the future aligning to such existing models for allowing their integration into the network.

The current realisation of this topic consists of one process ODP, specifying the generic concepts involved in process modelling, and a process module as a specialisation of that, for including the CVN-specific processes that are targeted in the project. The process modules refer to concepts in the actor and resource ODPs.

2.3.5 Resource

Resources are at the core of the value network, since they are the things that are needed as input and output of each step. Most prominently the resources are the materials, components, and products that the network aims to manage circularly, but resources can also include the additional materials needed for processing, such as consumables or catalysts, the work and investments needed. Similarly to the case of processes, much work already exist in modelling both products and materials, and their relations, hence this topic again mainly acts as a small set of general bridge modules, to be able to properly align to other ontologies in the future.

This part of the network is realised through a generic resource ODP, which is then specialised into two modules, i.e. one modelling materials and one modelling products and components. The materials module is modelled in the same style as the EMMO core ontology for materials modelling, although at the moment we do not provide a concrete alignments module (this is still future work, but see also the alignment section of this report).

3 FAIR Ontology Publishing

Once ontologies have been modelled, they also need to be shared with the community. In order to actually be useful, they need to be both findable, accessible, interpretable and interoperable with standards and other ontologies, as well as highly reusable. In general, this holds for all scientific results and artefacts, but perhaps specifically for ontologies, that are supposed to act as mediators and provide semantic interoperability in a domain. To guide and support the sharing of scientific results in general, and artefacts in particular, the FAIR principles were proposed [14]. The ontologies developed by the project are published according to the FAIR principles. However, recent analyses by several researchers and projects [12, 10, 3, 8] come to the conclusion that there are different ways to fulfil the FAIR principles, and it is not always clear exactly what is the best solution. Still, many of the principles are quite naturally fulfilled simply by the fact that we rely on Web technologies, e.g. the ontology language OWL which is based on Web standards, and use URIs as unique identifiers. In this section we therefore discuss what aspects are important to take into account, as well as outline some specific methodological practices for the project.

3.1 Ontology Design Guidelines

In order to allow for a good design and representation of our ontologies, we have set up a number of concrete design guidelines for the project. These include:

- URI:s – Each ontology should have a unique and resolvable URI, using the stable URI namespace of the project. Ontology modules are collected under the sub-path `https://w3id.org/CEON/ontology/`.

- Versioning – Each ontology module has a version IRI that includes a version number, but the ontology URI always leads to the latest version.
- Naming conventions – Local names (in terms of URI suffixes) are created using the camel notation, where classes start with a capital letter, and properties with a lower case letter.
- Labels – Every entity in the ontology modules should have a label (using `rdfs:label`), at least in English.
- Documentation – The ontology modules themselves are documented using a set of annotation properties, including `dc:creator` etc., and `rdfs:comment` is used to document all the elements inside the ontology (in terms of natural language definitions and explanations in English).

Changes to the ontologies are managed through issues and branching in the underlying GitHub repository where the ontologies are stored.

3.2 Publishing Pipeline

The development of the ontology network will entail multiple inter-dependent ontologies, several of which will go though multiple development iterations. In order to keep track of such changes, we are using a GitHub[5] repository to handle versioning and to create new releases. Proper ontology versioning ensures both consistency and predictability over time, since any reference to a specific version of the ontology will remain valid.

The w3id service is used to provide permanent identifiers for the ontologies, all of which are aligned with the ontology releases. This provides a way of decoupling the identifiers used from any specific domain name or publishing platform, thus providing resilience in the long term, and the identifiers can be redirected as needed. Additionally, the w3id service can be used to support some aspects of content negotiation, allowing the ontologies to be made available according to the requirements of the user (e.g. Turtle files when access by an application, human-readable documentation when accessed via a browser).

Documentation is an important aspect when it comes to making ontologies both accessible and understandable. However, creating such documentation can be both labor intensive and time-consuming. In order to streamline this process, the project leverages pyLODE[6] for generating web-friendly documentation directly from the ontology files, thus removing the need for manually creating such content. Additionally, we employ OWL2VOWL[7] and WebVOWL[8] to generate interactive visualizations, providing an easy to understand overview of each ontology. These tools are all available open-source under the MIT licence and will be combined into a pipeline that allows ontology documentation to be generated automatically, ensuring that the documentation always remains up to date.

4 Ontology Evaluation Summary

In this section, we briefly summarise the findings from the ontology evaluation conducted during the project evaluation phase, and reported in D6.7. In addition, we comment on how the areas of improvement have been addressed, and what is left for future work, or in some cases deliberately left undefined for flexibility reasons.

4.1 Ontology Evaluation Method

First of all, applying an ontology in a concrete use case is often the best evaluation method, where both errors and misconceptions can be found, and the effectiveness of the ontology assessed. Hence the main evaluation of

[5] https://github.com/LiUSemWeb/CEON/
[6] https://github.com/RDFLib/pyLODE
[7] https://github.com/VisualDataWeb/OWL2VOWL
[8] https://github.com/VisualDataWeb/WebVOWL

the ontology network constitutes applying it in our project use cases, together with the data sharing platform, and gathering feedback and observations from there. When it comes to the ontologies, applying them in the use cases mainly involves modelling the concrete use case-specific data (e.g. from D6.4), being able to formulate appropriate queries on the data, supporting the user stories and other requirements. For this purpose, a set of use case-specific ontologies were built, i.e., one per use case[9], as test cases for ontology application. While building these ontologies, a number of minor issues and missing concepts were identified in the core ontology modules, which were added to, or modified in, the core modules. In addition, a set of intermediate modules, mainly with reused concepts from other generic ontologies were also added to the network[10], to connect the highly generic core modules presented here, to use case specific concepts.

After testing the ability to specialise the ontologies for the use case data and requirements, we also conducted a more technical evaluation, including requirements validation and verification. As described in D6.7, ontology characteristics and consistency was assessed using Protégé, reasoner plugins (such as the HermiT reasoner), and manual inspection of inferred axioms. The purpose was to identify inconsistencies in the ontologies, and to provide input for updates to the ontology.

Next, the OOPS! [13] and FOOPS! [6] validators were used to detect potential violations of best practices in ontology modelling and publishing. The generated reports provided feedback on a range of design aspects. In some scenarios, however, a conscious design decision can lead to an error or warning being reported, such as when the domain or range of a property is deliberately left undefined, or when inverse relations and disjointess is deliberately left out in order to increase flexibility and reduce computational complexity of reasoning. Hence, the results from these validators are to be used mainly as guidance, rather than as an absolute list of issues to correct.

Another (non-user focused) evaluation was the verification of ontological requirements using SPARQL queries. That is, formulating the CQs presented in D3.1 related to each ontology module as a SPARQL query using the ontology vocabulary. When the modules were developed a set of CQs were intended to be covered by each one, and they were included as annotations into the module itself. During the evaluation, we tested each module by trying formulate a SPARQL query for each of the CQs claimed to be covered by the modules.

Finally, to also involve end-users in the evaluation, an ontology workshop and a small online survey were also conducted to gather feedback from the Onto-DESIDE use case partners with respect to the impression of the use cases on certain modelling choices. The survey included a number of examples illustrating the use of the ontology modules to model several use case specific sets of information, related to the evaluation scenarios set out in D6.7, i.e. in the construction, electronics, and textile use cases respectively. While we acknowledge that the ontologies should not be seen as "user-facing tools", hence the evaluation did not consider usability or understandability, it is important to detect potential misconceptions by the ontology engineers in modelling the use case data. Hence, the purpose here was to verify that the requirements as well as the data templates from D6.4 had been correctly interpreted, and that no major aspects had been missed. See D6.7 for further details on the ontology evaluation method.

4.2 Ontology Evaluation Results

Here we briefly summarise the evaluation results, both some general observations from building the use case specific ontologies and the technical and user-based evaluations already presented in detail in D6.7, to remind the reader of the starting point of the work on this new version of the ontology network.

When specialising the ontology network to represent the concrete data outlined in D6.4, a few notions were identified that were missing in the first release of the core ontology modules. Such notions include quantities and units, provenance, and detailed modelling of information, such as the notions of statements and datasheets. In addition, the distinction between a product as an abstract concept, i.e. actually the model of product such as an "iPhone 13 mini", its concrete realisation as a physical object, i.e. an item representing an instance of that product model, as

[9] See the table at the bottom of the CEON landing page at w3id.org/CEON/

[10] See the middle table on the CEON landing page at w3id.org/CEON/, named "Other modules".

well as batches of objects, such as the set of iPhone 13 mini phones in a certain shipment, or a pallet of floor tiles, were identified as missing notions in the first ontology release. However, no problems were otherwise found in reusing the core modules.

Regarding the technical evaluation, no inconsistencies nor unexpected inferences were detected when applying reasoners to the ontology modules and going through the list of inferred axioms manually. While this does not necessarily imply that there are no semantic defects in the ontology, at least they are formally correct. Hence, there were no issues from this evaluation that had to be addressed in the ontologies.

The reports generated by the OOPS! validator categorise problems as minor, important, or critical. The reports generated by FOOPS! on the other hand provide a summary of the proportion of tests passed, and lists detected errors. In the evaluation reports, all of the findings from these tools were included, regardless of whether they should be interpreted as errors or merely as observations that may need careful consideration. The reports were summarized in D6.7 but then also included in a set of GitHub issues related to the specific ontology modules in our repository. In this way, the evaluation results were used as a checklist for the ontology updates, while not all of them would be addressed in the end, since some issues are are also triggered based on things that are conscious design choices. Still, quite a few issues were detected, and in the next section we report on how these types of issues have been addressed.

Regarding the testing of ontology modules with SPARQL queries, a set of only partially covered CQs were detected. Mostly this is due to that the generic ODPs and core modules were annotated to solve CQs that were expressed in a more concrete way, so that the module actually did not include the specific concepts mentioned in the CQ, but where one could infer through common sense that probably those would be possible subclasses of the included concepts. For instance, such a case could be a CQ mentioning the “product” concept, while the resourceODP only includes the notion of a resource, not the concrete notion of a product, while it can be assumed that a product could be considered to be a resource. In this way we exposed an ambiguity in what is actually meant with addressing a CQ, i.e. whether the concrete terms in the CQ have to be present in the ontology module or not, for considering it to be covered. Another common reason for partial coverage was due to the modularisation of the ontology network, where in several cases concepts are defined in different modules, and hence a CQ that mentions one concept from one module and a second one from another module, would not be considered completely covered by either module, but using the ontology network as a whole the CQ is addressed. This raises the need for also performing integration testing, and potentially even providing an integration module for using (and testing) all modules together, which was not done in the first project iteration. Only a few CQs were identified to be completely uncovered by the modules, and in most of these cases we identify this as an erroneous annotation, rather than as a missing implementation (while the implementation is certainly part of future work).

Based on the feedback from the survey and the workshop, a few concrete points were identified, and added as comments to the module specific GitHub issues mentioned previously. More general feedback was also used to create specific issues related to, for example, naming conventions and documentation. In addition, a few common themes were identified and picked up for discussion specifically. These include the modelling of roles, and how different requirements on role modelling from different use cases could be captured in a flexible way, e.g. roles being context-specific or not etc. Another such general theme was the granularity needed for data provenance and frequency and need for tracking changes. For these general themes, a continuous discussion with the use cases were initiated, and culminated in another workshop discussion held at the consortium meeting in March 2024.

4.3 Main Changes Implemented

Here we provide a summary of the issues that have been addressed as part of the most recent version of the ontology modules (2024-03-29). We conclude the section with a brief overview of the issues that have not been addressed in the current version.

The missing notions that were found when building the use case specific ontology modules for demonstration and testing were added continuously as they were identified. However, a question arose what to add to the core ontology

network modules, and what to keep separate. As a general principle, we have not added large portions of concepts and relations that are already standardised and/or modelled elsewhere. Take as an example the provenance notion. This is already modelled by the W3C standard PROV-O[11], and it is not necessary for us to model these notions from scratch. Also the notion of provenance, while important in many cases, is not a central core concept of the Circular Economy (CE). Hence, we chose to create a separate provenance module, importing PROV-O and connecting it to our ontology network, but this is not (at this point) included as a core module in our ontology network, but merely available as an additional (optional) module. Mainly used for the use case specific modelling of data. In a similar way we have included parts of the QUDT ontologies[12], e.g. regarding quantities and units, as separate modules, but not as part of the core module network. Also, the notion of a datasheet was needed for modelling the D6.4 data, whereby such a module was created, but outside the core ontology network, for the time being.

Nevertheless, some notions were deemed to be central enough to the CE, to be included into the core modules. One such example is the *product model - concrete product - batch of products* (product - item - batch) distinction, which was incorporated into the resource ODP and the product modules respectively. More concepts from what is currently considered outside the core ontology network might be incorporated into it in the future, e.g. for upcoming ontology releases, but at the moment we maintain the three sets of ontologies, namely the core ontology network modules, additional general modules, and use case-specific demo ontologies[13] separately.

Moving to the technical evaluation of the core ontology network. In Table 1 we summarise the reported errors from OOPS! and FOOPS! and describe how they have been addressed. Since the ontologies are still under development some of the issues cannot yet be addressed (e.g. registering the ontologies in various online catalogues will be done when a first stable version is released at the end of the project).

In response to the requirements verification using SPARQL queries, no new concepts were added at this point but a revision was made regarding the annotations of the ontology modules. Hence, only including the correct set of requirements that are actually covered at this stage, but allowing for the partially covered CQs that are covered by using several modules together. In appendix A we include a list of the total set of requirements from D3.1 and show whether they are currently covered or not by the ontology network. While this is showing that not all requirements are covered, it is in line with the prioritisation made by WP6, i.e. through the data delivered in D6.4 and the evaluation scenarios chosen for the first project iteration (c.f. D6.7). Additionally, the intention is not to cover all requirements by building new models, but rather provide bridges for alignments and integration of existing ontologies. For instance, detailed process and task modelling is most likely out of scope of CEON, since existing ontologies already cover this area. This discussion will be revisited in our next requirements update, i.e. in D3.2. Instead we conclude that the focus is so far on the parts that (1) have been noted to be missing when surveying existing ontologies, and (2) represent requirements originating from the use cases where a generalisation can be made across industry domains, which is the focus of the project objectives.

The results from the use-case focused evaluation did not so far provide any input for concrete changes or updates in the ontology modules, instead they have provided a number of themes for future exploration, which will be explored together with the use cases in the coming months. An example is the modelling of roles, where the ontological requirements regarding roles will now be updated (for D3.2 due in May 2024) in accordance with the feedback and discussions, but also with respect to the new project requirements, including priorities, included in D2.2 that was recently released. Starting from those updated requirements, the next ontology release in D3.5 will include further details on this aspect. Similarly for the provenance and version tracking issues discussed.

[11] https://www.w3.org/TR/prov-o/

[12] https://qudt.org/

[13] It is important to note that the release in this deliverable only consists of the core ontology network, while the other modules are considered as supporting material for use case evaluation. However, parts of the additional modules might be promoted to be part of the network in the future. This distinction is also reflected on the CEON landing page: http://w3id.org/CEON/

Table 1: Summary of errors reported by the OOPS! and FOOPS! validators and how they have been addressed.

Reported issue	Comment
Version IRI not resolvable	Valid version IRI now provided for all ontology modules.
Inconsistent ontology IDs	Corrected for affected ontology modules.
Prefix not found in prefix.cc nor LOV registries	Not addressed (Ontology has not yet been released.)
Ontology not found in LOV registries	Not addressed (Ontology has not yet been released.)
Metadata not accessible in LOV registries	Not addressed (Ontology has not yet been released.)
Missing parts of recommended metadata	Added where applicable for all ontology modules.
Missing detailed metadata	Added for all ontology modules (where applicable).
Missing documentation labels	`rdfs:label` provided for all classes and properties.
Missing documentation comments	`rdfs:comment` provided for all classes and properties.
License is not resolvable	Resolvable link to license now provided for all modules.
Detailed provenance metadata missing	Added where applicable, but ontology not yet released.
Unconnected ontology elements	Addressed for all ontology modules.
Missing domain or range in properties	Updated but some are left unspecified by design.
Multiple domains or ranges defined for properties	Corrected for all ontology modules.
Missing disjointness	Commonly left out for flexibility, addressed where applicable.
Inverse relationships not explicitly declared	Commonly left out for reduced complexity.
Ambiguous namespace	Corrected for all ontology modules.
Check vocabulary reuse	Alignment addressed separately (see Section 5).

5 Ontology Alignment

To enhance the interoperability and knowledge exchange among relevant ontologies in the Circular Economy domain, we conduct experiments of aligning relevant ontologies. These relevant ontologies cover the ones surveyed in our prior work [11], and include newcomers after the previous survey was published, and the top-level ontology, EMMO (Elementary Multiperspective Material Ontology)[14]. Therefore, we have 6 CE-related ontologies, a number of domain-specific ontologies (5 for sustainability, 13 for materials, 14 for manufacturing, 9 for products, and 8 for logistics) and 1 top-level ontology (EMMO) to conduct ontology matching tasks. We establish three ontology matching tasks. They are (a): producing alignments among CE-specific ontologies, (b): producing alignments between CEON and industry domain-specific ontologies, and (c): producing alignments between CEON and top-level ontologies (e.g., EMMO). Furthermore, we set up a three-step pipeline to generate alignments. The first step is **matching** ontologies based on three existing matching systems, which are AML [4], LogMap [9], and AMD [15]. Another main step is **validation and/or manually matching** in which users validate candidate mappings or manually create new ones. While **Task a** and **Task b**, start from the first step, we use our prior experience in aligning MDO and EMMO, and start **Task c** from the manually matching step. The final step is alignments publishing and maintaining. The initial alignment results are published at a GitHub repository[15].

[14] https://github.com/emmo-repo/EMMO
[15] https://github.com/LiUSemWeb/Circular-Economy-Ontology-Catalogue/tree/main/alignments

6 Concluding Remarks and Future Work

The current state of the repository, constituting the deliverable 3.4, consist of 9 core ontology modules (where three of them are considered to be generic ODPs). All are published online in our ontology catalogue, including human-friendly documentation generated automatically from the ontology files, and versioned through GitHub. This second release has undergone a first evaluation cycle, and has been subsequently updated. It constitutes the starting point for further ontology development in the context of WP6, i.e. specialising these ontology modules for the three domain-specific use cases respectively, and for describing the data to be included in the research dataset of WP6. It should be noted that additional ontology modules have also been developed that are not part of the core ontology network. This includes modules reusing external ontologies, such as PROV-O and QUDT, as well as modules modelling notions specific to the use case data in D6.4. While some notions from these modules may be included into the core ontology network in future releases, for the time being they are being kept separate, and are not part of this release although they can be found in the GitHub repository.

Additionally, both the ontological requirements, and their realisation as ontology modules, will be further evaluated by end-users and domain-experts, whereby we consider this not as the final release. One part of such evaluation is their use in WP6, where the second evaluation cycle will take place in a few months, and will result in feedback on their suitability, coverage and usability. In addition, we will evaluate the set of ontology stories together with end-user partners in the project. In this way, the next version of D3.1 (i.e. D3.2) will also consist of updated ontological requirements, to be taken into account in the future releases (e.g. D3.5). Consequently, any use of the ontologies that are published currently should be done with care, since breaking changes may occur in the next version of the ontology network. Stable and production-ready versions of the ontologies are not envisioned until the final release at the end of the project.

Further next steps include to develop further alignment modules, consisting of alignments to the most prominent ontologies discovered in the ontology survey presented in D3.1 (and to be updated in D3.2). This can be seen both as an important way of increasing the reusability of the ontologies, as well as a part of the validation of the ontologies, i.e. making sure that they are aligned with existing ontologies, but also with emerging standards etc. So far we have studied the landscape of existing ontologies and standards (c.f. also D2.7), and made a preliminary ontology alignment pipeline setup, that generated a set of candidate alignments that will then be studied and curated, to arrive at a set of alignment modules to be released with the ontology network.

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Appendices

In this appendix we first provide the list of requirements and their coverage in the current ontology network, then some snapshot images of the VOWL visualisations of the ODPs and ontology modules that are available online. For interactive and up-to-date visualisations we refer the reader to the respective documentation pages linked from http://w3id.org/CEON/. Further we provide the documentation for the latest version of each ODP and ontology module.

A Requirements Coverage

In Table 2 we provide an overview of the current coverage of requirements in this release of the ontology network. Complete coverage (green) indicates that the mentioned concepts are directly modelled by the ontology network, and that the CQ can be answered, e.g., by formulating an appropriate SPARQL query. Indirect coverage (yellow) indicates that the exact concepts and relations are not present in the core modules, but that more general ones are included, thus facilitating the specialisation of those core modules to cover the concrete concepts and relations mentioned, for instance, in one of the use case-specific ontologies. Partial coverage (orange) indicates that only some aspects are currently modelled, and some parts are still missing and/or are not intended to be included in the core modules but are specific to an industry domain. White colour indicates CQs that have not yet been modelled, for instance since they may be considered out of scope of the project given the priorities set by the overall project requirements in WP2, or because they are industry specific. However, this may still change, due to changes in requirements before the third project iteration. The prioritisation of the ontological requirements has been made on the basis of the priorities of the overall project requirements, as well as guided by the evaluation scenarios set up by the three project use cases.

Table 2: Ontological requirements for modelling Circular Value Networks, as listed in D3.1. Colors indicate whether the requirements are covered (green), indirectly covered (yellow), partly covered (orange) or not covered (white), by the current ontology network.

ID (CVN)	ID (Construction)	ID (Electronics)	ID (Textile)
CVN-CVN-1	C0-1	E1-1	T1-1
CVN-CVN-2	C0-2	E1-2	T1-2
CVN-CVN-3	C1-1	E1-3	T2-1
CVN-CVN-4	C1-2	E1-4	T2-2
CVN-CVN-5	C1-3	E1-5	T2-3
CVN-CVN-6	C2-1	E1-6	T2-4
CVN-Proc-1	C2-2	E1-7	T2-5
CVN-Proc-2	C2-3	E1-8	T3-1
CVN-Proc-3	C2-4	E1-9	T3-2
CVN-Proc-4	C3-1	E1-10	T3-3
CVN-Proc-5	C3-2	E1-11	T3-4
CVN-VP-1	C3-3	E1-12	T3-5
CVN-VP-2	C3-4	E1-13	T4-1
CVN-VP-3	C3-5	E1-14	T4-2
CVN-VP-4	C3-6	E1-15	T4-3
CVN-Res-1	C3-7	E2-1	T4-4
CVN-Res-2	C3-8	E2-2	T4-5
CVN-Res-3	C3-9	E2-3	T5-1
CVN-Res-4	C4-1	E2-4	T6-1
CVN-Ph-1	C4-2	E2-5	T7-1
CVN-Ph-2	C4-3	E2-6	T8-1
CVN-Ph-3	C4-4	E2-7	T8-2
CVN-Ph-4	C4-5	E2-8	T8-3
CVN-Ph-5	C4-6	E2-9	T9-1
CVN-Wo-1	C4-7	E2-10	T9-2

CVN-Wo-2	C4-8	E3-1	T10-1
CVN-Wo-3	C4-9	E3-2	T10-2
CVN-Wo-4	C4-10	E3-3	T10-3
CVN-Wo-5	C5-1	E3-4	T10-4
CVN-Wo-6	C5-2	E3-5	T14-1
CVN-Wo-7	C6-1	E3-6	T15-1
CVN-Wo-8	C6-2	E3-7	T18-1
CVN-Wo-9	C6-3	E3-8	T19-1
CVN-Ac-1	C6-4	E4-1	T20-1
CVN-Ac-2	C7-1	E4-2	T21-1
CVN-Ac-3	C7-2	E4-3	T23-1
CVN-Ac-4	C7-3	E4-4	
CVN-Ac-5	C7-4	E4-5	
CVN-Ac-6	C7-5	E4-6	
CVN-Ac-7	C7-6	E4-7	
CVN-Co-1	C8-1	E4-8	
CVN-Co-2	C8-2	E4-9	
CVN-Co-3	C8-3	E4-10	
CVN-Co-4	C8-4	E4-11	
CVN-Co-5	C9-1	E5-1	
CVN-Co-6	C9-2	E5-2	
CVN-Co-7	C9-3	E5-3	
CVN-Co-8	C9-4	E5-4	
CVN-Co-9	C10-1	E5-5	
CVN-Ty-1	C10-2	E5-6	
CVN-Ty-2	C10-3	E5-7	
CVN-Ty-3	C10-4	E6-1	
CVN-In-1	C11-1	E6-2	
CVN-In-2	C11-2	E6-3	
CVN-In-3	C11-3	E6-4	
CVN-In-4	C12-1	E6-5	
CVN-Out-1	C12-2	E6-6	
CVN-Out-2	C12-3	E6-7	
CVN-Out-3	C13-1		
CVN-Out-4	C13-2		
CVN-Inf-1	C13-3		
CVN-Inf-2	C13-4		
CVN-Inf-3	C13-5		
CVN-Inf-4	C13-6		
CVN-Infr-1	C13-7		
CVN-Infr-2	C13-8		
CVN-Infr-3	C13-9		
CVN-Cal-1	C13-10		
CVN-Cal-2			
CVN-RT-1			
CVN-RT-2			
CVN-RT-3			
CVN-RT-4			
CVN-Comp-1			
CVN-Comp-2			
CVN-VT-1			
CVN-VT-2			
CVN-VT-3			

B Module Illustrations

Below, in Figures 2 to 10 we illustrate the content of the 9 core modules, using the visual notation of WebVOWL. The same illustrations are available in an interactive clickable manner from the documentation page of each module.

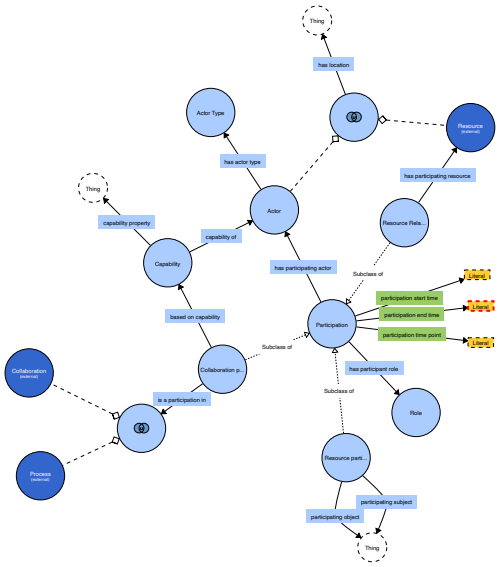

Figure 2: VOWL visualisation of the actor ODP.

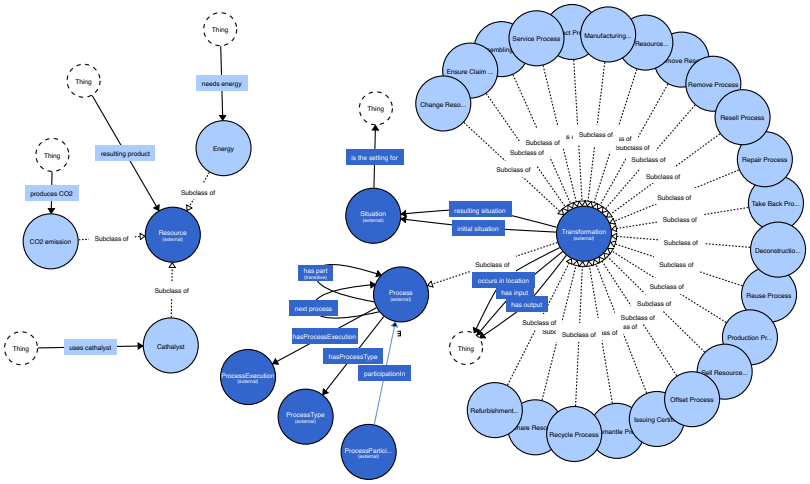

Figure 3: VOWL visualisation of the process ODP.

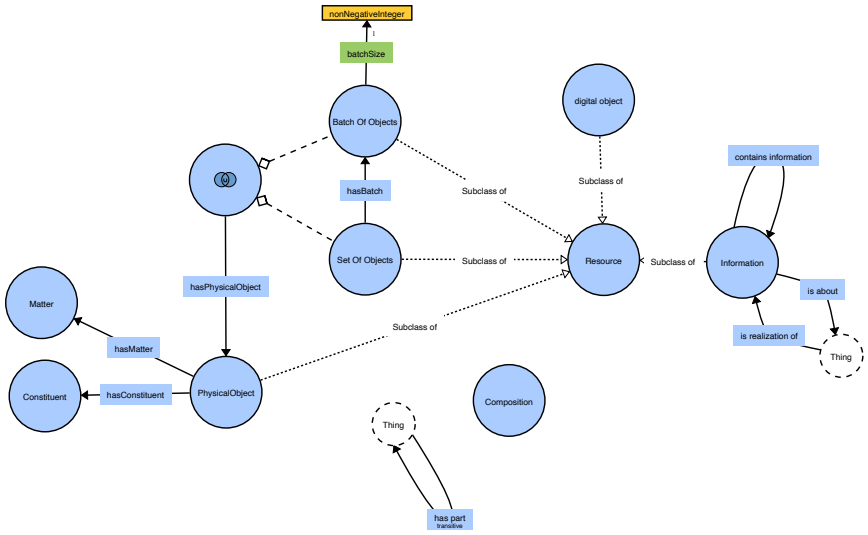

Figure 4: VOWL visualisation of the resource ODP.

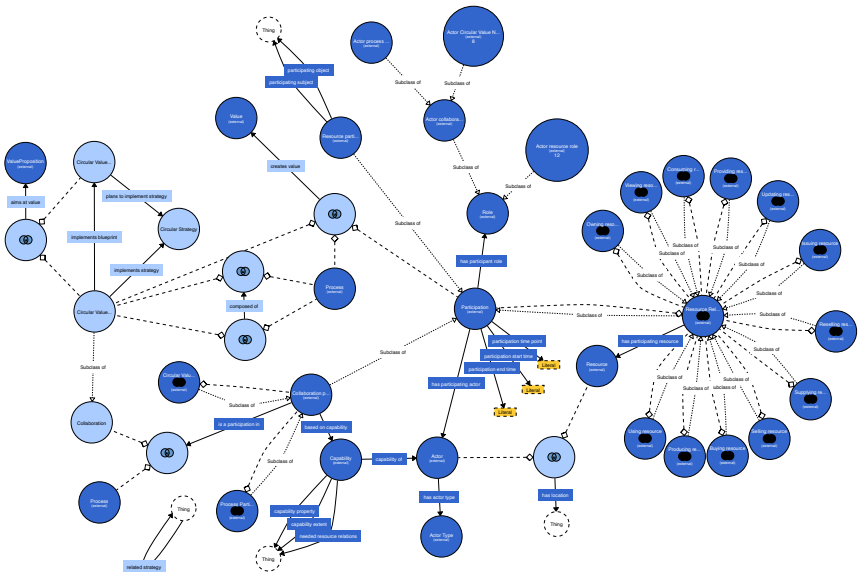

Figure 5: VOWL visualisation of the core part of the CVN module.

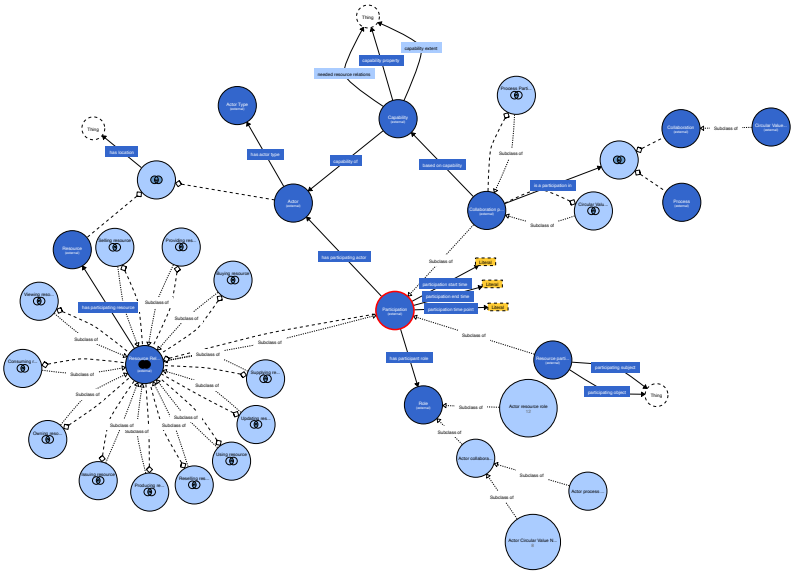

Figure 6: VOWL visualisation of the actor module, specialising the actor ODP.

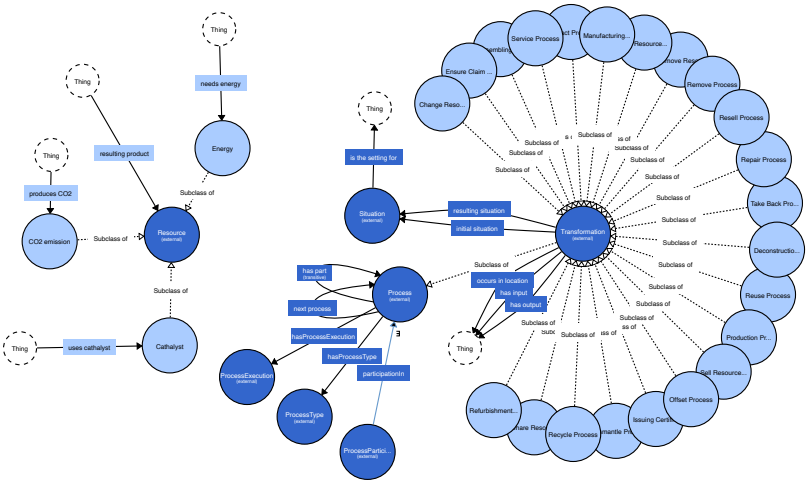

Figure 7: VOWL visualisation of the process module, specialising the process ODP.

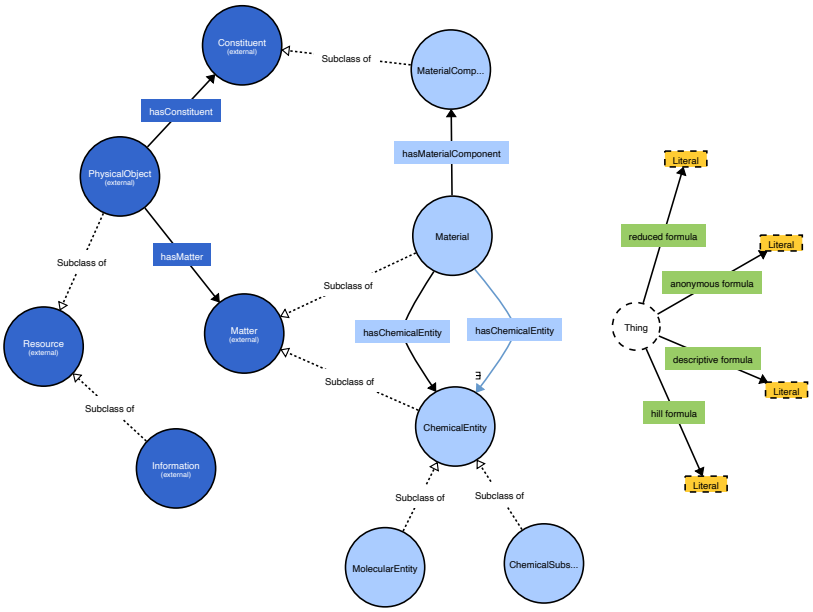

Figure 8: VOWL visualisation of the material module, specialising the resource ODP.

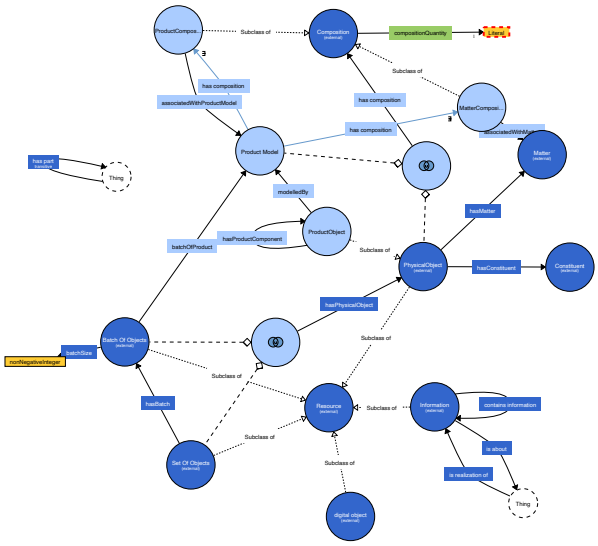

Figure 9: VOWL visualisation of the product module, specialising the resource ODP.

Figure 10: VOWL visualisation of the stub for the value module.

C Module Documentation

In this appendix we provide a snapshot of the documentation pages of the 9 core modules, as available online.

Circular Economy Ontology Network (CEON) - Actor Module

Metadata

IRI

http://w3id.org/CEON/ontology/actor/

Title

Circular Economy Ontology Network (CEON) - Actor Module

Creator

Eva Blomqvist

Contributor

Huanyu Li

Mikael Lindecrantz

Robin Keskisärkkä

Date Created

2023-03-16

License

https://creativecommons.org/licenses/by/4.0/

Version Iri

http://w3id.org/CEON/ontology/actor/0.2/

Version Info

0.2

Preferred Namespace Prefix

actor

Preferred Namespace Uri

http://w3id.org/CEON/ontology/actor/

Description

The Actor module of CEON (Circular Economy Ontology Network).

Covers Requirements

In addition to requirements covered by imported ODPs, covers the following requirements from Onto-DESIDE D3.1: C0-1, C0-2, C3-4, T3-4

Classes

Actor Circular Value Network role [c]

IRI http://w3id.org/CEON/ontology/actor/ActorCVNRole

Description The role(s) of an actor in a Circular Value Network, which is a specific type of collaboration.

Sub Class Of Actor collaboration role [c]

Named Individuals
collector [ni]
dismantler [ni]
manufacturer [ni]
recycler [ni]
reseller [ni]
seller [ni]
supplier [ni]
user [ni]

Actor collaboration role [c]

IRI http://w3id.org/CEON/ontology/actor/ActorCollaborationRole

Description The roles of an actor involved in a collaboration.

Sub Class Of actorODP:Role [c]

Super Class Of
Actor Circular Value Network role [c]
Actor process role [c]

Actor process role [c]

IRI http://w3id.org/CEON/ontology/actor/ActorProcessRole

Description The role(s) of an actor involved in a process.

Sub Class Of Actor collaboration role [c]

Actor resource role [c]

IRI http://w3id.org/CEON/ontology/actor/ActorResourceRole

Description The role(s) of an actor in relation to a resource.

Sub Class Of actorODP:Role [c]

Named Individuals
buyer [ni]
consumer [ni]
issuer [ni]
owner [ni]
producer [ni]
provider [ni]
reseller [ni]
seller [ni]
supplier [ni]
updater [ni]
user [ni]
viewer [ni]

Buying resource [c]

IRI http://w3id.org/CEON/ontology/actor/BuyingResource

Description The relation where the role of the actor is the buyer of a certain resource.

Sub Class Of Resource Relation [c]

Equivalentclass actorODP:participantRole [op] value buyer [c] *and* Resource Relation [c]

Circular Value Network Participation [c]

IRI http://w3id.org/CEON/ontology/actor/CVNParticipation

Description A participation-relation, that represents the participation of an actor in a CVN with a certain role. For instance, a specific company playing the role of recycler in a certain flow of a CVN. The participation may also be related to a certain time (or time interval).

Sub Class Of
actorODP:CollaborationParticipation [c]
actorODP:CollaborationParticipation [c] *and* actorODP:participantRole [op] some Actor Circular Value Network role [c] *and* actorODP:participationIn [op] some Circular Value Network [c] *and* actorODP:participatingActor [op] some actorODP:Actor [c]

Consuming resource [c]

IRI	http://w3id.org/CEON/ontology/actor/ConsumingResource
Description	The relation where the role of the actor is the consumer of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	Resource Relation [c] *and* actorODP:participantRole [op] value consumer [c]

Issuing resource [c]

IRI	http://w3id.org/CEON/ontology/actor/IssuingResource
Description	The relation where the role of the actor is the issuer of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	Resource Relation [c] *and* actorODP:participantRole [op] value issuer [c]

Owning resource [c]

IRI	http://w3id.org/CEON/ontology/actor/OwningResource
Description	The relation where the role of the actor is the owner of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	actorODP:participantRole [op] value owner [c] *and* Resource Relation [c]

Process Participation [c]

IRI	http://w3id.org/CEON/ontology/actor/ProcessParticipation
Description	Participation of a certain actor in a certain process, with a certain role. For instance, a certain department of a recycling company having the role of quality controllant, or material sorter, in a certain recycling process. The participation may also be given a time, e.g. a start and end time.
Sub Class Of	actorODP:CollaborationParticipation [c] actorODP:participationIn [op] some http://w3id.org/CEON/ontology/processODP/Process [c] *and* actorODP:participantRole [op] some Actor Circular Value Network role [c] *and* actorODP:CollaborationParticipation [c] *and* actorODP:participatingActor [op] some actorODP:Actor [c]

Producing resource [c]

IRI	http://w3id.org/CEON/ontology/actor/ProducingResource
Description	The relation where the role of the actor is the producer of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	actorODP:participantRole [op] value producer [c] *and* Resource Relation [c]

Providing resource [c]

IRI	http://w3id.org/CEON/ontology/actor/ProvidingResource
Description	The relation where the role of the actor is the provider of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	Resource Relation [c] *and* actorODP:participantRole [op] value provider [c]

Reselling resource [c]

IRI	http://w3id.org/CEON/ontology/actor/ResellingResource
Description	The relation where the role of the actor is the reseller of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	actorODP:participantRole [op] value reseller [c] *and* Resource Relation [c]

Selling resource [c]

IRI	http://w3id.org/CEON/ontology/actor/SellingResource
Description	The relation where the role of the actor is the seller of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	actorODP:participantRole [op] value seller [c] *and* Resource Relation [c]

Supplying resource [c]

IRI	http://w3id.org/CEON/ontology/actor/SupplyingResource
Description	The relation where the role of the actor is the supplier of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	actorODP:participantRole [op] value supplier [c] *and* Resource Relation [c]

Updating resource [c]

IRI	http://w3id.org/CEON/ontology/actor/UpdatingResource
Description	The relation where the role of the actor is the updater of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	Resource Relation [c] *and* actorODP:participantRole [op] value updater [c]

Using resource [c]

IRI	http://w3id.org/CEON/ontology/actor/UsingResource
Description	The relation where the role of the actor is the user of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	Resource Relation [c] *and* actorODP:participantRole [op] value user [c]

Viewing resource [c]

IRI	http://w3id.org/CEON/ontology/actor/ViewingResource
Description	The relation where the role of the actor is the viewer of a certain resource.
Sub Class Of	Resource Relation [c]
Equivalentclass	Resource Relation [c] *and* actorODP:participantRole [op] value viewer [c]

Actor [c]

IRI	http://w3id.org/CEON/ontology/actorODP/Actor

Capability [c]

IRI http://w3id.org/CEON/ontology/actorODP/Capability

In Domain Of
capability extent [op]
needed resource relations [op]

Collaboration Participation [c]

IRI http://w3id.org/CEON/ontology/actorODP/CollaborationParticipation

Super Class Of
Circular Value Network Participation [c]
Process Participation [c]

Participation [c]

IRI http://w3id.org/CEON/ontology/actorODP/Participation

Resource Relation [c]

IRI http://w3id.org/CEON/ontology/actorODP/ResourceRelation

Description
A relation between a resource, an actor, and the role the actor has in relation to the resource. For instance, the role of owner that a certain actor takes for a certain resource for a certain period of time. Or the seller of a certain resource, until that resource has been sold, and the actor no longer has that role in relation to the resource.

Sub Class Of
actorODP:participatingResource [op] some http://w3id.org/CEON/ontology/resourceODP/Resource [c] *and* actorODP:participatingActor [op] some actorODP:Actor [c] *and* actorODP:Participation [c] *and* actorODP:participantRole [op] some Actor resource role [c]

Super Class Of
Buying resource [c]
Consuming resource [c]
Issuing resource [c]
Owning resource [c]
Producing resource [c]
Providing resource [c]
Reselling resource [c]
Selling resource [c]
Supplying resource [c]
Updating resource [c]
Using resource [c]
Viewing resource [c]

Role [C]

IRI	http://w3id.org/CEON/ontology/actorODP/Role
Super Class Of	Actor collaboration role [C] Actor resource role [C]

Circular Value Network [C]

IRI	http://w3id.org/CEON/ontology/cvn/CVN
Description	A collaboration between actors that constitute a Circular Value Newtworks, implicitly or explicitly set up.
Sub Class Of	http://w3id.org/CEON/ontology/cvn/Collaboration [C]

Collaboration [C]

IRI	http://w3id.org/CEON/ontology/cvn/Collaboration
Super Class Of	Circular Value Network [C]

Process [C]

IRI	http://w3id.org/CEON/ontology/processODP/Process

Resource [C]

IRI	http://w3id.org/CEON/ontology/resourceODP/Resource

Object Properties

capability extent op

IRI http://w3id.org/CEON/ontology/actor/capabilityExtent

Description The extent of this capability, e.g. stating whether there are limist to the capability, such as a maximum amount or size of something.

Sub Property Of actorODP:capabilityProperty op

Domain actorODP:Capability c

needed resource relations op

IRI http://w3id.org/CEON/ontology/actor/neededResourceRelation

Description In order for an actor to have a capability, it needs to have certain resources, e.g. materials, infrastrucutre, know-how, information etc.

Sub Property Of actorODP:capabilityProperty op

Domain actorODP:Capability c

capability property op

IRI http://w3id.org/CEON/ontology/actorODP/capabilityProperty

Super Property Of

- capability extent op
- needed resource relations op

participant role op

IRI http://w3id.org/CEON/ontology/actorODP/participantRole

participating actor op

IRI http://w3id.org/CEON/ontology/actorODP/participatingActor

participating resource op

IRI http://w3id.org/CEON/ontology/actorODP/participatingResource

participation in [op]

IRI http://w3id.org/CEON/ontology/actorODP/participationIn

Annotation Properties

contributor [ap]

IRI http://purl.org/dc/terms/contributor

created [ap]

IRI http://purl.org/dc/terms/created

creator [ap]

IRI http://purl.org/dc/terms/creator

description [ap]

IRI http://purl.org/dc/terms/description

license [ap]

IRI http://purl.org/dc/terms/license

title [ap]

IRI http://purl.org/dc/terms/title

preferred namespace prefix [ap]

IRI http://purl.org/vocab/vann/preferredNamespacePrefix

preferred namespace uri [ap]

IRI http://purl.org/vocab/vann/preferredNamespaceUri

covers requirements ap

IRI	http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#coversRequirements

Namespaces

:

http://w3id.org/CEON/ontology/actor/

actorODP

http://w3id.org/CEON/ontology/actorODP/

dcterms

http://purl.org/dc/terms/

odp

http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#

owl

http://www.w3.org/2002/07/owl#

prov

http://www.w3.org/ns/prov#

rdf

http://www.w3.org/1999/02/22-rdf-syntax-ns#

rdfs

http://www.w3.org/2000/01/rdf-schema#

vann

http://purl.org/vocab/vann/

Legend

c	Classes
op	Object Properties
ap	Annotation Properties

Circular Economy Ontology Network (CEON) - Actor ODP

Metadata

IRI

http://w3id.org/CEON/ontology/actorODP/

Title

Circular Economy Ontology Network (CEON) - Actor ODP

Creator

Eva Blomqvist

Contributor

Huanyu Li

Mikael Lindecrantz

Robin Keskisärkkä

Date Created

2023-03-17

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Version Iri

http://w3id.org/CEON/ontology/actorODP/0.2/

Version Info

0.2

Preferred Namespace Prefix

actorODP

Preferred Namespace Uri

https://w3id.org/CEON/ontoloy/actorODP/

Description

A core ODP of the CEON ontology network, defining aspects of the actor concept.

Covers Requirements

Covers the following requirements from Onto-DESIDE D3.1: CVN-Process-3, CVN-Actor-1,4,6,7, CVN-Competency-3, CVN-Information-4, C11-1, C11-3, E1-6,6,6,9, E4-10

Classes

Actor [c]

IRI	http://w3id.org/CEON/ontology/actorODP/Actor
Description	An agent able to act in the context of a circular value network, e.g. an organisation, person.
In Domain Of	has actor type [op]
In Range Of	capability of [op] has participating actor [op]

Actor Type [c]

IRI	http://w3id.org/CEON/ontology/actorODP/ActorType
Description	The type of an actor, e.g. the type of company, or a specific subtype based on the organisations capabilities.
In Range Of	has actor type [op]

Capability [c]

IRI	http://w3id.org/CEON/ontology/actorODP/Capability
Description	Something that the actor is capable of doing, e.g. perfomring a certain role in a process, based on some properties, such as access to infrastructure, resources and know-how.
In Domain Of	capability of [op] capability property [op]
In Range Of	based on capability [op]

Collaboration participation [c]

IRI http://w3id.org/CEON/ontology/actorODP/CollaborationParticipation

Description The relation involving the role of a certain actor with respect to a value network or a process in such a network, e.g. an organisation (actor) acting as the recycler (role) in a glass recycling value netowrk (network) at a specific point or period in time. Or an organisation (actor) acting as the dismantler (role) in a dismantling step of a building deconstruction process (process step) at a specific point or period in time.

Sub Class Of Participation [c]

In Domain Of
based on capability [op]
is a participation in [op]

Participation [c]

IRI http://w3id.org/CEON/ontology/actorODP/Participation

Description Represents the participation of objects in some situation.

Sub Class Of participation start time [dp] *exactly* 1 1 [c] *or* participation time point [dp] *exactly* 1 1 [c]

In Domain Of
has participant role [op]
has participating actor [op]
participation end time [dp]
participation start time [dp]
participation time point [dp]

Super Class Of
Collaboration participation [c]
Resource participation [c]
Resource Relation [c]

Resource participation [c]

IRI http://w3id.org/CEON/ontology/actorODP/ResourceParticipation

Description The generic relation representing the particpation of a resource in some relation. For example, it can be specialized to represent a reified version of an object or data property.

Sub Class Of Participation [c]

In Domain Of
participating object [op]
participating subject [op]

Resource Relation [c]

IRI	http://w3id.org/CEON/ontology/actorODP/ResourceRelation
Description	The relation involving the role of a certain actor with respect to a certain resource, e.g. an organisation or individual (actor) owning (role) a specific product (resource) at a specific point or period in time.
Sub Class Of	Participation [c]
In Domain Of	has participating resource [op]

Role [c]

IRI	http://w3id.org/CEON/ontology/actorODP/Role
Description	A role that an actor can take in a specific context. Applies both to roles in the context of resources, such as owner, manufacturer, reseller etc. of that resource, as well as roles in relation to a circular value network, such as recycler, dismantler, transporter etc., in relation to a material flow.
In Range Of	has participant role [op]

Collaboration [c]

IRI	http://w3id.org/CEON/ontology/cvn/Collaboration
Description	A collaboration between a set of actors.

Process [c]

IRI	http://w3id.org/CEON/ontology/processODP/Process

Resource [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/Resource
In Range Of	has participating resource [op]

Object Properties

has actor type [op]

IRI	http://w3id.org/CEON/ontology/actorODP/actorType
Description	The type of the actor.
Domain	Actor [c]
Range	Actor Type [c]

based on capability [op]

IRI	http://w3id.org/CEON/ontology/actorODP/basedOnCapability
Description	An actor participates in a collaboration based on that it has some capability that is useful for the collaboration.
Domain	Collaboration participation [c]
Range	Capability [c]

capability of [op]

IRI	http://w3id.org/CEON/ontology/actorODP/capabilityOf
Description	Relates to the actor holding the capability.
Domain	Capability [c]
Range	Actor [c]

capability property [op]

IRI	http://w3id.org/CEON/ontology/actorODP/capabilityProperty
Description	Relates some properties to the capability, such as the parameters of it, or the needed resources.
Domain	Capability [c]

has location [op]

IRI	http://w3id.org/CEON/ontology/actorODP/hasLocation
Description	Defines the location of an actor or resource.
Domain	resourceODP:Resource [c] *or* Actor [c]

has participant role [op]

IRI	http://w3id.org/CEON/ontology/actorODP/participantRole
Description	Holds the value of the role of the participant in this participation relation.
Domain	Participation [c]
Range	Role [c]

has participating actor [op]

IRI	http://w3id.org/CEON/ontology/actorODP/participatingActor
Description	Holds the value of the actor involved in this participation relation.
Domain	Participation [c]
Range	Actor [c]

participating object [op]

IRI	http://w3id.org/CEON/ontology/actorODP/participatingObject
Description	Participating object in a resource participation. This is part of a resource participation that can be a directional relation, and the participating object is the end point of the relation.
Domain	Resource participation [c]

has participating resource op

IRI	http://w3id.org/CEON/ontology/actorODP/participatingResource
Description	The resource that this participation relation relates to, i.e. for which the actor holds the specified role.
Domain	Resource Relation c
Range	resourceODP:Resource c

participating subject op

IRI	http://w3id.org/CEON/ontology/actorODP/participatingSubject
Description	Participating subject in a resource participation. This is part of a resource participation that can be a directional relation, and the participating subject is the starting point of the relation.
Domain	Resource participation c

is a participation in op

IRI	http://w3id.org/CEON/ontology/actorODP/participationIn
Description	The collaboration or process that this participation relates to.
Domain	Collaboration participation c
Range	processODP:Process c *or* Collaboration c

Datatype Properties

participation end time dp

IRI	http://w3id.org/CEON/ontology/actorODP/participationEndTime
Description	The end of a time interval.
Domain	Participation c
Range	xsd:gMonthYear c *or* xsd:date c *or* xsd:gYear c *or* xsd:dateTime c

participation start time dp

IRI	http://w3id.org/CEON/ontology/actorODP/participationStartTime
Description	The start of a time interval.
Domain	Participation c
Range	xsd:date c *or* xsd:gYear c *or* xsd:dateTime c *or* xsd:gMonthYear c

participation time point dp

IRI	http://w3id.org/CEON/ontology/actorODP/participationTimePoint
Description	The point in time when something took place or was valid.
Domain	Participation c
Range	xsd:gYear c *or* xsd:dateTime c *or* xsd:date c *or* xsd:gMonthYear c

Annotation Properties

contributor ap

IRI	http://purl.org/dc/terms/contributor

created ap

IRI	http://purl.org/dc/terms/created

creator ap

IRI	http://purl.org/dc/terms/creator

description ap

IRI	http://purl.org/dc/terms/description

license [ap]

IRI	http://purl.org/dc/terms/license

title [ap]

IRI	http://purl.org/dc/terms/title

preferred namespace prefix [ap]

IRI	http://purl.org/vocab/vann/preferredNamespacePrefix

preferred namespace uri [ap]

IRI	http://purl.org/vocab/vann/preferredNamespaceUri

covers requirements [ap]

IRI	http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#coversRequirements

Namespaces

:

http://w3id.org/CEON/ontology/actorODP/

cvn

http://w3id.org/CEON/ontology/cvn/

dcterms

http://purl.org/dc/terms/

odp

http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#

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http://www.w3.org/2002/07/owl#

processODP

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prov

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http://www.w3.org/1999/02/22-rdf-syntax-ns#

rdfs

http://www.w3.org/2000/01/rdf-schema#

resourceODP

http://w3id.org/CEON/ontology/resourceODP/

vann

http://purl.org/vocab/vann/

xsd

http://www.w3.org/2001/XMLSchema#

Legend

c	Classes
op	Object Properties
dp	Datatype Properties
ap	Annotation Properties

Circular Economy Ontology Network (CEON) - Circular Value Network Module

Metadata

IRI

http://w3id.org/CEON/ontology/cvn/

Title

Circular Economy Ontology Network (CEON) - Circular Value Network Module

Creator

Eva Blomqvist

Contributor

Huanyu Li

Mikael Lindecrantz

Robin Keskisärkkä

Date Created

2023-03-22

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Version Iri

http://w3id.org/CEON/ontology/cvn/0.1/

Version Info

0.1

Preferred Namespace Prefix

cvn

Preferred Namespace Uri

http://w3id.org/CEON/ontoloy/cvn/

Description

A core module of the CEON ontology network, defining aspects of the circular value network (CVN) itself.

Covers Requirements

In addition to requirements covered by imported ODPs, covers the following requirements from Onto-DESIDE D3.1: CVN-CVN-1, CVN-Process-1,6, CVN-VP-1, CVN-Type-3, C0-1.

Classes

Participation [C]

IRI http://w3id.org/CEON/ontology/actorODP/Participation

Circular Value Network [c]

IRI	http://w3id.org/CEON/ontology/cvn/CVN
Description	An instantiation of a circular value network, i.e. a concrete network of different actors collaborating to achieve some goal.
Sub Class Of	Collaboration [c]
In Domain Of	implements blueprint [op] implements strategy [op]

Circular Value Network Blueprint [c]

IRI	http://w3id.org/CEON/ontology/cvn/CVNBlueprint
Description	A plan or a pattern of a CVN configuration that can then be filled with actual actors and processes. The blueprint can be used to capture a desired setup of a network, or for reusing patterns of CVNs.
In Domain Of	plans to implement strategy [op]
In Range Of	implements blueprint [op]

Circular Strategy [c]

IRI	http://w3id.org/CEON/ontology/cvn/CircularStrategy
Description	A circular strategy, such as to reccycle, reuse or refurbish something.
In Range Of	implements strategy [op] plans to implement strategy [op]

Collaboration [c]

IRI	http://w3id.org/CEON/ontology/cvn/Collaboration
Super Class Of	Circular Value Network [c]

Process [c]

IRI	http://w3id.org/CEON/ontology/process/Process

Resource [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/Resource

Value [c]

IRI	http://w3id.org/CEON/ontology/value/Value
In Range Of	creates value [op]

Value Proposition [c]

IRI	http://w3id.org/CEON/ontology/value/ValueProposition
In Range Of	aims at value [op]

Object Properties

aims at value [op]

IRI	http://w3id.org/CEON/ontology/cvn/aimsAtValue
Description	The value proposition that the planned abstract CVN configuration, or concrete network wants to achieve.
Domain	Circular Value Network [c] *or* Circular Value Network Blueprint [c]
Range	value:ValueProposition [c]

composed of [op]

IRI	http://w3id.org/CEON/ontology/cvn/composedOf
Description	Both a CVN and a process can be composed of other CVNs or processes.
Domain	process:Process [c] *or* Circular Value Network [c]
Range	process:Process [c] *or* Circular Value Network [c]

creates value op

IRI	http://w3id.org/CEON/ontology/cvn/createsValue
Description	Value creation can be captured at the actor level, i.e. value created by an actor's participation in a collaboration, or at the process or complete CVN level.
Domain	actorODP:Participation c *or* process:Process c *or* Circular Value Network c
Range	value:Value c

implements blueprint op

IRI	http://w3id.org/CEON/ontology/cvn/implementsBlueprint
Description	The blueprint (or plan) that this concrete CVN is an instance of.
Domain	Circular Value Network c
Range	Circular Value Network Blueprint c

implements strategy op

IRI	http://w3id.org/CEON/ontology/cvn/implementsStrategy
Description	A strategy that is implemented by this CVN or CVN blueprint.
Sub Property Of	related strategy op
Domain	Circular Value Network c
Range	Circular Strategy c

plans to implement strategy op

IRI	http://w3id.org/CEON/ontology/cvn/plansToImplementStrategy
Description	A strategy that is planned to be implemented by this CVN or CVN blueprint.
Sub Property Of	related strategy op
Domain	Circular Value Network Blueprint c
Range	Circular Strategy c

related strategy op

IRI	http://w3id.org/CEON/ontology/cvn/relatedStrategy
Description	A strategy that is targeted by this CVN or CVN blueprint.
Super Property Of	• implements strategy op • plans to implement strategy op

Annotation Properties

contributor ap

IRI	http://purl.org/dc/terms/contributor

creator ap

IRI	http://purl.org/dc/terms/creator

description ap

IRI	http://purl.org/dc/terms/description

title ap

IRI	http://purl.org/dc/terms/title

preferred namespace prefix ap

IRI	http://purl.org/vocab/vann/preferredNamespacePrefix

preferred namespace uri ap

IRI	http://purl.org/vocab/vann/preferredNamespaceUri

Namespaces

:

http://w3id.org/CEON/ontology/cvn/

actor

http://w3id.org/CEON/ontology/actor/

actorODP

http://w3id.org/CEON/ontology/actorODP/

dcterms

http://purl.org/dc/terms/

odp

http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#

owl

http://www.w3.org/2002/07/owl#

process

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prov

http://www.w3.org/ns/prov#

rdf

http://www.w3.org/1999/02/22-rdf-syntax-ns#

rdfs

http://www.w3.org/2000/01/rdf-schema#

resourceODP

http://w3id.org/CEON/ontology/resourceODP/

value

http://w3id.org/CEON/ontology/value/

vann

http://purl.org/vocab/vann/

xsd

http://www.w3.org/2001/XMLSchema#

Legend

c	Classes
op	Object Properties
ap	Annotation Properties

Circular Economy Ontology Network (CEON) - Material Module

Metadata

IRI

http://w3id.org/CEON/ontology/material/

Title

Circular Economy Ontology Network (CEON) - Material Module

Creator

Huanyu Li

Contributor

Eva Blomqvist

Mikael Lindecrantz

Robin Keskisärkkä

Date Created

2023-03-16

License

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Version Iri

http://w3id.org/CEON/ontology/material/0.1/

Version Info

0.1

Preferred Namespace Prefix

material

Preferred Namespace Uri

http://w3id.org/CEON/ontology/material/

Description

The Material module of CEON (Circular Economy Ontology Network).

Covers Requirements

In addition to requirements covered by imported ODPs, covers the following requirements from Onto-DESIDE D3.1: CVN-Resource-2, CVN-ResourceType-4, C3-3, E1-3, E2-4, E5-2, T1-1, T10-2.

Classes

Chemical entity [c]

IRI	http://w3id.org/CEON/ontology/material/ChemicalEntity
Description	A chemical entity is an abstraction of entities that can compose matter. For instance, a chemical entity can be a molecular entity or a chemical substance.
Sub Class Of	resourceODP:Matter [c]
In Range Of	has chemical entity [op]
Super Class Of	Chemical substance [c] Molecular entity [c]

Chemical substance [c]

IRI	http://w3id.org/CEON/ontology/material/ChemicalSubstance
Description	A chemical substance is made up of a collection of molecular entities.
Sub Class Of	Chemical entity [c]

Material [c]

IRI	http://w3id.org/CEON/ontology/material/Material
Description	Material as a sub-concept of Matter, can be a substance or a collection of substance which a physical object is composed of.
Sub Class Of	resourceODP:Matter [c]
In Domain Of	has chemical entity [op] has material component [op]
Restriction	has chemical entity [op] some Material [c]

Material component [c]

IRI	http://w3id.org/CEON/ontology/material/MaterialComponent
Description	A material component is a part of a material.
Sub Class Of	resourceODP:Constituent [c]
In Range Of	has material component [op]

Molecular entity [c]

IRI	http://w3id.org/CEON/ontology/material/MolecularEntity
Description	A molecular entity means a singular/distinguishable entity. It can be for instance, atom, ion.
Sub Class Of	Chemical entity [c]

Constituent [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/Constituent
Super Class Of	Material component [c]

Matter [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/Matter
Super Class Of	Chemical entity [c] Material [c]

Object Properties

has chemical entity op

IRI http://w3id.org/CEON/ontology/material/hasChemicalEntity

Description hasChemicalEntity intends to represent that a material can have a collection of chemical entities.

Domain Material c

Range Chemical entity c

has material component op

IRI http://w3id.org/CEON/ontology/material/hasMaterialComponent

Description hasMaterialComponent intends to represent that a material can have a collection of components.

Domain Material c

Range Material component c

Datatype Properties

anonymous formula dp

IRI http://w3id.org/CEON/ontology/material/AnonymousFormula

Description AnonymousFormula represents that a molecular entity has the anonymous formula in a string.

descriptive formula dp

IRI http://w3id.org/CEON/ontology/material/DescriptiveFormula

Description DescriptiveFormula represents that a molecular entity has the descriptive formula in a string.

hill formula dp

IRI	http://w3id.org/CEON/ontology/material/HillFormula
Description	HillFormula represents that a composition has the hill formula in a string.

reduced formula dp

IRI	http://w3id.org/CEON/ontology/material/ReducedChemicalFormula
Description	ReducedChemicalFormula represents that a molecular entity has the reduced chemical formula in a string.

Annotation Properties

description ap

IRI	http://purl.org/dc/elements/1.1/description

Namespaces

:

http://w3id.org/CEON/ontology/material/

dc

http://purl.org/dc/elements/1.1/

dcterms

http://purl.org/dc/terms/

odp

http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#

owl

http://www.w3.org/2002/07/owl#

prov

http://www.w3.org/ns/prov#

rdf

http://www.w3.org/1999/02/22-rdf-syntax-ns#

rdfs

http://www.w3.org/2000/01/rdf-schema#

resourceODP

http://w3id.org/CEON/ontology/resourceODP/

vann

http://purl.org/vocab/vann/

Legend

c	Classes
op	Object Properties
dp	Datatype Properties
ap	Annotation Properties

Circular Economy Ontology Network (CEON) - Process Module

Metadata

IRI

http://w3id.org/CEON/ontology/process/

Title

Circular Economy Ontology Network (CEON) - Process Module

Creator

Huanyu Li

Contributor

Eva Blomqvist

Mikael Lindecrantz

Robin Keskisärkkä

Date Created

2023-03-16

License

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Version Iri

http://w3id.org/CEON/ontology/process/0.1/

Version Info

0.1

Preferred Namespace Prefix

process

Preferred Namespace Uri

https://w3id.org/CEON/ontology/process/

Description

The Process module of CEON (Circular Economy Ontology Network).

Covers Requirements

In addition to requirements covered by imported ODPs, covers the following requirements from Onto-DESIDE D3.1: T8-2

Classes

Assembling Process [C]

IRI	http://w3id.org/CEON/ontology/process/AssemblingProcess
Description	A process of assembling.
Sub Class Of	processODP:Transformation [C]

Buy Resource Process [c]

IRI	http://w3id.org/CEON/ontology/process/BuyResourceProcess
Description	A process of buying a resource.
Sub Class Of	processODP:Transformation [c]

CO2 emission [c]

IRI	http://w3id.org/CEON/ontology/process/CO2Emission
Description	An amount of CO2.
Sub Class Of	resourceODP:Resource [c]
In Range Of	produces CO2 [op]

Cathalyst [c]

IRI	http://w3id.org/CEON/ontology/process/Cathalyst
Description	A resource that is needed as a cathalyst by a process, but that is not considered the direct input or output of it.
Sub Class Of	resourceODP:Resource [c]
In Range Of	uses cathalyst [op]

Change Resource Process [c]

IRI	http://w3id.org/CEON/ontology/process/ChangeResourceProcess
Description	A process of a changing resource.
Sub Class Of	processODP:Transformation [c]

Contact Process [c]

IRI	http://w3id.org/CEON/ontology/process/ContactProcess
Description	A contact process.
Sub Class Of	processODP:Transformation [c]

Deconstruction Process [c]

IRI	http://w3id.org/CEON/ontology/process/DeconstructionProcess
Description	A process of deconstruction.
Sub Class Of	processODP:Transformation [c]

Dismantle Process [c]

IRI	http://w3id.org/CEON/ontology/process/DismantleProcess
Description	A process of dismantling.
Sub Class Of	processODP:Transformation [c]

Energy [c]

IRI	http://w3id.org/CEON/ontology/process/Energy
Description	An amount of energy.
Sub Class Of	resourceODP:Resource [c]
In Range Of	needs energy [op]

Ensure Claim Process [c]

IRI	http://w3id.org/CEON/ontology/process/EnsureClaimProcess
Description	A process of ensuring a claim.
Sub Class Of	processODP:Transformation [c]

Issuing Certificate Process [c]

IRI	http://w3id.org/CEON/ontology/process/IssuingCertificateProcess
Description	A process of issuing a certificate.
Sub Class Of	processODP:Transformation [c]

Manufacturing Process [c]

IRI	http://w3id.org/CEON/ontology/process/ManufacturingProcess
Description	A process of manufacturing.
Sub Class Of	processODP:Transformation [c]

Offset Process [c]

IRI	http://w3id.org/CEON/ontology/process/OffsetProcess
Description	A process of offsetting.
Sub Class Of	processODP:Transformation [c]

Production Process [c]

IRI	http://w3id.org/CEON/ontology/process/ProductionProcess
Description	A process of production.
Sub Class Of	processODP:Transformation [c]

Recycle Process [c]

IRI	http://w3id.org/CEON/ontology/process/RecycleProcess
Description	A process of recycling.
Sub Class Of	processODP:Transformation [c]

Refurbishment Process [C]

IRI	http://w3id.org/CEON/ontology/process/RefurbishmentProcess
Description	A process of refurbishment.
Sub Class Of	processODP:Transformation [C]

Remove Process [C]

IRI	http://w3id.org/CEON/ontology/process/RemoveProcess
Description	A process of removing.
Sub Class Of	processODP:Transformation [C]

Remove Resource Process [C]

IRI	http://w3id.org/CEON/ontology/process/RemoveResourceProcess
Description	A process of removing a resource.
Sub Class Of	processODP:Transformation [C]

Repair Process [C]

IRI	http://w3id.org/CEON/ontology/process/RepairProcess
Description	A process of repairing.
Sub Class Of	processODP:Transformation [C]

Resell Process [C]

IRI	http://w3id.org/CEON/ontology/process/ResellProcess
Description	A process of reselling.
Sub Class Of	processODP:Transformation [C]

Reuse Process [C]

IRI	http://w3id.org/CEON/ontology/process/ReuseProcess
Description	A process of reusing.
Sub Class Of	processODP:Transformation [C]

Sell Resource Process [C]

IRI	http://w3id.org/CEON/ontology/process/SellResourceProcess
Description	A process of selling a resource.
Sub Class Of	processODP:Transformation [C]

Service Process [C]

IRI	http://w3id.org/CEON/ontology/process/ServiceProcess
Description	A process of servicing.
Sub Class Of	processODP:Transformation [C]

Share Resource Process [C]

IRI	http://w3id.org/CEON/ontology/process/ShareResourceProcess
Description	A process of sharing a resource.
Sub Class Of	processODP:Transformation [C]

Take Back Process [C]

IRI	http://w3id.org/CEON/ontology/process/TakeBackProcess
Description	A process of taking back.
Sub Class Of	processODP:Transformation [C]

Transformation [C]

IRI http://w3id.org/CEON/ontology/processODP/Transformation

Super Class Of

- Assembling Process [C]
- Buy Resource Process [C]
- Change Resource Process [C]
- Contact Process [C]
- Deconstruction Process [C]
- Dismantle Process [C]
- Ensure Claim Process [C]
- Issuing Certificate Process [C]
- Manufacturing Process [C]
- Offset Process [C]
- Production Process [C]
- Recycle Process [C]
- Refurbishment Process [C]
- Remove Process [C]
- Remove Resource Process [C]
- Repair Process [C]
- Resell Process [C]
- Reuse Process [C]
- Sell Resource Process [C]
- Service Process [C]
- Share Resource Process [C]
- Take Back Process [C]

Resource [C]

IRI http://w3id.org/CEON/ontology/resourceODP/Resource

In Range Of resulting product [op]

Super Class Of

- CO2 emission [C]
- Cathalyst [C]
- Energy [C]

Object Properties

needs energy op

IRI	http://w3id.org/CEON/ontology/process/needsEnergy
Description	The energy needed to perform a certain process.
Sub Property Of	processODP:hasInput op
Range	Energy c

produces CO2 op

IRI	http://w3id.org/CEON/ontology/process/producesCO2
Description	The CO2 released or produced by the process.
Sub Property Of	processODP:hasOutput op
Range	CO2 emission c

resulting product op

IRI	http://w3id.org/CEON/ontology/process/resultingProduct
Description	The resource that is the output (product, i.e. what is produced) from a certain process.
Sub Property Of	processODP:hasOutput op
Range	resourceODP:Resource c

uses cathalyst op

IRI	http://w3id.org/CEON/ontology/process/usesCathalyst
Description	The cathalyst used in a process.
Sub Property Of	processODP:hasInput op
Range	Cathalyst c

has input op

IRI http://w3id.org/CEON/ontology/processODP/hasInput

Super Property Of

- needs energy op
- uses cathalyst op

has output op

IRI http://w3id.org/CEON/ontology/processODP/hasOutput

Super Property Of

- produces CO2 op
- resulting product op

Annotation Properties

contributor ap

IRI http://purl.org/dc/terms/contributor

created ap

IRI http://purl.org/dc/terms/created

creator ap

IRI http://purl.org/dc/terms/creator

description ap

IRI http://purl.org/dc/terms/description

license ap

IRI http://purl.org/dc/terms/license

title ap

IRI	http://purl.org/dc/terms/title

preferred namespace prefix ap

IRI	http://purl.org/vocab/vann/preferredNamespacePrefix

preferred namespace uri ap

IRI	http://purl.org/vocab/vann/preferredNamespaceUri

covers requirements ap

IRI	http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#coversRequirements

Namespaces

:

http://w3id.org/CEON/ontology/process/

dcterms

http://purl.org/dc/terms/

odp

http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#

owl

http://www.w3.org/2002/07/owl#

processODP

http://w3id.org/CEON/ontology/processODP/

prov

http://www.w3.org/ns/prov#

rdf

http://www.w3.org/1999/02/22-rdf-syntax-ns#

rdfs

http://www.w3.org/2000/01/rdf-schema#

resourceODP

http://w3id.org/CEON/ontology/resourceODP/

vann

http://purl.org/vocab/vann/

Legend

c	Classes
op	Object Properties
ap	Annotation Properties

Circular Economy Ontology Network (CEON) - Process ODP

Metadata

IRI

http://w3id.org/CEON/ontology/processODP/

Title

Circular Economy Ontology Network (CEON) - Process ODP

Creator

Huanyu Li

Contributor

Eva Blomqvist

Mikael Lindecrantz

Robin Keskisärkkä

Date Created

2023-03-23

License

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Version Iri

http://w3id.org/CEON/ontology/processODP/0.1/

Version Info

0.1

Preferred Namespace Prefix

processODP

Preferred Namespace Uri

http://w3id.org/CEON/ontology/processODP/

Description

A core ODP of the CEON ontology network, defining aspects of the process concept.

Covers Requirements

Covers the following requirements from Onto-DESIDE D3.1: CVN-Process-3,4,5, C3-1, C4-2, C4-5, C4-7, C4-9, C13-2, E2-6

Classes

Process Participation [c]

IRI	http://w3id.org/CEON/ontology/actor/ProcessParticipation
Restriction	actorODP:participationIn [op] some actor:ProcessParticipation [c]

Process [c]

IRI	http://w3id.org/CEON/ontology/processODP/Process
Description	An activity in the context of a circular value network, handling resources.
In Domain Of	has part [op] has process execution [op] has process type [op] next process [op]
In Range Of	has part [op] next process [op]
Super Class Of	Transformation [c]

Process execution [c]

IRI	http://w3id.org/CEON/ontology/processODP/ProcessExecution
Description	An execution of a specific process.
In Range Of	has process execution [op]

Process type [c]

IRI	http://w3id.org/CEON/ontology/processODP/ProcessType
Description	The type of a process.
In Range Of	has process type [op]

Situation [c]

IRI	http://w3id.org/CEON/ontology/processODP/Situation
Description	A situation that may involve some resources and actors, i.e. a state of affairs at a certain point in time.
In Domain Of	is the setting for [op]
In Range Of	initial situation [op] resulting situation [op]

Transformation [c]

IRI	http://w3id.org/CEON/ontology/processODP/Transformation
Description	A process that transforms some situation into another situation, i.e. changes the state of affairs of some actor, resource etc.
Sub Class Of	Process [c]
In Domain Of	has input [op] has output [op] initial situation [op] occurs in location [op] resulting situation [op]

Object Properties

participation in [op]

IRI	http://w3id.org/CEON/ontology/actorODP/participationIn

has input [op]

IRI	http://w3id.org/CEON/ontology/processODP/hasInput
Description	The situation before the transformation takes place, i.e. the state of affairs before the process takes places, such as the set of components before they are assembled into a product.
Domain	Transformation [c]

has output [op]

IRI	http://w3id.org/CEON/ontology/processODP/hasOutput
Description	The output situation of a transformation, i.e. the state of affairs after the transformation took place.
Domain	Transformation [c]

has part [op]

IRI	http://w3id.org/CEON/ontology/processODP/hasPart
Description	A process can consists of several part, which are sub-processes.
Domain	Process [c]
Range	Process [c]

has process execution [op]

IRI	http://w3id.org/CEON/ontology/processODP/hasProcessExecution
Description	A process can have specific executions.
Domain	Process [c]
Range	Process execution [c]

has process type [op]

IRI	http://w3id.org/CEON/ontology/processODP/hasProcessType
Description	The type of the process.
Domain	Process [c]
Range	Process type [c]

initial situation [op]

IRI	http://w3id.org/CEON/ontology/processODP/intialSituation
Description	The situation before executing a process.
Domain	Transformation [c]
Range	Situation [c]

is the setting for [op]

IRI	http://w3id.org/CEON/ontology/processODP/isSettingFor
Description	The thing(s) that this situation is the setting for, e.g. a resource that is in a certain state.
Domain	Situation [c]

next process [op]

IRI	http://w3id.org/CEON/ontology/processODP/nextProcess
Description	A relation between one process and the next one following it in some sequence of processes, e.g. a sequence of transformations in a material flow.
Domain	Process [c]
Range	Process [c]

occurs in location [op]

IRI	http://w3id.org/CEON/ontology/processODP/occursInLocation
Description	The location in which a transformation takes place, e.g. the factory location where something is manufactured.
Domain	Transformation [c]

resulting situation [op]

IRI	http://w3id.org/CEON/ontology/processODP/resultingSituation
Description	The situation after the execution of a process.
Domain	Transformation [c]
Range	Situation [c]

Annotation Properties

contributor ap

IRI	http://purl.org/dc/terms/contributor

created ap

IRI	http://purl.org/dc/terms/created

creator ap

IRI	http://purl.org/dc/terms/creator

description ap

IRI	http://purl.org/dc/terms/description

license ap

IRI	http://purl.org/dc/terms/license

title ap

IRI	http://purl.org/dc/terms/title

preferred namespace prefix ap

IRI	http://purl.org/vocab/vann/preferredNamespacePrefix

preferred namespace uri ap

IRI	http://purl.org/vocab/vann/preferredNamespaceUri

covers requirements ap

IRI	http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#coversRequirements

Namespaces

:

http://w3id.org/CEON/ontology/processODP/

actor

http://w3id.org/CEON/ontology/actor/

actorODP

http://w3id.org/CEON/ontology/actorODP/

dcterms

http://purl.org/dc/terms/

odp

http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#

owl

http://www.w3.org/2002/07/owl#

prov

http://www.w3.org/ns/prov#

rdf

http://www.w3.org/1999/02/22-rdf-syntax-ns#

rdfs

http://www.w3.org/2000/01/rdf-schema#

vann

http://purl.org/vocab/vann/

Legend

c	Classes
op	Object Properties
ap	Annotation Properties

Circular Economy Ontology Network (CEON) - Product Module

Metadata

IRI

http://w3id.org/CEON/ontology/product/

Title

Circular Economy Ontology Network (CEON) - Product Module

Creator

Huanyu Li

Contributor

Eva Blomqvist

Mikael Lindecrantz

Robin Keskisärkkä

Date Created

2023-03-16

License

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Version Iri

http://w3id.org/CEON/ontology/product/0.2/

Version Info

0.2

Preferred Namespace Prefix

product

Preferred Namespace Uri

http://w3id.org/CEON/ontology/product/

Description

The Product module of CEON (Circular Economy Ontology Network).

Covers Requirements

In addition to requirements covered by imported ODPs, covers the following requirements from Onto-DESIDE D3.1: CVN-Resource-2, CVN-ResrouceType-4, C11-2, C12-1, C13-3, E2-1, T8-3.

Classes

Matter composition [c]

IRI	http://w3id.org/CEON/ontology/product/MatterComposition
Description	A product composition is the composed information of a product in terms of a specific component, in which such a component is also a matter.
Sub Class Of	resourceODP:Composition
In Domain Of	associated with matter [op]
Restriction	associated with matter [op] *exactly* 1 Matter composition [c]

Product model [c]

IRI	http://w3id.org/CEON/ontology/product/Product
Description	Represents the common sense notion of a product, i.e. the abstract notion of a product type or product model, which is a model that is used for manufacturing products.
In Range Of	associated with product model [op] batch of products [op] modelled by [op]
Restriction	has composition [op] some Product model [c] has composition [op] some Product model [c]

Product composition [c]

IRI	http://w3id.org/CEON/ontology/product/ProductComposition
Description	A product composition is the composed information of a product in terms of a specific component, in which such a component is also a product.
Sub Class Of	resourceODP:Composition
In Domain Of	associated with product model [op]
Restriction	associated with product model [op] *exactly* 1 Product composition [c]

Product object [c]

IRI	http://w3id.org/CEON/ontology/product/ProductObject
Description	A product object is a physical object put into a market for sale, i.e. corresponding to the notion of an item, which conforms to the abstract idea of a product model. The product can be a thing that grows naturally or produced through some chemical or manufacturing processes.
Sub Class Of	resourceODP:PhysicalObject
In Domain Of	has product component [op] modelled by [op]
In Range Of	has product component [op]
Restriction	modelled by [op] *exactly* 1 Product object [c]

Object Properties

associated with matter [op]

IRI	http://w3id.org/CEON/ontology/product/associatedWithMatter
Description	associatedWithMatter intends to represent the matter to which a matter compopsition information regards to.
Domain	Matter composition [c]
Range	resourceODP:Matter

associated with product model [op]

IRI	http://w3id.org/CEON/ontology/product/associatedWithProductModel
Description	associatedWithProductModel intends to represent the matter to which a product compopsition information regards to.
Domain	Product composition [c]
Range	Product model [c]

batch of products op

IRI	http://w3id.org/CEON/ontology/product/batchOfProduct
Description	batchOfProduct intends to represent what is the model product of a batch of objects.
Domain	resourceODP:BatchOfObjects
Range	Product model c

has composition op

IRI	http://w3id.org/CEON/ontology/product/hasComposition
Description	hasComposition intends to represent that a product model or physical object can have compostition information.
Domain	Product model c *or* resourceODP:PhysicalObject c
Range	resourceODP:Composition

has product component op

IRI	http://w3id.org/CEON/ontology/product/hasProductComponent
Description	hasProductComponent intends to represent that a product can have other product components.
Domain	Product object c
Range	Product object c

modelled by op

IRI	http://w3id.org/CEON/ontology/product/modelledBy
Description	modelledBy intends to represent that product objects follow particular product models.
Domain	Product object c
Range	Product model c

Datatype Properties

Composition quantity dp

IRI	http://w3id.org/CEON/ontology/product/compositionQuantity
Description	compositionQuantity intends to represent the quantity value of composed elements of a composition. The quantity value can be the number of a element or the percentage of a element.
Domain	resourceODP:Composition
Range	xsd:positiveInteger c *or* xsd:double c

Annotation Properties

contributor ap

IRI	http://purl.org/dc/terms/contributor

created ap

IRI	http://purl.org/dc/terms/created

creator ap

IRI	http://purl.org/dc/terms/creator

description ap

IRI	http://purl.org/dc/terms/description

license ap

IRI	http://purl.org/dc/terms/license

title ap

IRI	http://purl.org/dc/terms/title

preferred namespace prefix [ap]

IRI http://purl.org/vocab/vann/preferredNamespacePrefix

preferred namespace uri [ap]

IRI http://purl.org/vocab/vann/preferredNamespaceUri

covers requirements [ap]

IRI http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#coversRequirements

Namespaces

:

http://w3id.org/CEON/ontology/product/

dcterms

http://purl.org/dc/terms/

odp

http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#

owl

http://www.w3.org/2002/07/owl#

prov

http://www.w3.org/ns/prov#

rdf

http://www.w3.org/1999/02/22-rdf-syntax-ns#

rdfs

http://www.w3.org/2000/01/rdf-schema#

resourceODP

http://w3id.org/CEON/ontology/resourceODP/

vann

http://purl.org/vocab/vann/

xsd

http://www.w3.org/2001/XMLSchema#

Legend

c	Classes
op	Object Properties
dp	Datatype Properties
ap	Annotation Properties

Circular Economy Ontology Network (CEON) - Resource ODP

Metadata

IRI

http://w3id.org/CEON/ontology/resourceODP/

Title

Circular Economy Ontology Network (CEON) - Resource ODP

Creator

Huanyu Li

Contributor

Eva Blomqvist

Mikael Lindecrantz

Robin Keskisärkkä

Date Created

2023-03-16

License

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Version Iri

http://w3id.org/CEON/ontology/resourceODP/0.2/

Version Info

0.2

Preferred Namespace Prefix

resourceODP

Preferred Namespace Uri

http://w3id.org/CEON/ontology/resourceODP/

Description

A core ODP of the CEON ontology network defining aspects of the resource concept.

Covers Requirements

Covers the following requirements from Onto-DESIDE D3.1: CVN-Resource-1,3, CVN-Composition-1,2, CVN-ResrouceType-4, C7-3, E2-2, E4-6, E5-1, E6-3, T3-1.

Classes

Batch of objects [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/BatchOfObjects
Description	A batch of objects is a collection of physical objects that are of the same type, e.g. a set of items (product objects) adhering to the same product model.
Sub Class Of	Resource [c] has physical object [op] some Physical object [c] *and* has physical object [op] only Physical object [c]
In Domain Of	batch size [dp]
In Range Of	has batch [op]
Restriction	batch size [dp] *exactly* 1 Batch of objects [c]

Composition [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/Composition
Description	A composition is used to represent how a whole or mixture is made up. E.g., for chemical elements composing a chemical structure, the compostion should hold information of the ratio of the composing chemical elments.

Constituent [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/Constituent
Description	A constituent is a component of object.
In Range Of	has constituent [op]

Digital object [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/DigitalObject
Description	A digital object, e.g. a computer file, that is located on some server, hard drive, or on the web. Most often the digital object is the realization of some piece of information.
Sub Class Of	Resource [c]

Information [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/Information
Description	Information is an abstract concept that represents any kind of interpretations. For instance, information can be data generated by software systems or data used by people for communications.
Sub Class Of	Resource [c]
In Domain Of	contains information [op] is about [op]
In Range Of	contains information [op] is realization of [op]

Matter [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/Matter
Description	A matter is a physical substance.
In Range Of	has matter [op]

Physical object [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/PhysicalObject
Description	A physical object is a collection of matter.
Sub Class Of	Resource [c] has constituent [op] only Constituent [c] *and* has constituent [op] some Constituent [c] has matter [op] some Matter [c] *and* has matter [op] only Matter [c]
In Domain Of	has constituent [op] has matter [op]
In Range Of	has physical object [op]

Resource [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/Resource
Description	A resource able to be handled in the context of a circular value network, e.g. data generated by software systems in the CVN, materials or prooducts as physical objects handled in the CVN.
Super Class Of	Batch of objects [c] Digital object [c] Information [c] Physical object [c] Set of objects [c]

Set of objects [c]

IRI	http://w3id.org/CEON/ontology/resourceODP/SetOfObjects
Description	A set of objects is a set of physical objects (items) that can be of different types, i.e. different kinds of items.
Sub Class Of	Resource [c] has batch [op] some Batch of objects [c] *and* has batch [op] only Batch of objects [c] has physical object [op] only Physical object [c] *and* has physical object [op] some Physical object [c]
In Domain Of	has batch [op]

Object Properties

contains information [op]

IRI	http://w3id.org/CEON/ontology/resourceODP/containsInformation
Description	Indicating that some piece of information is contained in a larger collection of information, e.g. a data sheet contains a statement about a certain parameter of a product.
Sub Property Of	has part [op]
Domain	Information [c]
Range	Information [c]

has batch [op]

IRI	http://w3id.org/CEON/ontology/resourceODP/hasBatch
Description	hasBatch intends to represent that a set of objects can be captured by a number of batches where each batch contains a number of physical objects.
Domain	Set of objects [c]
Range	Batch of objects [c]

has constituent [op]

IRI	http://w3id.org/CEON/ontology/resourceODP/hasConstituent
Description	hasConstitutent intends to represent that a physical object can have a collection of composing components.
Sub Property Of	has part [op]
Domain	Physical object [c]
Range	Constituent [c]

has matter [op]

IRI	http://w3id.org/CEON/ontology/resourceODP/hasMatter
Description	hasMatter intends to represent that a physical object can have a collection of matter.
Domain	Physical object [c]
Range	Matter [c]

has part [op]

IRI	http://w3id.org/CEON/ontology/resourceODP/hasPart
Description	Indicating that something is part of or is contained by something else.
Super Property Of	• contains information [op] • has constituent [op]

has physical object [op]

IRI	http://w3id.org/CEON/ontology/resourceODP/hasPhysicalObject
Description	hasPhysicalObject intends to represent that a batch of objects or a set of objects can have composing components of physical objects.
Domain	Batch of objects [c] *or* Set of objects [c]
Range	Physical object [c]

is about [op]

IRI	http://w3id.org/CEON/ontology/resourceODP/isAbout
Description	Connecting the information to the object (physical, virtual, imaginary) that the information is about.
Domain	Information [c]

is realization of [op]

IRI	http://w3id.org/CEON/ontology/resourceODP/isRealizationOf
Description	Relates a thing, e.g. a digital object, or a physical object, to the information it is a realization of. C.f. a physical book that is the realization of a novel, or a pdf or Excel-file that is a realization of a certain data sheet.
Range	Information [c]

Datatype Properties

batch size [dp]

IRI	http://w3id.org/CEON/ontology/resourceODP/batchSize
Description	batchSize intends to repsent how many physical objects are belong to a batch of objects.
Domain	Batch of objects [c]
Range	xsd:nonNegativeInteger

Annotation Properties

description ap

IRI http://purl.org/dc/elements/1.1/description

contributor ap

IRI http://purl.org/dc/terms/contributor

created ap

IRI http://purl.org/dc/terms/created

creator ap

IRI http://purl.org/dc/terms/creator

description ap

IRI http://purl.org/dc/terms/description

license ap

IRI http://purl.org/dc/terms/license

title ap

IRI http://purl.org/dc/terms/title

preferred namespace prefix ap

IRI http://purl.org/vocab/vann/preferredNamespacePrefix

preferred namespace uri ap

IRI http://purl.org/vocab/vann/preferredNamespaceUri

covers requirements ap

IRI	http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#coversRequirements

Namespaces

:

http://w3id.org/CEON/ontology/resourceODP/

dc

http://purl.org/dc/elements/1.1/

dcterms

http://purl.org/dc/terms/

odp

http://www.ontologydesignpatterns.org/schemas/cpannotationschema.owl#

owl

http://www.w3.org/2002/07/owl#

prov

http://www.w3.org/ns/prov#

rdf

http://www.w3.org/1999/02/22-rdf-syntax-ns#

rdfs

http://www.w3.org/2000/01/rdf-schema#

vann

http://purl.org/vocab/vann/

xsd

http://www.w3.org/2001/XMLSchema#

Legend

c	Classes
op	Object Properties
dp	Datatype Properties
ap	Annotation Properties

Circular Economy Ontology Network (CEON) - Value Module

Metadata

IRI

http://w3id.org/CEON/ontology/value/

Title

Circular Economy Ontology Network (CEON) - Value Module

Creator

Eva Blomqvist

Contributor

Huanyu Li

Mikael Lindecrantz

Robin Keskisärkkä

Date Created

2023-03-30

License

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Version Iri

http://w3id.org/CEON/ontology/value/0.1/

Version Info

0.1

Preferred Namespace Prefix

value

Preferred Namespace Uri

https://w3id.org/CEON/ontoloy/value/

Description

A core ODP of the CEON ontology network, defining aspects of the value concept. Currently a "stub" for future extension.

Classes

Value [c]

IRI	http://w3id.org/CEON/ontology/value/Value
Description	Some notion of value.

Value proposition [c]

IRI	http://w3id.org/CEON/ontology/value/ValueProposition
Description	Proposed or intended value outcome of some process, action or collaboration.

Annotation Properties

contributor [ap]

IRI	http://purl.org/dc/terms/contributor

creator [ap]

IRI	http://purl.org/dc/terms/creator

description [ap]

IRI	http://purl.org/dc/terms/description

title [ap]

IRI	http://purl.org/dc/terms/title

preferred namespace prefix [ap]

IRI	http://purl.org/vocab/vann/preferredNamespacePrefix

preferred namespace uri [ap]

IRI	http://purl.org/vocab/vann/preferredNamespaceUri

Namespaces

:

http://w3id.org/CEON/ontology/value/

dcterms

http://purl.org/dc/terms/

owl

http://www.w3.org/2002/07/owl#

prov

http://www.w3.org/ns/prov#

rdf

http://www.w3.org/1999/02/22-rdf-syntax-ns#

rdfs

http://www.w3.org/2000/01/rdf-schema#

vann

http://purl.org/vocab/vann/

xsd

http://www.w3.org/2001/XMLSchema#

Legend

c	Classes
ap	Annotation Properties