ONTO COMMONS
ONTOLOGY-DRIVEN DATA DOCUMENTATION FOR INDUSTRY COMMONS

OntoCommons

ROADMAP

OntoCommons Roadmap

https://ontocommons.eu/roadmap

- *Nadja Adamovic (TU Wien)*

OntoCommons "Ontology-driven data documentation for Industry Commons" has received funding from the European Union's Horizon Programme call H2020 -NMBP-TO-IND-2020-singlestage, Grant Agreement number 958371

Agenda

13:00 - *Welcome & introduction* - Nadja Adamovic (TU Wien)
13:10 - *Top Reference Ontology* - Emanuele Ghedini (UNIBO)
13:18 - *Industrial Domain Ontologies* - Arkopaul Sarkar (ENIT)
13:26 - *Ontology Commons EcoSystem Toolkit* - Hedi Karray (ENIT)
13:34 - *Infrastructure* - Florina Piroi (TU Wien)
13:42 - *Industrial Application* - Umutcan Simsek (UIBK)
13:50 - *Standardisation* - Silvana Muscella (Trust-IT)
13:58 - *Knowledge Management Translator for Industry Commons* - Gerhard Goldbeck (GCL)
14:06 - *Ontology-based digital-marketplaces cooperation* - Joana Francisco Morgado (Fraunhofer)
14:14 - *Innovation and perspectives* - Michela Magas (ICF)
14:23 - *Conclusion* - Nadja Adamovic (TU Wien) & Hedi Karray (ENIT)

Introduction

OntoCommons CSA

HORIZON 2020

Topic: Towards Standardised Documentation of Data through taxonomies and ontologies

Start date: 11/2020 , Duration: 3 years

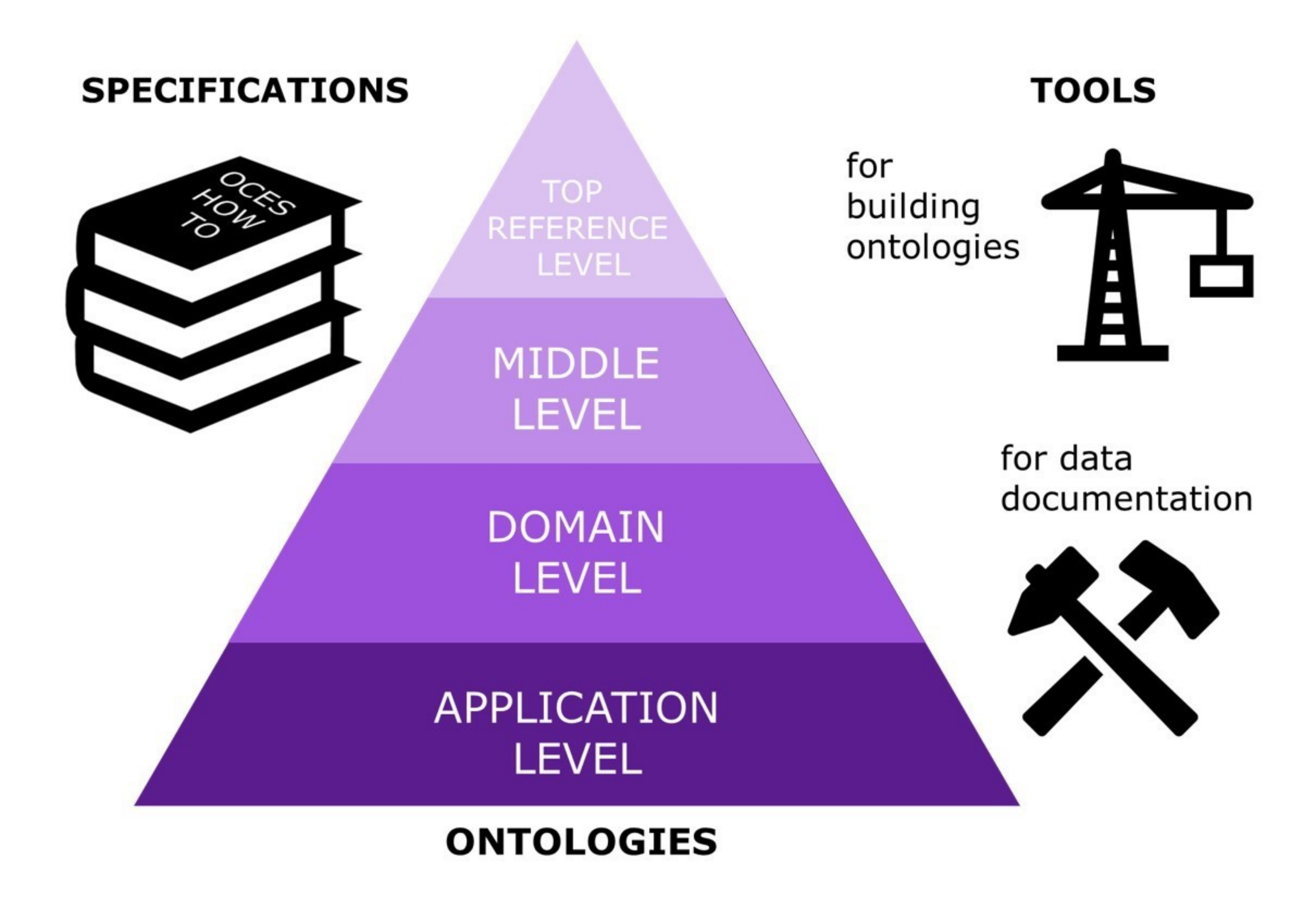
OntoCommons Project

Data sharing within and across domains can offer enormous opportunities for innovation and for overcoming various bottlenecks in industry.

OntoCommons aims at

- community development
- developing an Ontology Commons EcoSystem (OCES)
- demonstration cases: to prove effectiveness of OCES
- harmonizing data documentation through ontologies and taxonomies, making the data FAIR
- enabling intra- and cross-domain interoperability

Ontology Commons EcoSystem



OntoCommons Roadmap

considers a number of topics contributing to an Ontology Commons Ecosystem for ontology-based data documentation:

1. Ontology Foundations: Top Reference, Middle, Domain and Application Levels
2. Integrated Development Environment (Tools) and Infrastructures
3. Industrial Impact including Marketplaces, Standardisation, Education and Human Resources

The Roadmap presents:

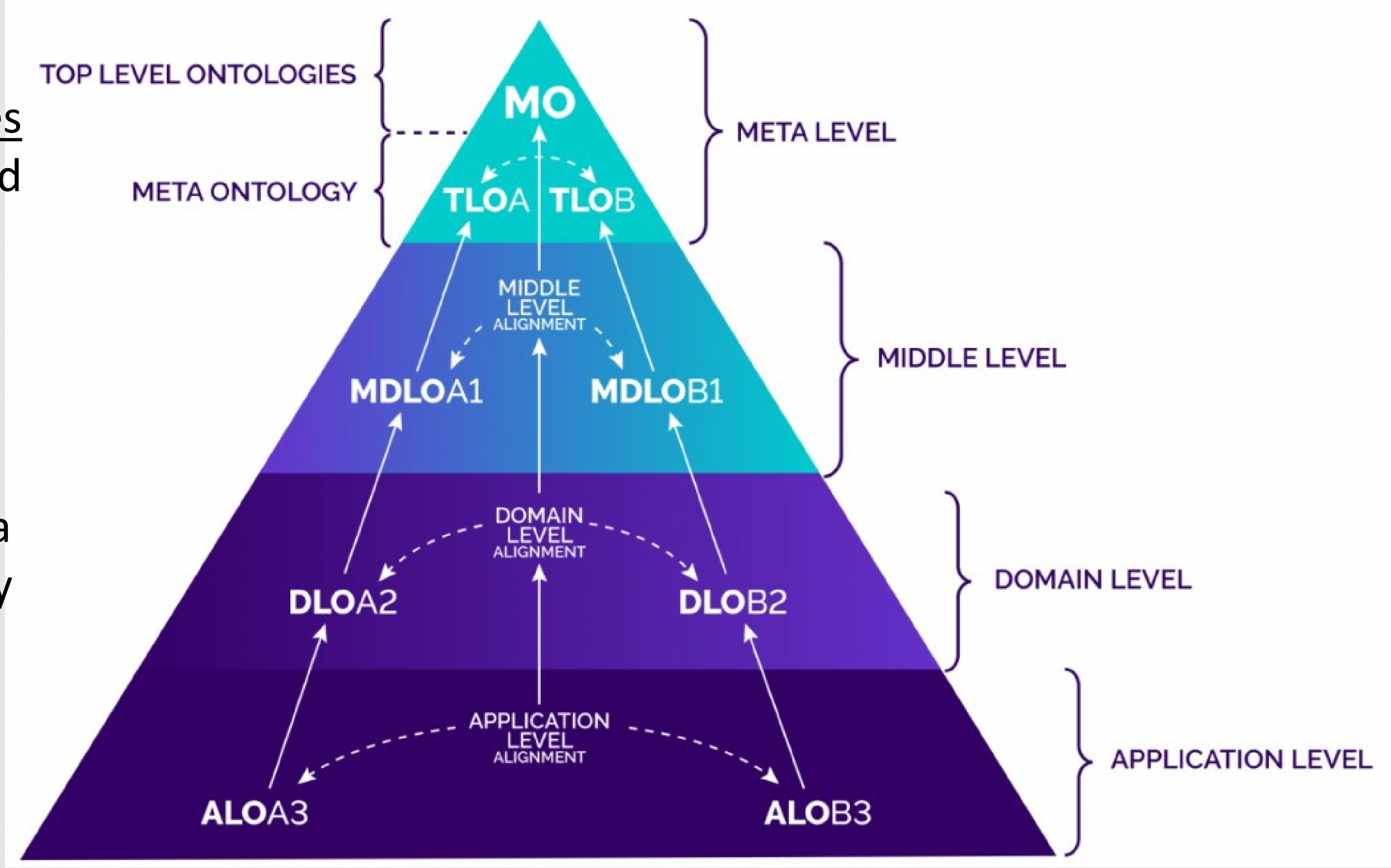
Needs, State of the Art, Gaps, Definition of Success and Recommended Actions

Ontology Foundations

- create a system of interoperable ontologies based on widely accepted and used TLO/MLO/DLO

- has a plurastic approach, recognising that there are different TLOs

- introduced the concept of a TRO, defining a common foundation for data interoperability to enable knowledge sharing across TLOs



Integrated Development Environment

- A well-supported integrated environment is required in order to develop, maintain and use ontologies.
- An environment that makes it easy and efficient to map existing data sources to ontological concepts would speed up the development of ontologies and increase their sustainability and impact.

The Ontology Commons EcoSystem (OCES) Toolkit provides a specification for both methodological and tool support for industry-oriented ontology development, maintenance, and usage. The Toolkit consists of state-of-the-art methodologies as well as references and specifications for tools.

Industrial Impact

The adoption of ontology-based data documentation and knowledge management practices in industry is still at a low level, with some noteworthy exceptions.

To reach wider adoption and impact, the ontologies, tools and infrastructure, as well as human resources, need to be developed.

Industry can expect to reap substantial benefits including:

- Standardised data documentation and FAIR data within and across organisations;
- Improved communication within a company;
- Time and cost saving;
- Increased innovation capacity; and
- Optimised product quality and environmental footprint.

Industrial Impact

- In addition to the benefits for individual companies, there are huge untapped opportunities of data sharing in an "Industry Commons".

- A system of digital marketplaces can support needs such as data integration and interoperability, as well as improving the transfer of data between industries and marketplaces.

Roadmap Chapters

- TOP Reference Ontology
- Industrial Domain Ontologies
- Ontology Commons EcoSystem Toolkit
- Infrastructure
- Industrial Application
- Standardisation
- Knowledge Management Translator for Industry Commons
- Ontology-based digital-marketplaces cooperation
- Innovation and perspectives

Needs
State-of-the-art
Gaps
Definition of Success
Recommended Actions

- Thank you very much for your attention!

- **Follow us on**

- *Questions*

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OntoCommons Roadmap Webinar

- Chapter 3.1 – Top Reference Ontology

- *Emanuele Ghedini (UNIBO)*

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Introduction

As requested by the call text, a single apical ontology, called the *OntoCommons* **Top Reference Ontology (TRO)** will be provided to enable a common foundation for data interoperability between TLOs and lower level ontologies.

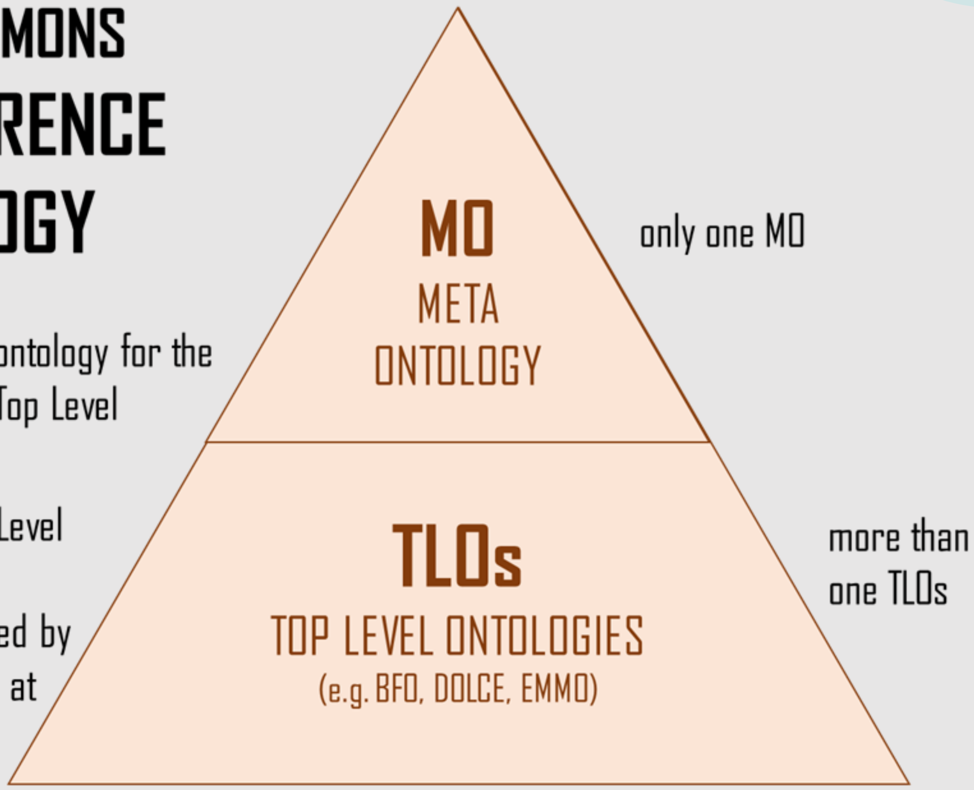
The structure of the TRO is designed in order to provide:

i) a **pluralistic perspective** in the choice of a TLO for lower level ontology development or harmonisation, and at the same time

ii) allow **TLOs comparison and interoperability** as foundation for harmonisation and data sharing between ontologies based on different TLOs.

OntoCommons Top Reference Ontology

- a Meta Ontology, i.e. an ontology for the alignement of available Top Level Ontologies
- a set of well known Top Level Ontologies whose interoperability is granted by the alignement provided at Meta Level



Industrial Needs

NEED #	NEED DESCRIPTION
1	**COVERING THE GAP BETWEEN HUMAN AND DIGITAL TOOLS (INDUSTRY 5.0)** The need for expressing human knowledge through a widely applicable and general methodology that is both human understandable and at the same time easily processable by digital devices.
2	**INTEROPERABILITY BETWEEN STANDARDS, VOCABULARIES, DATA, AND SOFTWARE TOOLS** Industrial innovation via multi-disciplinary interactions between disciplines. The need to enhance interoperability (human, machine and data level).
3	**BETTER FORMAT FOR STANDARDS AND VOCABULARIES** The need to formalise standards using a logic-based framework of concepts and relations easily understandable by human agents
4	**EFFECTIVE DATA DOCUMENTATION** The need for a generic data documentation methodology that enables to easily find, assess, interpret, and retrieve data generated in different sectors is required to enable the harvesting of the data resources that are generated by the European industry and not fully exploited.
5	**KNOWLEDGE BASED REASONING AS OPPOSED TO GENERIC AI** The need to provide strong foundations for knowledge-based AI, by formalising as much as possible the knowledge already available from the existing scientific disciplines. At the same time, to provide knowledge structures that can be used as reference for the analysis and interpretation of machine and deep learning AI findings.

State-of-the-art

- A **landscape analysis of the current active TLOs and MLOs** has been provided by OntoCommons, focusing on BFO, EMMO, DOLCE, BORO, ISO 15926, OPM and SUMO. Another general survey of TLOs has been recently provided by the Construction Innovation Hub
- **TLOs are expressed at many different levels of expressivity/computability** (e.g., from RDF to HOL). Most of the existing TLOs provide an axiomatisation based on semantic web technologies, enabling the use of tools that have been developed in the last decades and that are nowadays fully available (e.g., RDF databases, reasoners) at production level.
- **TLOs are actually used in several projects and initiatives** aimed to facilitate the development of a framework of homogeneous and interoperable MLOs and DLOs. The interoperability between frameworks based on different TLOs can be achieved by creating mappings between the concepts expressed by each TLO. However, mappings between TLOs are actually not available for practical usage and need to be further developed.
- **A wider usage of TLOs is prevented by barriers**, such as different vocabularies and disciplinary barriers between top level and domain level ontologists, or by initial design effort overhead.

For this reasons, end users usually develop *ad hoc* domain or application level ontologies focused on their particular domains, without committing to a more general TLO framework, thus creating ontological silos for their knowledge representations.

Gaps

Gap #	Gap Description
1	**TRO AND TLO ESTABLISHMENT** Ontology developers are not investing in the overhead of introducing a TLO as knowledge representation foundation. However, a TRO and TLO are though recognised as advantageous when the scope are beyond a single project.
2	**CROSS-DISCIPLINARY GAP** There is a gap in the adoption of TLOs, based on the lack of cross-disciplinary understanding. TLO terms and concepts come from the ontology or philosophy fields that are often unknown to people working in a specific application field. Adoption of TLOs is also hampered by the gap in knowledge on TLOs approaches and architecture. MLO and DLO are easier to understand by non-ontology experts, that usually refer directly to them instead of investigating more high-level general approaches provided by TLOs.
3	**LACK OF INTER-TLOS CONNECTIONS** There are many TLOs, expressions of different communities, often with conflicting commitments, so that there isn't a one-size fits all approach. This created silos in terms of both communities and data.
4	**LACK OF HIGH-LEVEL TOOLS FOR TLO/MLO ENGINEERING** There is a lack of professional tools for ontology engineering. These must include tools for reasoning, validation (not only verification), code generators, complexity management tools, as well as tools that help with ontology reuse, including leveraging on ontology patterns and anti-patterns.
5	**LACK OF COMPUTABILITY POWER** There is a lack in the development of new algorithms and HPC solutions for the symbolic computations (e.g. provers, reasoners) of theories in expressive logical languages (e.g. OWL 2 DL, FOL), that would enable the exploitation of the TLOs semantic richness. The few existing tools often impose constraints to the choice of ontology expressivity (i.e. the language used to represent the logical system, such as FOL, RDFS, OWL) in favour of computability.
6	**LACK OF MULTIDISCIPLINARY COMPETENCES (FROM DOMAIN EXPERT TO ONTOLOGY)** There is a lack of multi-disciplinary competences within all the communities involved in ontology development and usage. Potential users, scientific communities and industry are often affected by a competence bottleneck when reaching for formal representation of knowledge. There is a lack of people that can write good and reusable ontologies.

Definition of Success

- The applicability and usability of TLOs and MLOs can be measured according to their capability:
  a) of being used in different knowledge domain environments
  b) of being the foundations for mutual interoperable lower level ontologies.
- The scalability of a TLO/MLO can be measured by its capacity to be applied in environments that makes use of tools based on different expressivity levels (formal languages).
- The ability to enable cross-ontology interoperability is demonstrated with the establishment of an effective methodology for the mapping between relevant TLOs and the mapping of relevant MLOs with more than one TLOs.
- The ability of TLO/MLO to overcome the cultural and disciplinary gap between the top and the application level is demonstrated with the successful development by non TLO/MLO experts of application ontologies based on a TLO/MLO framework, without the support of high level ontology experts.
- The industrial level success of a TLOs/MLOs framework can be defined as its capability to enable sharing of data or data re-use, where the same data being used by different companies for different materials, products, and processes.

Recommended Actions

ACTION #	ACTION DESCRIPTION
1	**PUSH FOR ADOPTION OF TRO/TLO/MLO** Action: A well-defined and accurate **adoption route** (e.g., dedicated training courses and educational paths), together with **good documentation** should be the priority to overcome some of these barriers.
2	**STIMULATE TLO COMMUNITIES TO WORK TOGETHER AND ADOPT A TRO** Action: **Clear communication** between TLO/MLOs communities, **concrete mappings**, should be developed **to prevent creating ontological silos**.
3	**ONTOLOGY SCALABILITY (EXPRESSIVITY VS COMPUTABILITY)** Action 1: Promote a **scalable approach to ontologies development and usage** by proposing funding of multi-disciplinary projects that puts together philosophers, formal ontologists, computer scientists, applied scientists, engineers, and industrial end users. Action 2: Promote projects dedicated to the **development of HPC tools for symbolic based reasoning** (which is part of AI field), to be proposed as an **alternative/complementary to machine and deep learning approaches**.
4	**TOOLS** Action: Awareness about the need of **tools for ontology development is falling short with policy makers and scientists: need to raise the awareness** about the need of tools for ontology development.
5	**EDUCATION AND TRAINING** Action 1: **Clear communication**, which problem classes can be solved with ontologies and which problems can't be solved with ontologies is to be mounted. Action 2: **Education and training**, together with incentives for using ontologies in the scientific community and in industry are to be developed.
6	**EXPERT** Action: We are always dealing with **already established domain-specific classificatory systems** that often **lack rigorous and consistent logical structure** and introduce **ambiguities** in the definitions MLO being **coherent with the existing definitions or standards provided by each discipline of interest** (e.g., chemistry, metrology), and at the same time to provide **constraints on the formal structure of the ontological representation of the discipline** (e.g., taxonomy class levels).

Conclusion

- TLOs are for sure a way to **enhance understanding and interoperability between disciplines**, both at human and machine levels.
- **Multidisciplinary approaches** are required to take advantage of the formal logic-based approach proposed by an ontology: TLOs exploits multidisciplinarity as **innovation enhancer**
- The benefits of adopting a TLO are **not understood by the industrial and scientific community**. This considerably slowed down the development of tools for their usage beyond Semantic Web technologies.
- TLO are a great approach towards a more **human-centric representation of knowledge**, that can **exploit the power of modern digital technologies.**

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- Thank you very much for your attention!

- *Questions*

- **Follow us on**

Contact

WP 2 Leader:

Emanuele Ghedini

emanuele.ghedini@unibo.it

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OntoCommons Roadmap Webinar

- Chapter 3.2 – Domain Ontologies

- *Arkopaul Sarkar (ENIT)*

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Introduction

- Domain level ontology (DLO) can be seen as a specialized module of Mid-Level Ontology (MLO), targeting the specific domain of applications (e.g., additive manufacturing, composite material).
- A DLO is characterized by an increased level of detail concerning an MLO, a more pronounced horizontal extension, and a strong dependency on the domain of application, while still maintaining some neutrality to the specific problem addressed.

Industrial Needs

Data integration and sharing

- There is a unanimous understanding in the industrial stakeholders that they will be benefited from an improvement of data integration, sharing and format conversion, while 70% of the respondent of a survey conducted responded that they have started or already adopted such standards in their practice.

Standardisation

- Though there are many standards available for the domain of material and manufacturing, there is a general lack of consensus among these standards. while in some of our domains we have standards at the level of ISO (as per 2/3 of respondents being in favour), in others we are very far from that (e.g., a CWA). Though there is no doubt that standards are key, they are very hard/impossible to be produced within the timescale of a typical EU project, unless the project is really about just producing the standard.

Various domain Perspectives

- Regarding domain ontology development a major problem is how to combine various views and domains. According to industry, it is still an unsolved problem in engineering.

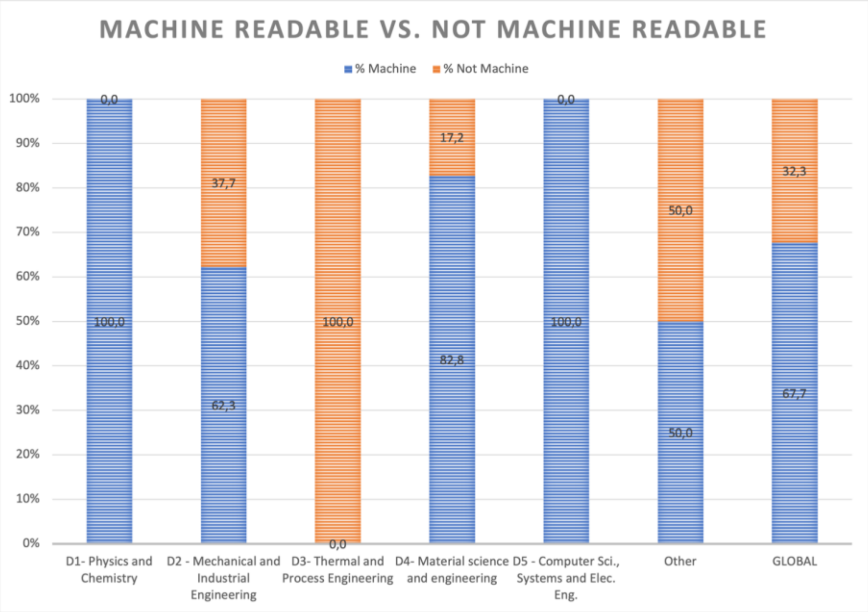
Interface domain ontologies with TLOs

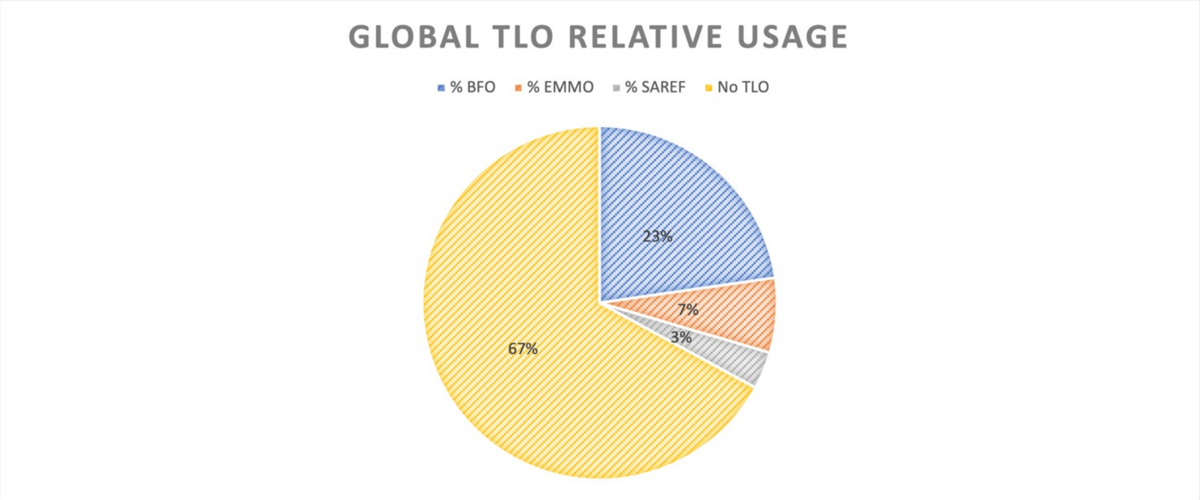
- The interface to TLO is more relevant from the point of view of developers of domain ontologies but not the intricacies of the TLO. In other words, we should "isolate" the domain ontologies from the TLO's theoretical and technical details.

Link domain experts to Ontologists

- The domain experts and ontologists complement each other's role where the former brings the domain level requirements and help in characterising the ontology terms from domain's point of view and the latter provide formalisation in the ontology model using theoretical grounding and ontology engineering best practices.

State-of-the-art





Domain	Ontology Name	FAIR Score	Global FAIR Score	FOOPS! score
D1 Physics and Chemistry	Chemical Methods Ontology	50	46.2	39
	Reaction ontologies	50	46.2	48
	CHEBI	50	53.8	14
	Chemical Analysis Ontology	37.5	46.2	29
	Chemical information ontology	37.5	46.2	39
	NanoParticleOntology	25	46.2	38
	EMMO-Crystallography	25	38.5	44
	EMMO-Atomistic	25	38.5	31
	CIF Ontology	12.5	23.1	54
	Average (± STD)	34.7% (±13.7%)	42.7% (±8.7%)	37.3% (± 11.7%)

222 collected entries out of which we identified initially a total number of 108 relevant ontologies including 74 machine-readable ontologies vs 34 non machine-readable ontologies.

Gaps

Models Granularity

- Need for more extensive and granular models addressing areas of manufacturing and materials.

Lack of Generic and Application-specific Ontologies

- A general lack of ontologies that covers fundamental and application-specific physics and chemistry-related topics

Lack of standardised methodology and tools

- Although number of existing ontology development methodology and tools are available, no such methodology and tool have been standardised with a wide agreement from the community. Furthermore, no significant methodology and tool specific to harmonising ontologies is available.

Ontology as a conceptualization of reality vs information model

- The need of ontology is to formalize the terms used by engineers in the manufacturing field. Engineers often find it difficult to change their perspective because they find it difficult to connect their domain-specific view to a global point of view.

Ontology Sustainability

- Many good quality ontologies are lost due to lack of maintenance and not found wider adoption. A lack of sustainable strategy also hinders the development and maintenance of the ontology and ultimately the quality. Because of this lack of quality, some of the ontologies lose trust among industrial users.

Lack of Standardised Method for Domain Ontology Evaluation

- The quality and coverage of DLOs need to be evaluated by formal methods.

Definition of Success

- The success of domain ontology critically depends on its adoption by the community. To reach an agreement on the ontology, the ontology must demonstrate that it can bring the desired interoperability in the industrial value chain.
- High-quality domain ontologies are essential for their successful resolution of interoperability. .
- The quality of the ontology should be checked not only according to some metrics and/or if the ontology answers the competency questions of a specific application but also should be done according to a philosophical basis of common understanding of different perspectives within the same domain.
- OBO Foundry has been a successful venture in the bioinformatics domain, and its approach is now being copied by others such as Industrial Ontologies Foundry. Barry Smith provided a demonstration of the utility of the Foundry methodology in the neurophysiological, neuroanatomical, and biomedical domains.
- The United Nations Environmental Program (UNEP) approach to achieving interoperability is modelled on the OBO Foundry and OBO Foundry principles for ontology development are now in use by ontology developers also in other areas, including manufacturing, geology, transport, and security.
- Financial Industry Business Ontology (FIBO) developed as an open standard by the EDM Council is another success story of domain ontologies. For FIBO to become a widely accepted standard to be implemented in many systems across the industry, the Council is testing and demonstrating FIBO ontologies as they move through a rigorous process and become available to the industry.
- ISO 15926-8:2018 specifies an ontology Integration of life-cycle data for process plants including oil and gas production facilities. Since its inception and standardization under ISO in 13 parts including rigorous upper level semantic, Oil industries (Norwegian Oil Industry Association) and many other capital-intensive projects have adopted ISO 15926.

Recommended Actions

Standardization of the ontology engineering steps

- Standardize every facet of the domain ontology engineering steps. Some of the recommendations for standardizing the ontology engineering method is to adopt one of the formal methodologies such as LOT including the use of well-defined competency questions for requirement engineering and validation of the ontology using well-defined completion criteria.

TLO-MLO Alignment

- Adopt a coherent top-level ontology and a set of mid-level ontologies to ensure interoperability across domains in the domain ontology model.

Balance of Theory and Practice

- Adopt a Hybrid approach for the definitions of terms in the domain ontology by making a balance between utility and deep ontological (philosophical grounding) analysis on the conceptualisation and the formalisation.

FAIRNESS

- Make domain ontologies FAIR by storing the ontology in a permanent ontology repository specific to the industry (industryportal), adopting FAIR metadata for annotation and documentation. At the same time, the current proposals for FAIR metadata require enhancement to support domain ontology alignment and FAIRification at the content level (classes and relationships).

Follow Domain related standards

- While building an ontology for a certain domain area, existing standards covering that topic need to be identified and ontologized as much as possible. As the nomenclature of these standards is already well accepted in the community, they need to be directly adopted in the ontology.

Classify domains

- Standardized domain classification needs to be globally implemented to Classify all existing, under development, and future ontologies (domain level) as per their target domain.

Bridging the gap between domain experts and ontologists

- Supporting educational, training and professional development needs and in particular supporting a 'Translator' role, able to bridge gaps in the stakeholder value chain from ontology design to exploitation for data documentation

Conclusion

- The success of an ontology needs to be ensured by the right choice of the development process.
- Apart from proper requirement engineering and technical development, the ontology needs to be continuously maintained with periodic release cycles to address the progress in the industry.
- A framework to focus collaborative efforts on developing, standardizing, sharing, maintaining, updating, and documenting industrial ontologies needs to be implemented to ensure the success of domain ontology development.
- An ontology being a tool for industrial data interoperability and organization, it needs to be viewed as an asset for the organization.
- To bring in open collaboration among industries or industries and academia, a comprehensive set of fully open-source, stable ontologies for different aspects of science, technology, and business need to be established. These ontologies need to be fully harmonized by using unambiguous and formalized foundational concepts and well-documented for their use. In this regard, the adoption of FAIR metadata, standardized by initiatives like FAIRsFAIR and EOSC, for annotation, may help in ensuring easy discovery, accessibility, and reusability of these ontologies by the community.
- Finally, domain ontologies need close collaboration between ontologies and domain experts. To ensure interoperability across domains, disciplines and industries, domain ontologies need semantically unambiguous and formalize definitions for their content. For this purpose, every domain ontology needs to be built with a coherent top-level ontology. At the same time, the scope and purpose of the ontologies need to be derived from content contributed and monitored by domain specialists and need to take the domain expert's viewpoint into the account during modelling. As already mentioned, a successful ontology needs to be understandable to the domain practitioners and able to capture the interpretation of application data as intended by industries.

- Thank you very much for your attention!

- *Questions*

- **Follow us on**

Contact

WP # Leader:

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OntoCommons Roadmap Webinar

- Chapter 4.1 - Ontology Commons EcoSystem Toolkit

- *Lan Yang (University of Galway)*

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Introduction

Ontology Commons EcoSystem (OCES) Toolkit consists of

- Methodologies
- References and specifications for tools
- Guildlines for implementation

For industry-oriented ontology development, maintenance, and application

Industrial Needs

Improved delivery of various functional services

- Integrating a set of components that can perform specific tasks in ontology engineering and use

Supporting non-functional services

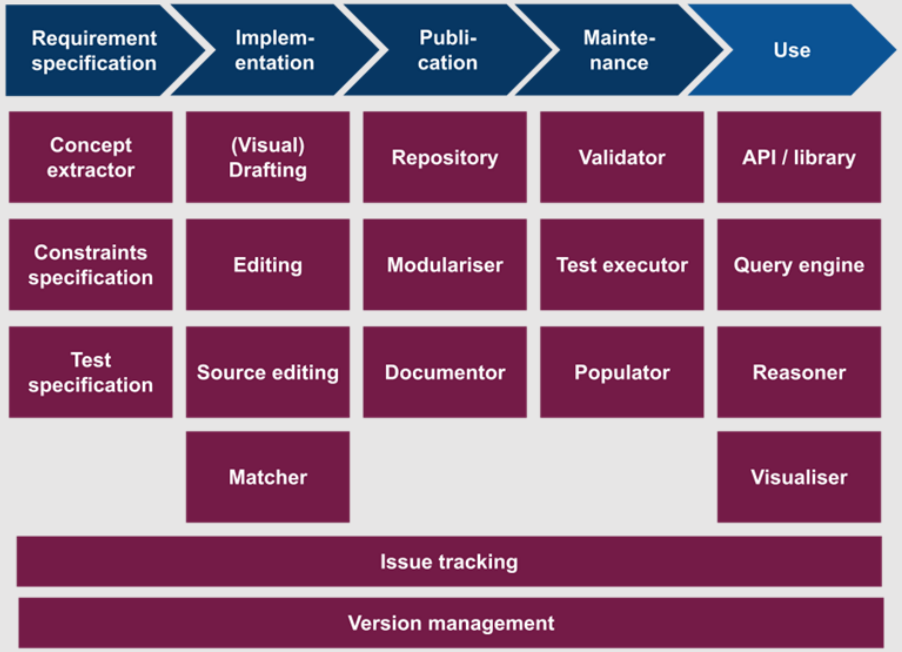
- A flexible, open and robost architecture
- An interoperable interface
- A collaborative setting
- Sustaining the FAIR principles for ontology publication

State-of-the-art

Common workflow for ontology development on the basis of the state-of-the-art methodologies

- Grüninger and Fox (Grüninger and Fox, 1995),
- METHONTOLOGY (Fernández-López et al., 1997),
- On-To-Knowledge (Sure et al., 2004),
- DILIGENT (Pinto et al., 2009), and
- NeOn (Suárez-Figueroa et al., 2012).

The OCES Toolkit reuses many of the core components



Gaps

- **Limited tool support**

  For concept identification, constraint specification, test specification, visual drafting, navigating ontologies, and ontology visualisation

- **Gap in ontology validation**

  A typical ontology engineering process does not include the generation of linked data, APIs or SHACL shapes for data validation

- **In need of integration among existing tools or a tool chain**
- **Unsatisfactory and unsustainable solutions**

  e.g., usability, user experience, costs, not sustainable or robust

Definition of Success

Critical factors for the OCES Toolkit becoming a success

- Whether its components can fulfil the functional requirements
- Whether its components can meet the non-functional industrial needs
- Whether the OCES Toolkit can support the entire life cycle of ontologies
- Whether the domain experts can create and document ontologies based on recommendations tailored to meet the present challenges

Recommended Actions

- **Refine methodologies and tools especially for ontology validation**
  - Provide recommendations on principles, best practices, and methods for the creation and maintenance of ontologies
  - Better coordination amongst tool providers
- **Leverage Industrial Ontology Portal and ontology adoption**
- **Create user-friendly tool chain and reference implementation**
  - A methodological framework and reference implementation toolkit should be developed that offers a practical and user-friendly method for reusing data across domains and industries

Conclusion

- In order for community and industry to develop, maintain and use ontologies, a powerful, well-supported toolkit is required.
- Within the ecosystem, industries can benefit from an integrated development environment, with a set of good practice recommendations that will support them in integrating ontologies successfully and effectively into their operations.

- Thank you very much for your attention!

- *Questions*

- **Follow us on**

Contact

WP 4 Leader: John Breslin, Lan Yang

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OntoCommons Roadmap Webinar

- Chapter 4.2 - Infrastructure

- *Florina Piroi (TU Wien - ISE)*

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Introduction

Infrastructure: set of systems and services,
basic and necessary for an entity to function

- Limit to *Research Infrastructure* (as defined by art. 2 of the EU Regulation 2021/695 - Horizon Europe)
- Components:
  - Hardware, physical networks
  - software stack, services and API definitions
  - Organizational aspects:
    - rules of participation,
    - Financial regulations
    - Human resources

Introduction

Infrastructure for OntoCommons must be a base

- for the functionality of the ecosystem of ontology engineering tools,
- for (standardized) data documentation tools and processes,
- to support secure communication between stakeholders,
- for secure data sharing or integration

Industrial Needs

Abstracting from the industrial needs

- Secure collaborative tools for multiple stakeholders (inter-organisation)
  - Interaction, data exchange (through standards)
  - Data collection, documentation, cataloguing
  - Digital markets (data markets) availability
- Interactive visualization of data
  - Data analysis and understanding
  - Trend identification
  - Interaction with the data
- Data quality assurance and analytics, data validation,
- Trustworthy data repositories and trusted computation

Gaps

- Low maturity level of available infrastructure components (usually prototypes)
- Missing fundamental low-level ontologies (mostly compensated by coding)
  - Contribute to trustworthiness and quality of MLO, TLO
  - Central to developing standards for interoperability
- Ontology data provisioning
  - Services, APIs for maintaining, creating, etc.
  - Outside of the environments the tools / data was created
- Federated, interconnected virtual research environments
  - Scalability, evolving hardware
  - Data management and curation, security, …
  - FAIR services
- Few pilot end-to-end application demonstrators (cross-walks)
- No well-defined (and semantically described) pipelines
  - To define routine processes for infrastructure evolution
- Insufficient support for transfer from R&D department and funding stream activities into infrastructure operations.

Definition of Success

- Number of quality-assured concept spaces
- Number of federated institutions providing the mentioned services
- Number of federated virtual (research) environments
- Number and domain-coverage of end-to-end demonstrators
- Number of services deployed at each maturity levels of the pipeline
- Sufficient funding streams devised to support hand-over from R&D results into institutional operations

Recommended Actions

Part of a long-term vision for life cycle of services, complementing R&D services

- Development of low-level ontologies
  - Avoid misinterpretation of implicit knowledge
- Secure platforms for ontology data creation, provisioning, and exchange
- Virtual Research and Innovation Environments
  - A blue print for the domains covered by OntoCommons

Conclusion

- Our vision:
  - low-level data and meta-data representations are available,
  - workflows for data processing, integration, documentation (by FAIR) are available.
  - existence of a layer of tools and services for data provisioning (e.g. standardisation, FAIRification, etc)
  - computing infrastructures or Virtual Research Environments to be built on top of it,
- Data markets and tool spaces interoperate seamlessly to a user.

- Thank you very much for your attention!

- *Questions*

OntoCommons "Ontology-driven data documentation for Industry Commons" has received funding from the European Union's Horizon Programme call H2020 -NMBP-TO-IND-2020-singlestage, Grant Agreement number 958371

OntoCommons Roadmap Webinar

- Chapter 5.1 - Industrial Application

- *Umutcan Simsek (Universität Innsbruck)*

OntoCommons “Ontology-driven data documentation for Industry Commons” has received funding from the European Union’s Horizon Programme call H2020 -NMBP-TO-IND-2020-singlestage, Grant Agreement number 958371

Introduction

The current version of the roadmap for industrial application has been created based on the input of 22 demonstrators and a larger circle of stakeholders. The input for the roadmap collected from following sources:

* First focused demonstrator workshop “Demonstrators at work to deliver an Industry Commons Marketplace”
* First Global Workshop: Ontology Commons addressing challenges of the Industry 5.0 transition
* Second focused demonstrator workshop “Value of OntoCommons”
* Various deliverables created based on demonstrator input

Industrial Needs

Need #	Need Description
People	
1	**Ease of interoperability and communication between different stakeholders** The ontology development tools should allow different stakeholders to work simultaneously and the ontologies should provide a “commons language” for this to happen.
2	**Best practices for data model governance as well as modelling tools** Industrial stakeholders need best practices about how to maintain data models and intuitive tool support. This is particularly important for bringing domain experts on board.
Data	
3	**Easy to use and to understand ontologies** The industry needs ontologies that are easy to use and understand. They need to be applicable without much explanation. This points out to the need for proper documentation and concrete examples of usage for ontologies.
4	**Improved reusability of (meta-)data and processes** With little or no use of standard vocabularies and ontologies the reusability of (meta-)data is not very high.
Processes	
5	**Time savings in industrial processes** One of the main industrial needs is to saving resources, particularly time in industrial processes. Time savings is expected in terms of increased automation for tasks like decision making and interaction between different actors.
6	**Avoidance of physical testing** In many industrial processes, it is desired to avoid physical testing and create reliable simulations for resource and cost saving reasons. The need for simulation particularly manifests in manufacturing, for example in aircrafts.

State-of-the-art

* The industrial applications currently address the industrial needs to some extent
* In the core of the fulfilling many needs, ontologies play an important role.
  * To that end, there is already a significant amount of (planned) ontology adoption, particularly well-known ontologies like BFO, CheBI, DOLCE, EMMO, IOF-Core and SSN.
* From the domain ontologies perspective, many stakeholders rely on in-house development.
* From a tools perspective, we see that Protege is the mostly adopted tool for ontology development.
  * It is usually combined with reasoners like Hermit++ and Pellet.
* A widespread of Triplestores are used to store semantically described such as Stardog and Virtuoso, as well as property graph databases like Neo4j and virtualization solutions like OnTop for relational databases.

State-of-the-art

* Several community efforts and W3C recommendations are also adopted as declarative languages. RML is adopted for mapping heterogenous sources to RDF and SHACL is used for defining data shapes for verification purposes.

* Needs regarding interoperability and reusability are particularly related with FAIR principles.
  * There is already a certain level of implementation of FAIR
  * However it is also observed that the adoption has reached to a certain limit that prevents further adoption.
  * Mostly the data privacy and proprietary data issues are cited as a reason for this situation.

Gaps

Gap #	Gaps
People	
1	**Learning barriers for semantic technology in the industry** The ontology development and its support tools should be made more intuitive for easy introduction of semantic technology in industry. **This is particularly important for bringing non-ontology experts on board.**
2	**High cost of ontology development** Related to the end, ontology development incurs high costs due to high learning barriers for non-ontologists. This gap hinders the fufillment of reusability of data, metadata and processes
3	**Ontologies are difficult to maintain** The ontology shall be easy to maintain (e.g. adding lower level terms, additional relations, etc.) from non-ontology experts (e.g. SW engineers).
4	**Company internal/partner interaction should be optimised** Currently it is a major gap across many industrial parties to speak a common language during development of industrial processes. Tooling and methodologies are not mature for enabling such communication (e.g. between domain experts and ontology developers)
Data	
5	**The ontologies are not well documented** The ontology documentation should define how the reuse and harmonisation of different ontologies could be achieved. This also includes the formal documentation of ontology where formal constraints and scope are clear.
6	**Lack of comprehensive domain ontologies in NMBP domains** There are many domain ontologies scattered around however there are not many reference domain ontologies that cover a large portion of their domain and contain canonicalized definitions of concepts and their relationships

Gaps

	Data
7	**Arguments for using FAIR principles** It is not always clear for industrial stakeholders what that concrete benefits of application of FAIR principles are. This contributes to the natural barriers occuring in front of further FAIR adoption.
8	**Dealing with content protected with IPR** Many industrial standards are protected with licenses that prevent publishing derivations of the work. This hinders the creation of semantic resources from those standards. From a data perspective, this also creates a hinderence for FAIR adoption.
9	**The ontologies should follow higher level ontologies** The aligned ontologies should follow top or mid-level ontologies to allow a higher compatibility with other ontologies
10	**Interoperability between TLOs** There should be interoperability between TLOs to facilitate harmonisation of ontologies allowing for interoperability among ontologies that are based on different top-level ontologies.
Processes	
11	**Lack of standards and guidelines** Although ontology usage is there to some extent, there are still challenges in terms of heteregoneity of ontologies and lack of standards for alignment as well as documentation. There is also a lack of comprehensible methodology.

Gaps

Tools	
12	**User interface** There are already tools like Protege used for ontology development, however the user interfaces can be incomprehensible, particularly for non-ontology experts.
13	**Tools for ontology engineering are not complete** The tools shall support visualisation, debugging, validation, search of existing ontologies and import. Tools shall be provided to support initial brainstorming and conceptualisation on models of concepts relevant for the domain and applications, to enhance transition from initial ideas to standard tools
14	**Maturity of the (collaborative) ontology development tools** The ontology development tools are not always intuitive and easy to use. One needs to have already some experience with ontologies, their structure and what are the possibilities in order to be able to use the existing development tools. Many of them also have serious drawbacks in terms of collaborative development.
15	**Lack of easy to use tools to put ontologies in production** Not only developing an ontology, but also deploy them in the production envrionments need intuitive tool support. Such tools may include reasoners to support an application with inferred knowledge as well as declaritive mapping languages and tools for populating an ontology with instances and NLP tools that use ontologies as a basis for knowledge extraction.

Definition of Success

#	Definition of Success
People	
1	**Improved communication within company personnel and with external partners** Using a “common language”, i.e. ontology and vocabularies, the communication between stakeholders will improve. This can be also seen as a consequence of achieving standardized data documentation from people perspective.
Data	
2	**Achieving standardized data documentation** Achieving standardized data documentation, typically via ontologies is seen as a sign of success for many industrial stakeholders. Such data documentation increases Findability, Interoperability and Reusability of data within and across organizations for different projects and allow companies to increase their innovation capacity.
Processes	
3	**Time and cost saving** An important factor for all industrial customers is time saving saving costs can also be important for customers, but saving time is more globally comprehensible. (e.g. ontology-enabled automation, optimized communication, more efficient integration across systems, and improved reusability)
4	**Optimised product quality and environmental footprint** Many industrial stakeholders provided a KPI for improving product quality and reducing environmental footprint e.g., in terms of CO_2 emission
5	**Gaining competitive advantage for small and large companies** Small and large companies can benefit from the use of ontologies. Large companies can benefit because they repeat a process very often. Small companies can benefit from the time improvement because they are faster than the competition.

Recommended Actions

Action #	Recommended Action
People	
1	**Knowledge engineering education** A major gap on ontology development and usage is the high cost and struggles of finding trained people. Trainings on ontology usage and development issues is an important point, to allow early education on ontologies. This education must be adaptive to the needs and competencies of various stakeholders.
2	**Demonstrate examples on saving time and cost** Examples and success stories should be shown on the topic of time and savings to increase awareness of the benefits.
3	**Networking** Networking events where people share their experience with ontology adoption in industrial settings may be beneficial for a large audience and increase engagement.
4	**Highlight advantages of ontology usage** Demonstrate what the use of ontologies can do. This can be done by establishing a translator role in companies (see Section 5) and disseminating success scenarios with conrete improvements on specifc KPIs (e.g., increased automation, time saved, reduced carbon footprint)
Data	
5	**Data sharing and standardisation** Several gaps are related to reusability of (meta-)data and lack of standardisation. Ontologies make data sharing and data standardisation easier/possible. In general, standardisation is crucial (e.g. for legal requirements). At the minimum, ontologies must be aligned with industrial standards as much as possible.

Recommended Actions

Data	
6	**Demonstration of FAIR benefits** Industrial stakeholders may need concrete examples of how adopting a specific or a set of principles will help them. The community should provide minimal examples to demonstrate the benefits.
7	**FAIR principles also for metadata** Implementation of all FAIR principles is hard, therefore implement it for metadata is a good starting point.
8	**Close cooperation with FAIR communities** Close cooperation with communities, use/development of standardized tools for the implementation and the evaluation off FAIR principles. This will also help to clarify the misunderstandings about FAIR principles that prevent further adoption.
Processes	
9	**Follow good ontology development practices and provide a comprehensible methodology** This would guarantee high quality of ontology development. The best practices must be supported by comprehensive methodologies to enable sustainable development of ontologies.
Tools	
10	**Increase user-friendliness of tools** The most major gap regarding tools is their usability. Tools should be user friendly, complex details should be in the background. Tools must be developed more user centric with a constant feedback regarding the usability. Research and Development projects targeting higher TRL can include usability testing of developed prototypes as a criterion.
11	**Support development of collaborative, modular and open tools for ontology development** One thing we heard from almost all stakeholders is how challenging it is for them to find a tool for ontology development. The development of a collaborative, extensible and open ontology development tool must be supported. The tool should provide open APIs for developers to develop plugins or convert their existing tools into plugins.

Conclusion

* Tool support and guidelines must be improved to bring domain experts more into the engineering process
  Collaborative development is not mature enough

* Knowledge engineering education tailored to different target groups is important

* Alignment with standards

* Demonstration of FAIR benefits is important

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- Thank you very much for your attention!

- Questions

- **Follow us on**

Contact

WP 5 Leader: Umutcan Simsek

umutcan.simsek@sti2.at

OntoCommons “Ontology-driven data documentation for Industry Commons” has received funding from the European Union’s Horizon Programme call H2020 -NMBP-TO-IND-2020-singlestage, Grant Agreement number 958371

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OntoCommons Roadmap Webinar

- Chapter 5.2 - Standardisation

- *Silvana Muscella (Dissemination & Communication Manager, Trust-IT)*

OntoCommons “Ontology-driven data documentation for Industry Commons” has received funding from the European Union’s Horizon Programme call H2020 -NMBP-TO-IND-2020-singlestage, Grant Agreement number 958371

Introduction

- The Standardisation section of the OntoCommons Roadmap (Chapter 5.2) explores the importance of **standardisation** and how **ontologies** can contribute to:
  - the **harmonisation** of **standards** use in **materials** and **manufacturing** processes
  - building a **common understanding** between materials and manufacturing companies
- Europe must be a **rule-maker** and not a rule-taker in terms of international rules and standards
- OntoCommons.eu is contributing to shaping **22 demonstrators** with industrial relevance that responds well to Horizon Europe call requirements around standardisation efforts:
  - thanks to the demonstrators it is possible to gain better understanding of what **standards** the industrial communities are using, what **requirements** they should have, for users of **NMBP domain** to exploit them.

Through the OntoCommons Roadmap, we draw upon some relevant **recommendations** to help bridge EU policies and standardisation activities across materials and manufacturing, that are aligned with the Annual Union WP for European Standardisation

State-of-the-art

- **FAIRness**, **interoperability**, **trust**, **security** and **reliability** in **data sharing** are crucial attributes that must be guaranteed in all phases of the **production chain** to embed **digital capabilities** in **operations** of competitive **industries** and **services**.
- The **Standardisation Strategy Roadmap*** has identified coordination of **European Standards** and addressing **bottlenecks** within the standardisation system as some fundamental **challenges**, among others, to achieve an effective and **harmonised standardisation.**

* https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13099-Standardisation-strategy_en

Ontologies play a fundamental role, contributing to standards harmonisation and interoperability, and offering better categorisation of information and process efficiency

Industrial Needs

Need #	Need Description
1	European industrial strategic autonomy through better integration of materials and manufacturing standards and standardisation
2	Stronger integration of multi-domain stakeholder clusters with streamlined, digitally-supported workflows
3	Agile and market responsive SMART standards
4	Widely recognise standardisation as a channel of technology transfer from science to industry and a way to valorise those results
5	Engineering software systems need to be reusable

- Standardisation processes require **stronger integration** of **multi-domain stakeholder clusters** with streamlined, digitally-supported workflows for greater **efficiency**;
- Standardisation should be promoted as a key enabler for **industry** which can also reinforce links between **research** and **innovation**.

OntoCommons.eu adopts ontologies and standards to build its **demonstrators** and aims to cooperate with National (NSBs) and International Standards Bodies (SDOs) for proper industrial implementation of standards

Demonstrators analysis

- BOSCH Ontology (In-house development)

•ISO 15926-14
•Material-Core (In-house development)
•Standards Ontology (In-house development)
•ChEBI
•SKOS

•EMMO
•TribAIn
•VAR Ontology

•VIMMP Ontologies
•EMMO
•SWO
•MODA (CEN-CENELEC CWA17284)

•ISO/IEC 21838
•IOF-Core (OAGi)
•QU4LITY Ontology
•GRACE Ontology
•Z-BRE4K Ontology

•Product Service System (PSS)
•IOF Core
•Material Ontology
•Logistic Ontology
•Supply Chain Ontology

•ISO 13320
•DIN ISO 4497
•BET DIN 66131
•DIN ISO 3923-1
•DIN ISO 3923-2
•DIN 66137-1
•DIN 66137-2
•EMMO

•ISO 15936
•QuED
•SSN
•UMATI
•eClass
•OPC-UA (in-house transformation from the standard)
•CFIHOS

•OYSTER Mechanical Testing Ontology
•eNanoMapper Ontology
•Additive Manufacturing Ontology
•EMMO
•BFO

•iiRDS Ontology

•EMMO
•PROV-O
•CheBI
•QUDT

- ifcOWL

- BONSAI ontology

- In-house development

•QU Ontology
•SSU Ontology
•IoT-Lite Ontology
•POS Ontology
•ROCO - RoboticCloud Ontology

- EMMO
- Mechanical Testing Ontology

- Materials Design Ontology

The mapping of the standards and ontologies currently used by industrial use cases can help better identify user requirements! If you want to contribute contact info@ontocommons.eu!

Gaps

Gap #	Gap Description
1	Coordination of European standards and addressing bottlenecks within the standardisation system
2	Slow approval of harmonised standards
3	Re-usability of engineering software systems
4	Literature on the role of standards and standardisation in technology transfer and in research initiatives is recent and not widespread
5	Different data representations making it difficult to reuse different systems
6	Barriers to communication between devices in ICT
7	Facilitating greater R&I contributions to the standardisation ecosystem

- Software systems might have different representations of data and different digital information, that, therefore, cannot be re-used by other systems, resulting in extra costs.
- **Accessibility**, **approval procedure**, **awareness**, **engagement** and **IP rights** are the main **barriers** preventing ICT Standards to achieve a tangible impact towards full device **interoperability.**
- **Standardisation experts** in the **Ontologies** field should support the contributions of **R&I projects to EU standardisation activities** through initiatives such as the EC's Horizon Standardisation Booster.

OntoCommons.eu is working on ensuring that efforts around standards harmonisation through ontologies are channelled in the same direction. An example is given by the work cited in the **"EC Scoping study for supporting the development of a code of practice for researchers on standardisation"**

Definition of Success

- The new **knowledge** resulting from publicly funded research and innovation programmes to **industry related projects** using **standards** can be included in **new, harmonised or improved standard.** This contributes to:
  - the implementation of **research** and **industrial innovation** outcomes through the usage of standards, addressing key impacts.
  - defining success in the **standardisation ecosystem.**

OntoCommons.eu can contribute to sharing new knowledge in the industrial ecosystem through best practices gathered by the **OCES** and **demonstrators** & **training materials** to be delivered by the end of the project's lifetime.

Recommended Actions

Action #	Action Description
1	Europe to ensure the efficient and effective functioning of its standardisation system improving speed to market
2	Focus on the achievement of a well-functioning standardisation system
3	Demonstrating SMART standards with end-users through dedicated interoperability test-bed frameworks
4	Promote standardisation as a key enabler for industry
5	Reinforce links between research, innovation and standardisation
6	Improve the connection between National (NSBs) and International Standards Bodies (SDOs)
7	Embed digital capabilities in operations of competitive industries and services
8	Focus on the use of ontologies to contribute to standards inclusivity, harmonisation and interoperability, offering better categorisation of information and process efficiency

Improving the inclusivity and interoperability of standards will strengthen Europe's worldwide innovative technologies competitive position

Conclusions [1 of 2]

Europe's competitiveness in the domain of advanced manufacturing is strongly linked to its ability to embed digital capabilities in operations of competitive industries and services. **Good performance alone is not sufficient**: **FAIRness, interoperability, trust, security and reliability in data sharing** are crucial attributes that must be guaranteed in all phases of the production chain

- OntoCommons.eu is contributing by:
    - Leveraging on its **demonstrators** to gain a better understanding of the **industrial communities' requirements** in standards and ontologies
    - Lowering the knowledge gap by sharing **best practices** coming from the demonstrators and the OCES and by organising training workshops

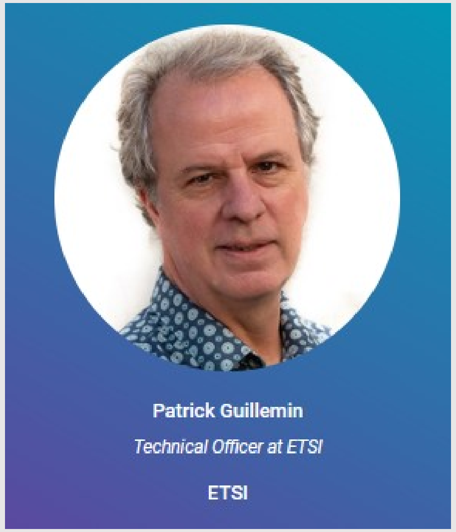
Conclusions [2 of 2]

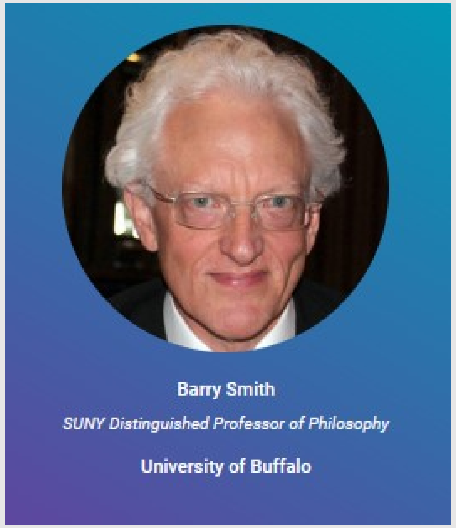
- Cooperating with the **Expert Advisory Group** & **EU-funded initiatives** to identify priorities on how **semantic interoperability** can support the implementation of standards in industrial contexts

Read the Interviews with some of our External Advisors:

- **OntoCommons and standardisation:** [the IOF perspective with Boonserm Kulvatunyou]
- **How OntoCommons will narrow the gaps between the understanding of ontologies benefits for standardisation and their implementation:** [an interview with Patrick Guillemin]
- **OntoCommons in the standardisation environment:** [an interview with Barry Smith]

EAG: https://ontocommons.eu/eag





Further Reading & Projects

On 18th January 2023, StandICT.eu 2023 in collaboration with the European Commission, organised a stimulating , three hour Workshop on “Future Standardisation Education” covering the principal results and impacts of StandICT.eu 2023, and other invited projects EU funded projects, fellows and SDOs.

The report can be downloaded here: https://doi.org/10.5281/zenodo.7561753

Adra-e AI, Data and Robotics ecosystem

- Mutual support in communication of respective initiatives and events,
- Three different TWGs (on Data, Robotics and AI) will be developed by ADRA-e following StandICT.eu model

Winning Applications from StandICT:

- Mark Schubert – iiRDS
- Marius Preda – ISO/IEC
- Antono Jara – IEEE
- Ulrike Parson – iiRDS
- Hedi Karray – ISO/IEC
- Nikita Lukianets – ISO/IEC (ISO/IEC AWI TR 5469)

HSbooster.eu Horizon Standardisation Booster

- StandICT.eu EPE members invited to join and feed the larger HSbooster.eu EPE,
- mutual support in communication of respective initiatives and events,
- Standards Academy
- Standards Mapping tool

STAND4EU Boosting the Exploitation of Standardisation Inputs from European Projects

- Understanding key bottlenecks in the standards development lifecycle
- development of recommendations and solutions,
- mutual support in communication of respective initiatives and events,
- Standards Academy

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- Thank you for your attention!

- *Questions?*

- **Follow us on**

Contact

Silvana Muscella,

Dissemination & Communication Manager Trust-IT

(s.muscella@trust-itservices.com)

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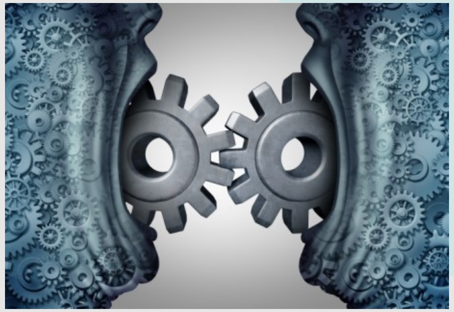
OntoCommons Roadmap Webinar

- Chapter 5.3 - Knowledge Management Translator for Industry Commons

- *Gerhard Goldbeck, Alex Simperler (GCL)*

OntoCommons "Ontology-driven data documentation for Industry Commons" has received funding from the European Union's Horizon Programme call H2020 -NMBP-TO-IND-2020-singlestage, Grant Agreement number 958371

Introduction: Translator



A role that bridges between communities with different backgrounds and semantics

There are two existing roles we are expanding:

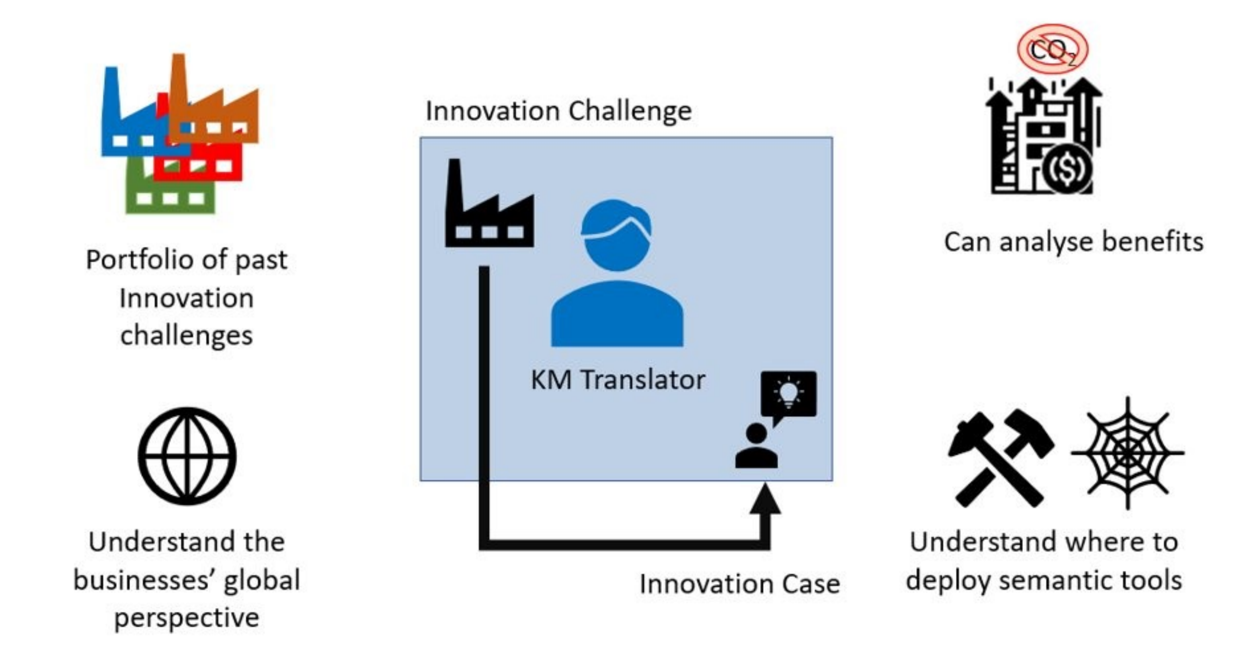
- Materials Modelling Translator- to close the “knowledge gap” between industrial stakeholders and materials modellers, thus promoting mutual understanding
- Analytics Translator – to close the “knowledge gap” between industrial stakeholders and data experts.

We introduced **a new role in the field of semantic knowledge management** which we call Translator in Knowledge Management for Innovation.

State-of-the-art

Defined translation process and detailed role description – supported by industry experts

Process - We defined the overall translation effort, broken down into a sequence of six steps, some more business and some more technology oriented, that are performed first successively and then in cyclic iterations.

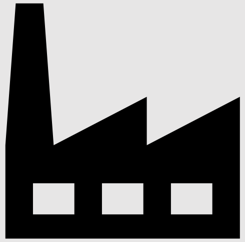


Goldbeck, Gerhard, Simperler, Alexandra, Bull, Lucy, Gao, David, Ghedini, Emanuele, Karray, Mohamedhedi, Kharlamov, Evgeny, Kiritsis, Dimitrios, Lomax, Jane, Matentzoglu, Nicolas, Noeske, Michael, Piroi, Florina, Sarka, Arkopaul, Vladislavleva, Katya, & Waaler, Arild. (2022). The Translator in Knowledge Management for Innovation – towards Industry Commons. Zenodo. https://doi.org/10.5281/zenodo.7041697

Step 1: Identify innovation case and elaborate on the benefits of adopting semantic technologies

Industrial Needs

High quality, reliable advice on ontology-based knowledge management/engineering



Skill and capability in industry

Information on what to expect, best practice

To fulfil the needs, we need to **build on skills** of current staff and experts in related fields

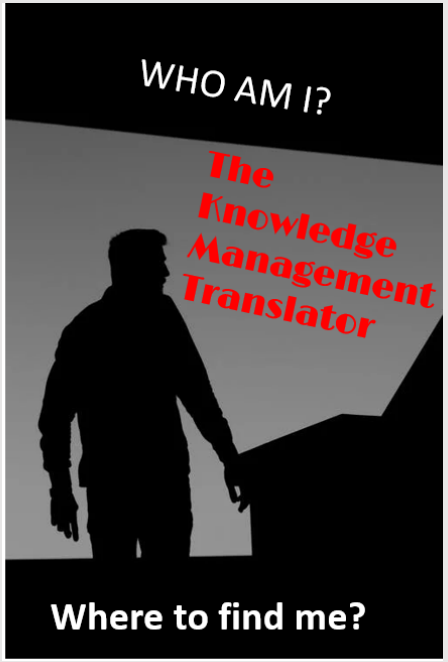
What we **have**: link to leading **experts**, willingness to **synergise**, **semantic first aid kit** to equip every person willing to be a KM translator

KM Translator "Job Description"

- Support building KM solutions to business problems ensuring that technical and business objectives are met.
- Ensure that the right KM approach is applied to the right business problem
- Support building a KM culture in the organisation
- Has and builds awareness of
  - Internal technology biases
  - Semantic trade-offs for all stacks
  - Mitigation strategies for all trade-offs and their cost
  - Bridges between Knowledge Engineering (KE) stacks
  - The landscape of tools, incl. maturity levels, costs, etc
  - FAIR semantics, re-use and collaborative workflows

Unbiased Project management

A good 'auditor' and benefits advisor



Technical skills in ontologies and knowledge engineering

Gaps

- **The need for training and professional development for Translators**
  - We need to establish collection of available training materials
  - We need to advise on Continuous Professional development

- **Create the Translator role, community and value to industry**
  - We need to address and define all the aspects of establishing the Knowledge Management (KM) Translator as a critical role in Industry Commons, including:
  - Value proposition of working as a KM Translator
  - Creation of a database of expert KM Translators.

Definition of Success

- Trainings Materials and established professional development
- Community and database of Experts
- KMT becomes a known and valued role in industry

Recommended Actions

- Establish “Translator Tools” for the comparison of different data processing technologies. Such a tool would point out the strong points and benefits of ontologies to organisations.
- A best practises guide to make KMT work transparent and FAIR, interoperable with existing standards, and trackable.
- Work closely with DOME 4.0, to build a network and directory of KMTs
- Initiate Training schemes
  - Use a curriculum developed within OntoCommons comprising literature, training, forums, etc, to provide self-training.
  - Application for Marie Sklodowska Curie Action Nov 2023 (train new generation of KMTs)

Conclusions Outlook

- KM Translators defined as a key role to supporting industry in benefitting from semantic technologies

- 2nd Expert Workshop on 28th Feb 2023
- 2nd WhitePaper with Solutions
- Presence at EMMC2023 and 2nd OntoCommons workshop (synergise)

- Thank you very much for your attention!

- Questions

- **Follow us on**

Contact

WP # Leader: Gerhard Goldvbeck

OntoCommons “Ontology-driven data documentation for Industry Commons” has received funding from the European Union’s Horizon Programme call H2020 -NMBP-TO-IND-2020-singlestage, Grant Agreement number 958371

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OntoCommons Roadmap Webinar

- Chapter 5.4 - Ontology-based digital-marketplaces cooperation

- *Joana F. Morgado (Fraunhofer IWM)*

OntoCommons "Ontology-driven data documentation for Industry Commons" has received funding from the European Union's Horizon Programme call H2020 -NMBP-TO-IND-2020-singlestage, Grant Agreement number 958371

Introduction

Digital-marketplaces are **multisided collaborative** and **trading platforms** that facilitate materials and manufacturing **innovation** by **easing access** to otherwise disparate sources and deployments of information, expertise, software applications and data.

Digital-marketplaces can benefit from the use of data models such as Taxonomies, Ontologies to:

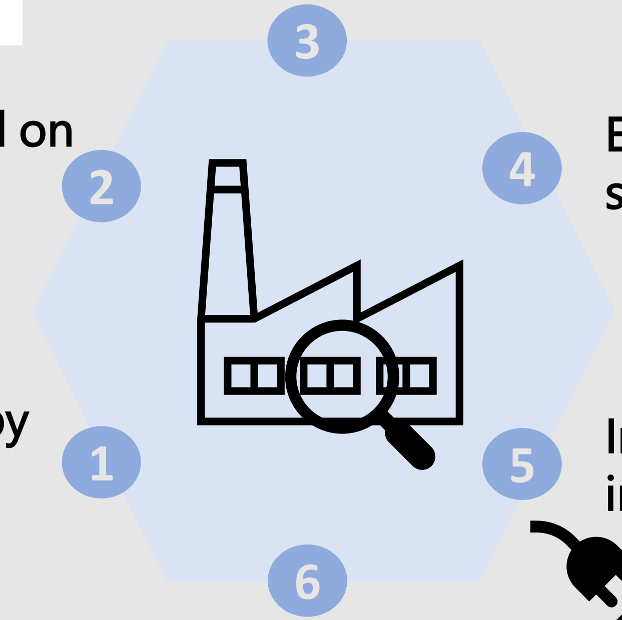
- enhance the **meaningful exchange** of products and services
- achieve a **standardised representation** of information about **datasets** (*e.g.*: authors, owners licenses…)
- encode the "**IT system**" in an extensible, machine readable form (*e.g.*: IDS Information Model, GAIA-X Core Ontology …)

Industrial Needs

Better user-friendly platform

Interoperability based on common standards

Effective data exchange between simulators and databases



Integrating data generated by simulation and experiments

Improving transferring data between industries and marketplaces

Access possibility

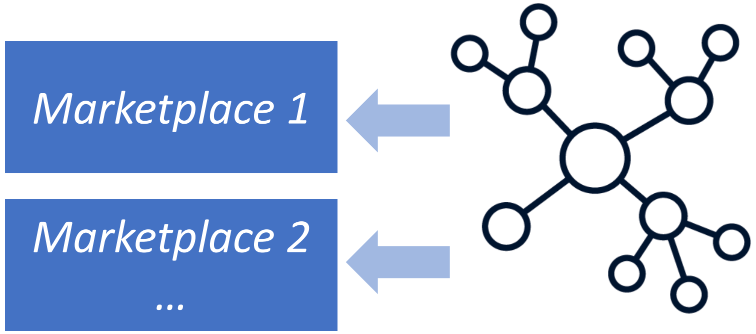
State-of-the-art

* The **digital marketplaces** are using ontologies for their **services and operations**

Current Scenario:

Project	Domain Knowledge	Dataset representation	Infrastructure
Market 4.0	N	N	Y
Weldgalaxy	Y	N	N
ViMMP	Y	N	Y
MarketPlace	Y	N	N
DOME 4.0	Y	Y	Y

Type of information captured by the used ontologies

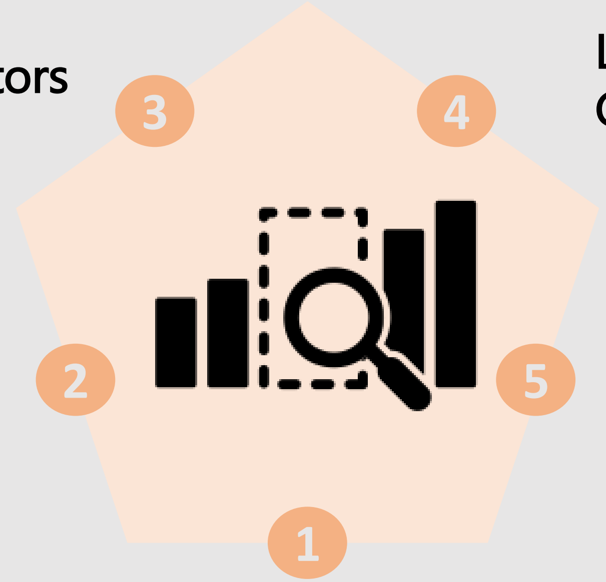


The ontology **EVMPO** (European Virtual Marketplace Ontology) was developed jointly by the projects involved in establishing the **EVMF** (i.e., VIMMP and Marketplace, with support from the EMMC-CSA project).

Gaps

Lack of demonstrators

Lack of user-friendly Graphical User Interfaces



Lack of tools and methodology

Better communication between EMMO and the marketplaces

Lack of communication between marketplaces to develop a common ontology

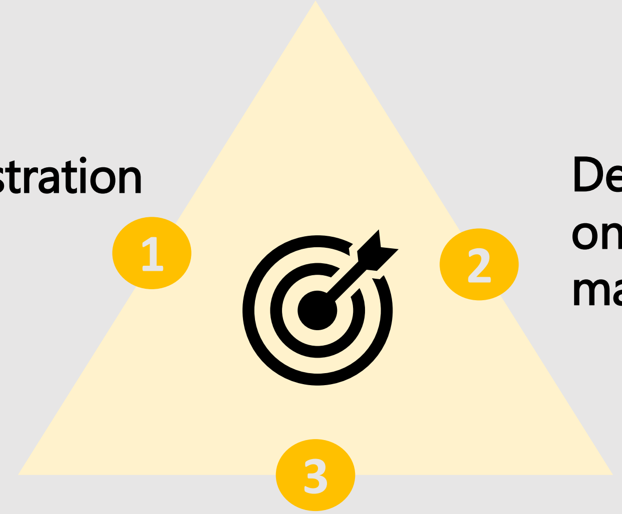
Definition of Success

3. Reuse of ontologies, integration/merging among marketplace applications
4. Share documents and technologies which are open among the marketplaces
2. Create a common space for sharing updates of each marketplace project
5. Share fundamental concepts and small (mid-level) ontologies that provide connection between marketplaces
1. Determined synergies (and 'common points') between the marketplaces

How can it lead to further collaborative developments?

Recommended Actions

Well-defined demonstration for marketplaces



Developing a common “global” ontology framework for the marketplaces

Establishing link between marketplaces

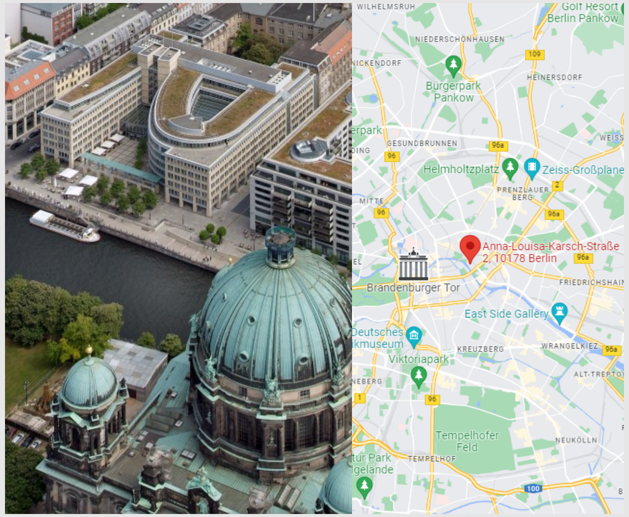
Conclusion

- Upcoming Workshop in Berlin with sessions about the digital marketplaces

  Date: 4-6th April 2023

  Venue: Fraunhofer Forum Berlin (Anna-Louisa-Karsch-Straße 2, 10178 Berlin)

Save the date!



ONTO COMMONS
ONTOLOGY-DRIVEN DATA DOCUMENTATION FOR INDUSTRY COMMONS

- Thank you very much for your attention!

- *Questions*

- **Follow us on**

Contact

Joana.Francisco.Morgado@iwm.fraunhofer.de

OntoCommons “Ontology-driven data documentation for Industry Commons” has received funding from the European Union’s Horizon Programme call H2020 -NMBP-TO-IND-2020-singlestage, Grant Agreement number 958371

OntoCommons Roadmap Webinar

- Chapter 5.5 – Innovation and Perspectives

- *Michela Magas (Industry Commons Foundation)*

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Introduction

Types of innovation (Pisano, 2019):

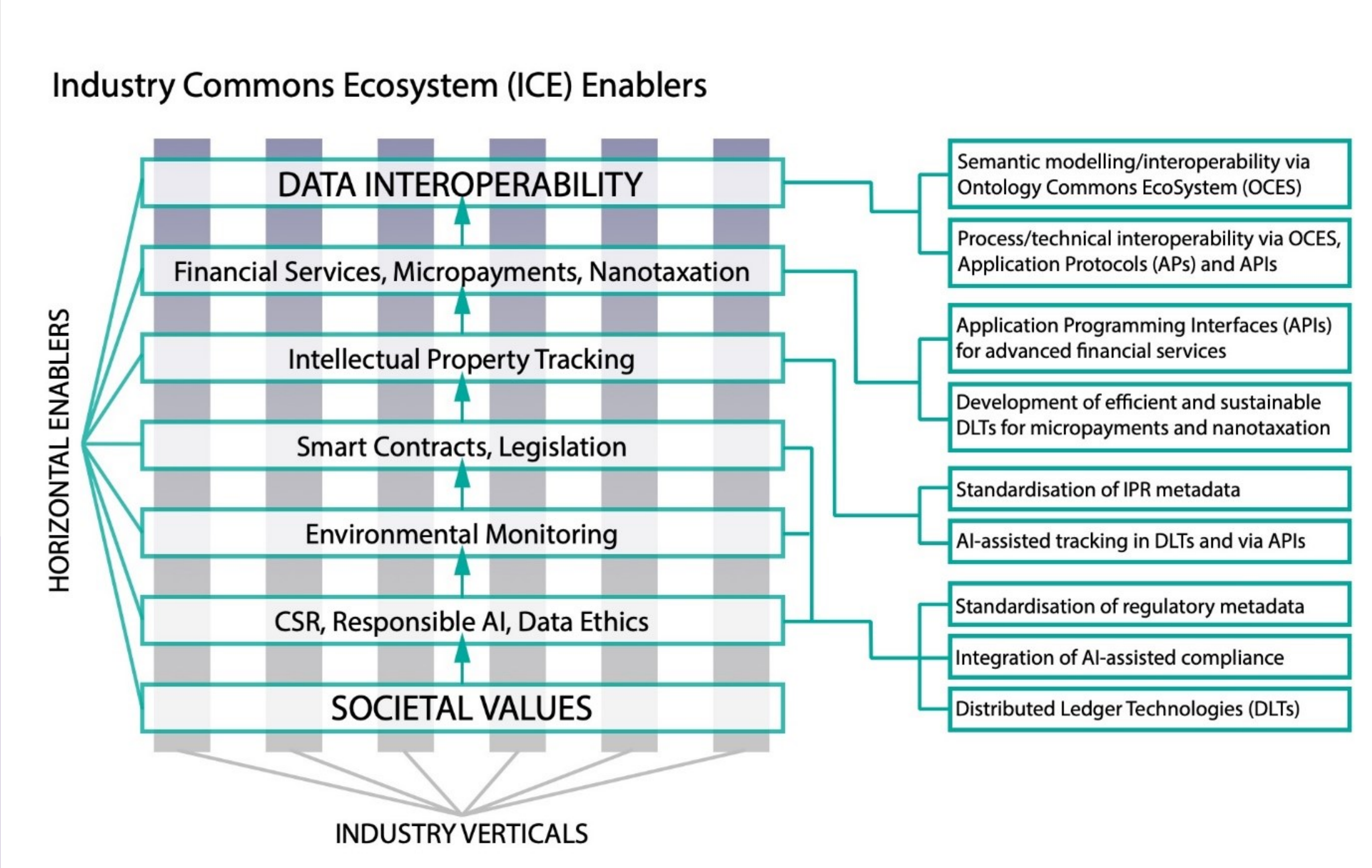
- incremental innovation for existing competencies and business models is ***routine***
- ***radical*** innovation builds new competencies for an existing business model
- ***disruptive*** innovation proposes a new business model for existing competencies
- ***architectural*** innovation introduces both new competencies and business models

Associated challenges:

- significant breakthroughs may fracture established organisational learning patterns (Dodgson and Gann, 2010);
- radical innovation may destabilise existing capabilities;
- disruptive innovation may disengage existing customers and the related secure income streams;

=> Progress from breakthrough innovation occurring in the “gaps” between the verticals to one which is fully integrated in the cross-domain value network entails a shift in organisational learning patterns and knowledge exchange practices.

Industry Commons



Preconditions

The ICE model builds on the assumption that sustainable cross-domain industrial innovation can be achieved when all aspects of Enterprise Integration are:

- sufficiently transparent to allow all involved actors to be proactive in their decision-making workflows;
- technologically harmonised to allow interoperability between involved actors' technological components;
- effectively supported by responsible societal and environmental parameters embedded in the system.

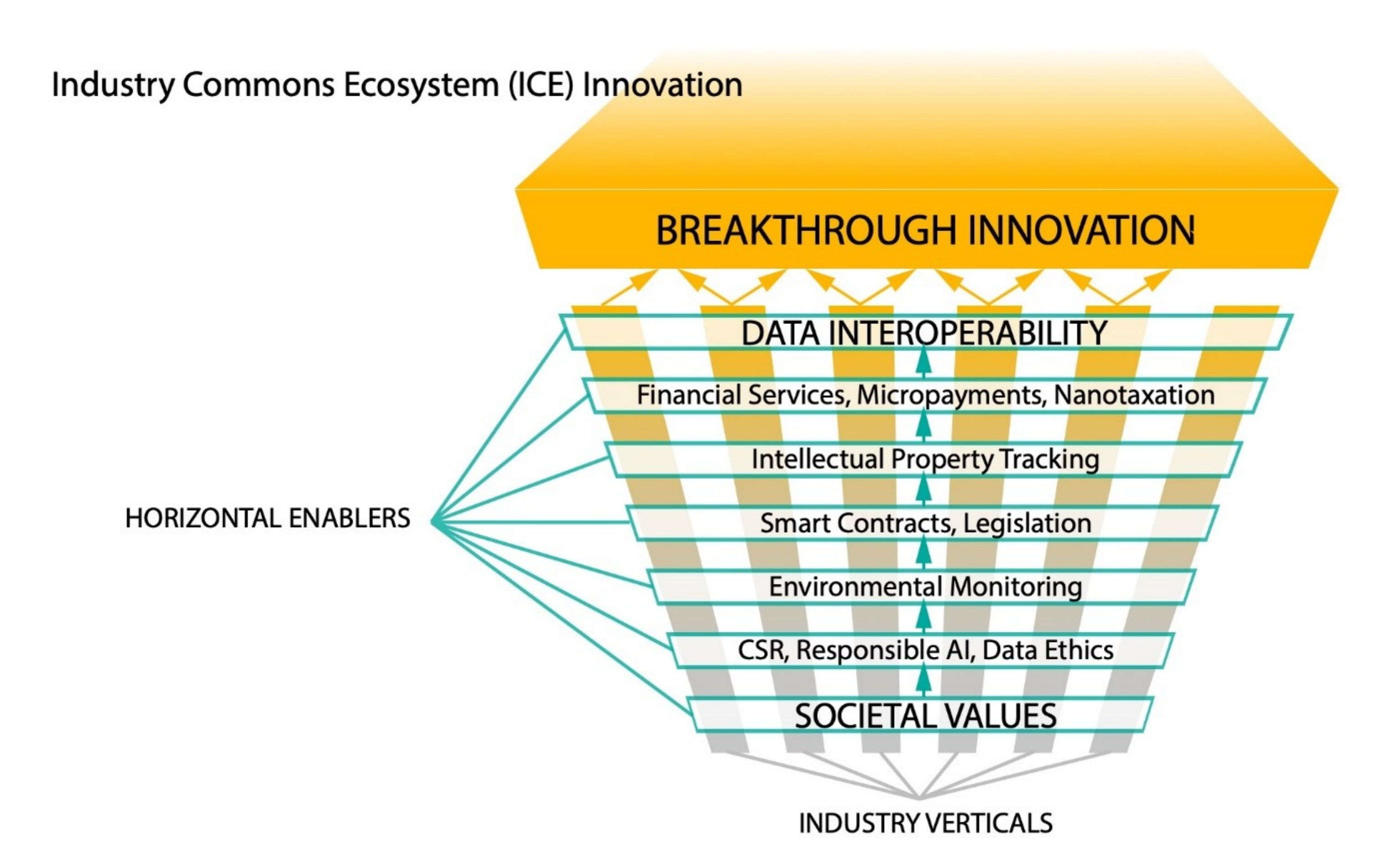
State-of-the-art

Properties of the Cross-Domain Ecosystem, building on Weichhart, Panetto and Molina, 2021:

- **Autonomy** allows for an increase in dynamic states for greater modularity and adaptability.
- **Belonging** is decentralised but closely monitored and tracked across the ecosystem. Market competitiveness is balanced by the ecosystem's supra purpose, encoded in the social dimensions.
- **Connectivity** is considered to be all-pervasive rather than a series of nodes and synapses. The value networks operate simultaneously in several dimensions creating value ecosystems.
- **Diversity** of capabilities is key to enabling innovation breakthroughs and therefore encouraged. Diverse ecosystem-oriented modules are open and ecosystem-facing, for modelling and coupling on the fly.

Definition of Success

EXAMPLE USE CASE: Data sets from two different domains may be combined in a simulation of a novel use case. The third data set which is thus generated indicates new market possibilities. The system notifies the proprietor of the intellectual property used in the simulation and allows them to make an informed decision on any further investment. Thus, the system enables continuous learning and decision-making control for organisations, and a sustainable integration of cross-domain innovation in decision-making processes.



Future work

During the second half of the OntoCommons project several routes to innovation are being drawn from the analysis of the results from the OntoCommons Demonstrators, including:

- (i) best practice for expansion across domains;
- (ii) potential novel business models;
- (iii) the role of interfaces in supporting work with ontologies;
- (iv) positioning of the OCES within the cross-domain data-driven landscape.

- Thank you very much for your attention!

- **Follow us on**

- *Questions*

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What can be improved?

Don't forget to complete our survey of the OntoCommons Roadmap!
We'd like **your feedback** on:

- Industrial needs addressed
- Gaps highlighted
- Recommended actions
- Suitable timeline for the actions identified
- Anything that's missing

Let us know!

https://ontocommons.eu/roadmap