

A Survey of General Ontologies for the Cross-Industry Domain of Circular Economy

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Agenda

- Motivation and Background
- Survey Scope and Methodology
- Overview of Existing Ontologies and Standards
- Outlook

Motivation and Background

- Circular Economy

“a model of production and consumption, which aims to share, lease, reuse, repair, refurbish and recycle existing materials and products as long as possible”

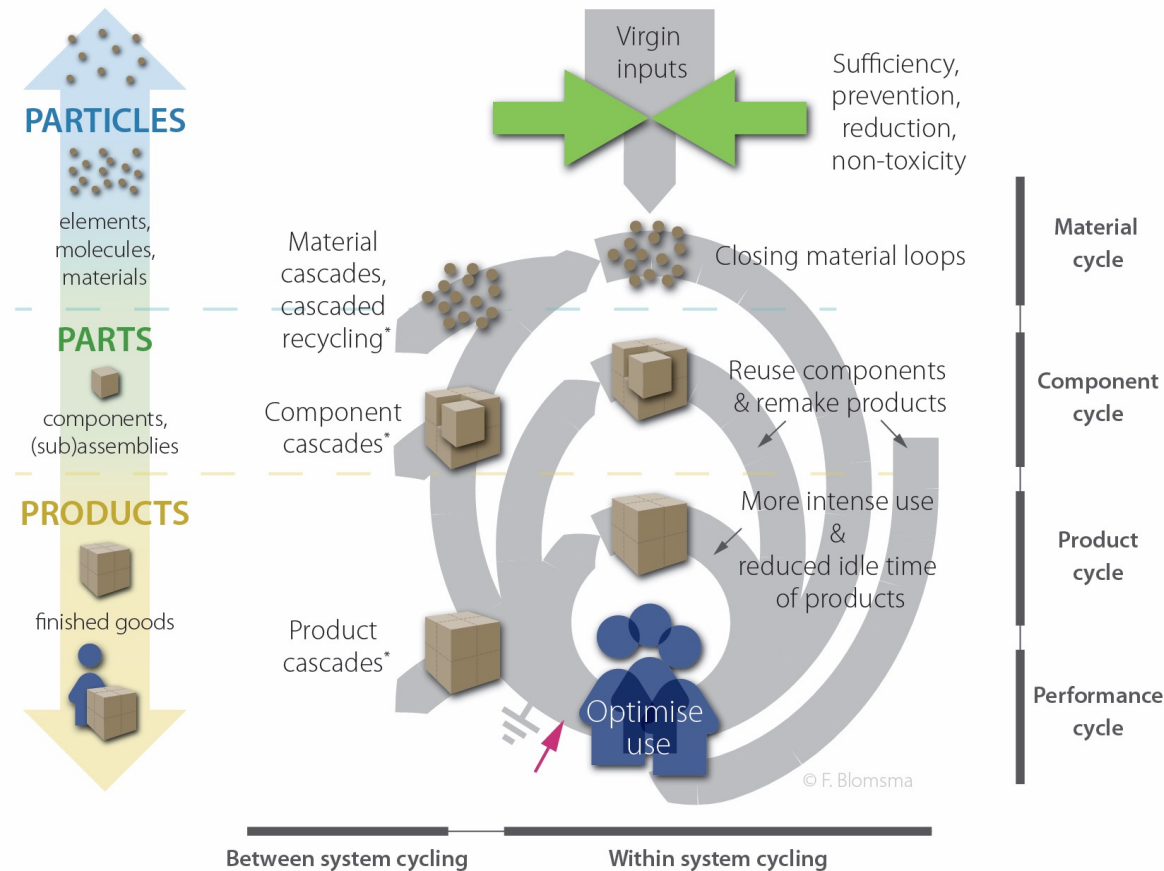
- Circular Value Network

- Configurations of multiple actors
- Information, Resources, Energy and Value flows
- Different domains are involved (e.g., production, manufacturing, materials)

- Data/Information from cross-industry domains are today not built on a common conceptual ground

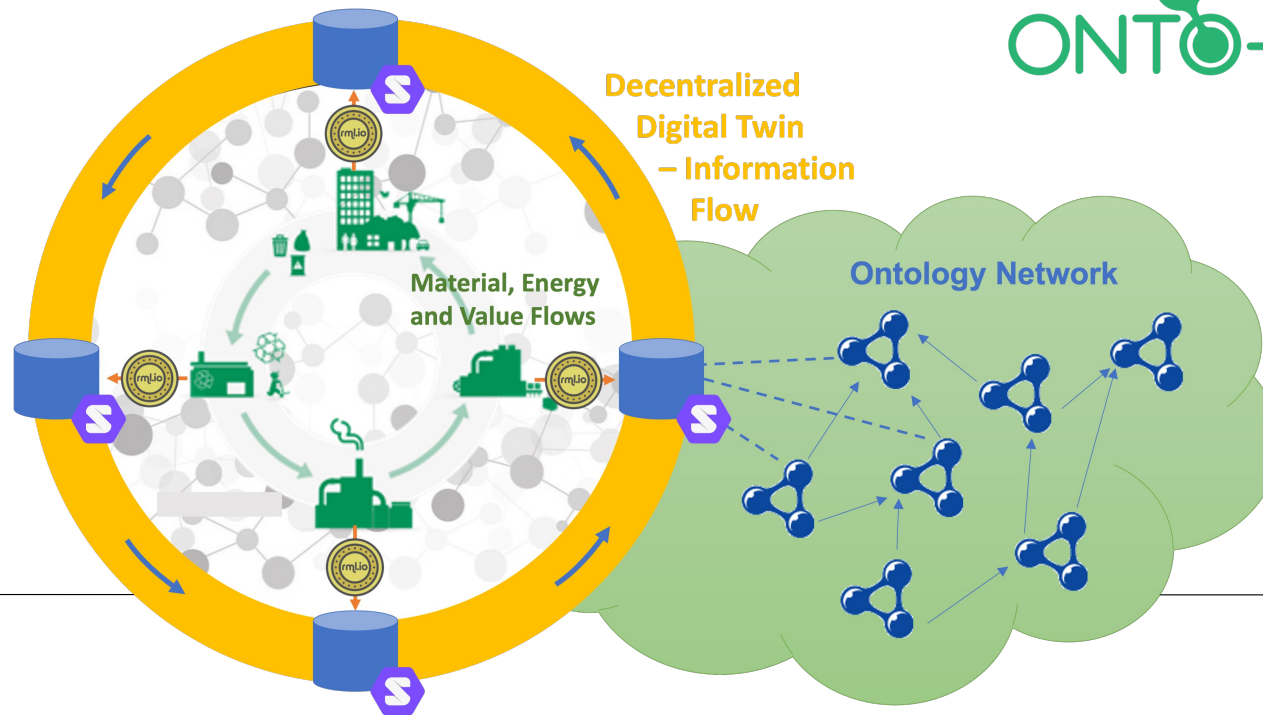
Motivation and Background

- Circular Strategies



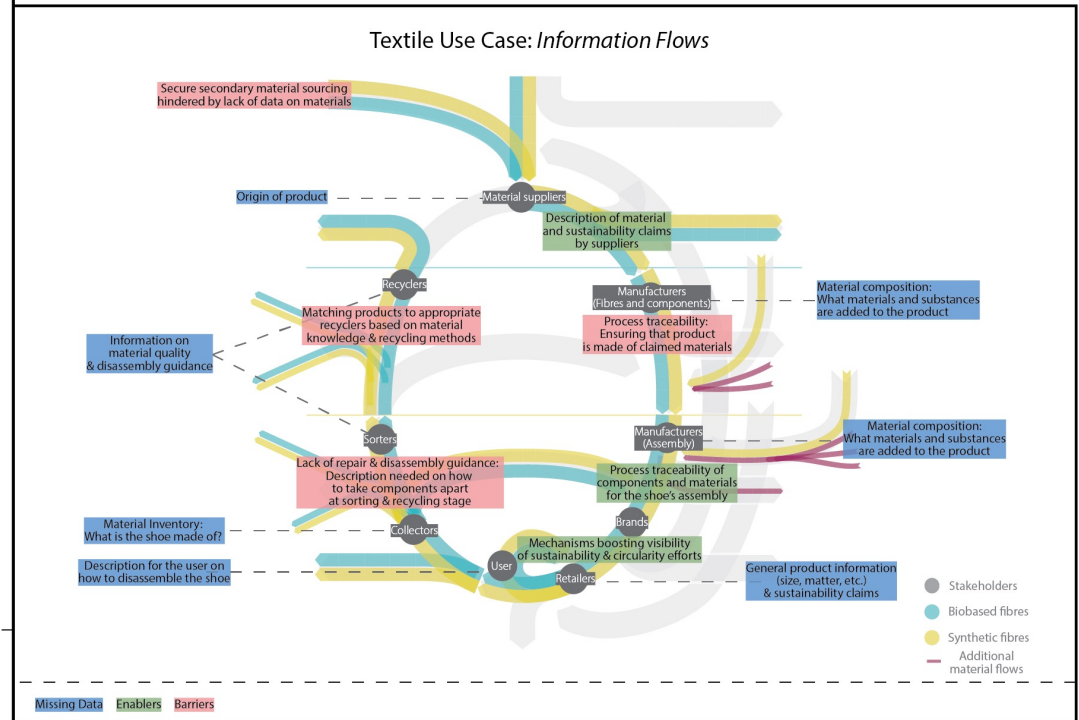
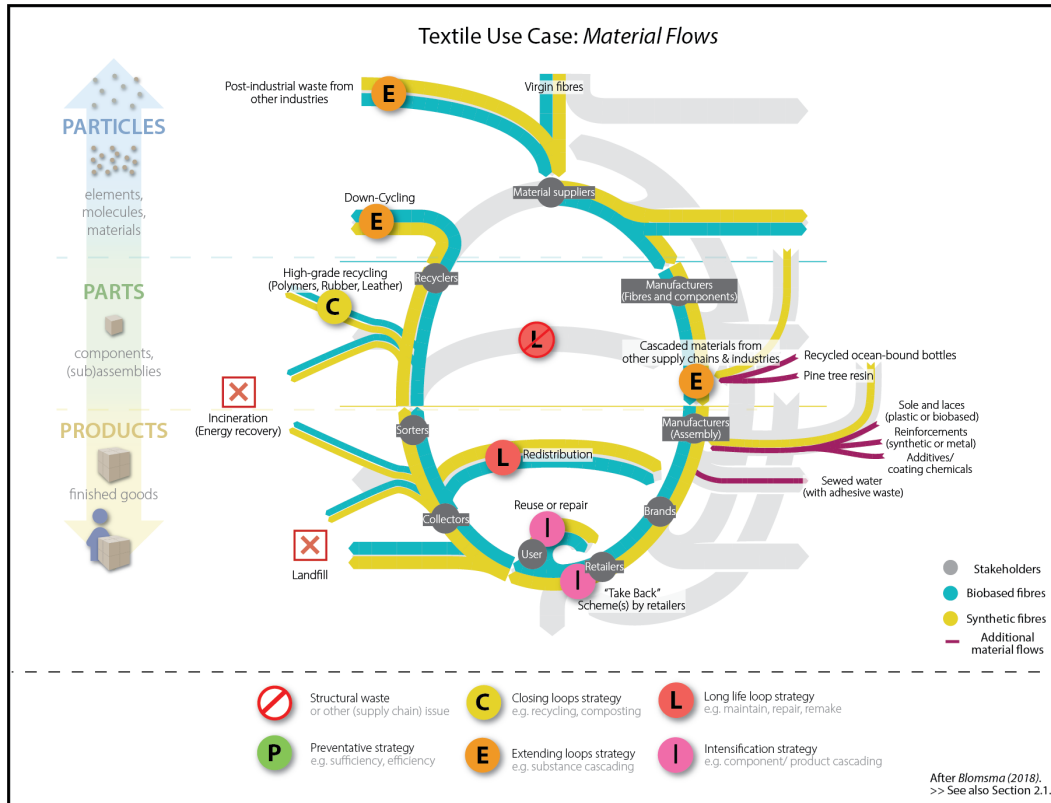
Motivation and Background

- Onto-DESIDE project (Ontology-based DEcentralized SHaring of Industry Data in the European circular economy)
 - A shared vocabulary (Ontology Network)
 - An open platform for data sharing
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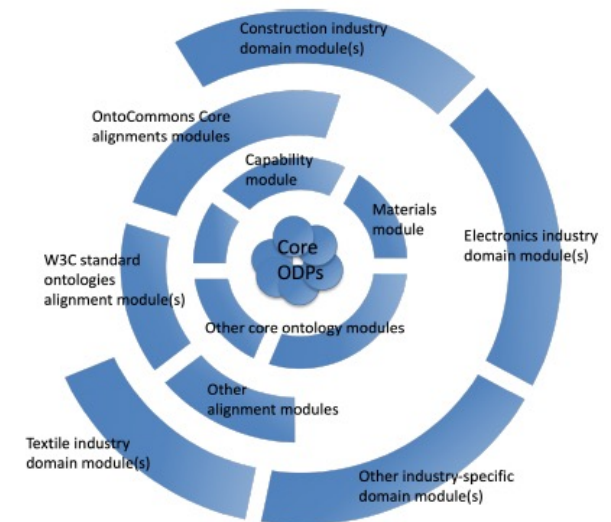
ONTO-DESIDE

Motivation and Background



Motivation and Background

- Before we develop an ontology network we conduct a survey of existing ontologies in the relevant cross-industry domains
- We assume that
 - some of these ontologies can be reused or linked to Onto-DESIDE ontology network directly
 - some might not be reused directly, but we plan to provide an alignment to achieve semantic interoperability



Survey Scope and Methodology

- Focus domains
 - Circular Economy, Sustainability, Materials, Manufacturing, Products, Logistics
- Collecting ontologies
 - Public repositories
 - MatPortal
 - IndustryPortal
 - OntoCommons ontology catalogue
 - Ontobee
 - Linked Open Vocabularies
 - Google and Google Scholar



What are the characteristics of existing ontologies of the cross-industry domains?

How may these ontologies be used or adapted for knowledge representation in the CE domain?

Overview of Found Ontologies – Total: 37 ontologies

- Focus domains
 - Circular Economy (4), Sustainability (6)
 - Manufacturing (15), Products (10), Logistics (8)
 - Materials (9)

Domain	AMO [36]	BCAO [37]	BiOnto [4]	BONSAI-core [16]	BPO [62]	BUILDMAT [59]	BWMD-Domain [49]	CAMO [47]	CEO [47]	CHAMP [51]	COMPOSITION [45]	ENVO [7]	GPO [55]	GRACE [28]	IMANO [22]	IOF-core [14]	ManuService [32]	MASON [29]	MATONTO [9]	MDO [31]	MPO [43]	MSDL [1]	MSO-OFM [8]	NMRVOCAB [35]	PRONTO [60]	PSS [33]	ROMAIN [21]	SAREF [12]	SAREF4ENVR [11]	SAREF4ENVI [42]	SAREF4INMA [13]	SDGIO [44]	SCONTO [61]	SCOR [41]	UNSPSC [17]	VERONTO [54]	Z-BRE4K [10]	Total	
CE	✓	✓						✓	✓																														4
SU			✓	✓								✓																	✓	✓		✓							6
MAT	✓					✓	✓	✓									✓		✓	✓	✓			✓														9	
MAN	✓						✓			✓	✓		✓	✓		✓	✓	✓				✓	✓				✓				✓				✓	✓		15	
PR	✓			✓	✓					✓					✓		✓								✓	✓									✓	✓		10	
LO											✓		✓		✓		✓						✓				✓						✓	✓				8	
General																												✓										1	

Existing Ontologies

- For the Circular Economy and Sustainability domains
 - Topics on business models, waste, recycling, sustainability, environment, etc.
- Not so many ontologies for these two domains
- Some ontologies target specific industry use cases, while considering CE

Main open issues:

- Lack of coverage
- Lack of focus on the collaborations and the network and its actors
- Industry domain-specific efforts

Existing Ontologies

- For the Manufacturing, Products and Logistics domains
 - Topics on manufacturing process, product life cycle, production, supply chain, etc.

- In a CVN, a resource can be realized in different states

- Particles (materials), Parts (components), Products (finished products)
- Manufacturing and logistics operations
- The three domains are tightly connected, not just one domain

- The modeling focuses include manufacturing concepts (e.g., participating people or machines)

Main open issues:

- Too many ontologies? Alignments?
 - Perspectives and context

Existing Ontologies

- For the Materials domain
 - Topics on raw materials, material composition, etc.
- Many ontologies exist, targeting very diverse domains in materials science
- Materials structure, materials
- The challenge for modeling detail and micro-structural representation for different

Main open issues:

- Flexible levels of granularity
- Perspectives and context

Existing Standards

➤ A basis for extracting relevant terms for developing ontologies

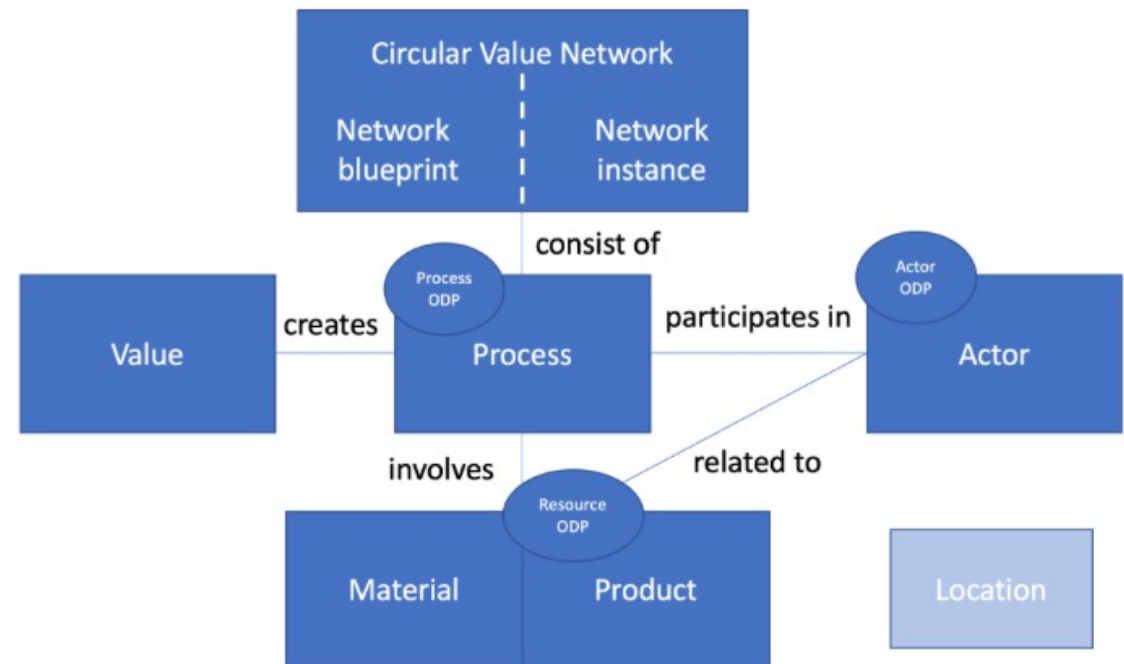
- ISO/EU work focusing on circular economy
- ISO/EU work focusing on general domains (e.g., waste collection, process, energy management)
- International organization standardization work
 - Global Traceability Standard
 - Ecodesign requirements

Open Challenges

- Circular Economy domain itself is not yet properly covered
- Cross-industry domain ontologies use the same or similar terms to represent concepts but with different ontological commitment
- Some ontologies are “lightweight” without many logical axioms defined but some contain more logical axioms
- How to use top-level ontologies (e.g., BFO, EMMO) to improve interoperability?
- How to represent and connect (flexibly) different levels of granularity, perspectives, and contexts?

Ongoing work in Onto-DESIDE

- Ontology Network development
 - First drafts are online:
<https://w3id.org/CEON/>
 - Focus is on capturing different perspectives and contextualization
- Alignment to other ontologies
 - E.g., EMMO



Thank you! Questions?