HSBooster Reports

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Standardisation for OntoCommons

HSbooster.eu
Horizon Standardisation Booster

ONTO COMMONS
ONTOLOGY-DRIVEN DATA DOCUMENTATION FOR INDUSTRY COMMONS

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Glossary of Terms

ATSM	American Society for Testing and Materials
CEN	European Committee for Standardisation
CSA	Coordination and Support Action
EMMC	European Materials Modelling Council
EU	European Union
FAIR	Findability, Accessibility, Interoperability, and Reuse
H2020	EU Horizon 2020
IEC	International Electrotechnical Commission
ISO	International Organisation for Standards
NC	National Committee
NSB	National Standards Body
OAGi	Open Applications Group, Inc.
SDO	Standards Developing Organisation
TC	Technical Committee
TPD	Technical Product Documentation
WG	Working Group

Intro-duction

OntoCommons[1] is an EU Horizon 2020 (H2020) coordination and support action (CSA) project with the goal of standardisation of data documentation across all domains related to materials and manufacturing.

It aims to achieve this goal through the use of ontologies and associated tools. The use of ontologies provides a well-defined representation of data that can be formally reasoned about, as opposed to the often-ambiguous nature of human language which is currently used in standards.

This report aims to support OntoCommons in its efforts to integrate, engage, and contribute its work to the standards community by presenting an introduction to the standards process and relevant considerations by providing an introduction to the role of standards and its goals, potentially relevant standards bodies for OntoCommons, and potential challenges that may be faced in pursuing standardisation for OntoCommons.

Overview of OntoCommons

As modern industrial activity continues to embrace software-driven or monitored processes, products, or services at its heart, data has emerged as an essential commodity. Concretely, the accuracy, design, description, selection, representation, and exchange of data (and knowledge derived from the data) requires a consistent approach.

Intuitively, this leads to standardisation as a method to describe these activities. However, this presents a challenge for existing standards activities that have primarily focused on inter-operability as a function of the interfaces between communicating entities [1]. Even in cases where efforts for common data descriptions exist, they can lack specificity and the ability to formally reason about the data due to the use of human language in the descriptions [2].

Instead, the OntoCommons project seeks to use ontologies to enable the interoperability and exchange of **knowledge** and **data**. Specifically, OntoCommons advocates for a tiered architecture approach with a domain-independent (top level) ontology at the top, domain-specific (mid-level) ontologies in the middle, and application-specific (low-level) at the bottom.

Additionally, the use of ontologies promotes the FAIR guiding principles [3] of Findability, Accessibility, Interoperability, and Reuse for digital assets, supporting the ability for data to be used with little or no human involvement, reused in new contexts, and further support the use of ontologies as standards for humans and machines. This also aligns well with standardisation goals.

1. ontocommons.eu/about

The Role of *Standards*

Put simply, the goal of standards is to provide a reliable basis for people (or machines) to share the same expectations about a process, product, or service. Accordingly, the main goals of standards[2] can be summarised as follows:

Fit For Purpose
Ensuring that a process, product, or service has the ability to fulfil a defined purpose in a given context.

Interchangeability
Ensuring that a process, product, or service may be used in place of another to fulfil some requirement.

Compatibility
Ensuring that independently created processes, products, or services may be used together under specific conditions to fulfil relevant requirements without causing unnecessary interaction.

Health and Safety
Identification and description of scenarios of normal and irregular use in which a process, product, or service may pose a threat to human life or property.

Optimality
Ensuring that resources used in the creation or operation of a process, product, or service achieve maximal utilisation and reduce waste.

Communication and Understanding
Ensuring clear, concise, and complete communication and communication forms for exchanges between different interacting parties.

Technology Transfer
Ensuring precise, well-documented descriptions of a process, product, or service greatly reduces the barrier to their transfer and adoption.

Removal of Trade Barriers
Ensuring precise, well-documented descriptions of a process, product, or service greatly reduces the barrier to trade across borders.

The Process of *Standardisation*

The process of creating or contributing to the elaboration of a standard is a multi-faceted challenge consisting of technological, social, human, industrial, and legal factors. As such, substantial dedication and time is required in pursing standards of any kind. Additionally, it is important to note that the technical contributions to the standards process must be considered with equal weight against the effort required in engaging with relevant stakeholders in the community.

The following pages describes considerations in the process of standardisation.

2. www.unido.org/sites/default/files/2009-04/Role_of_standards_0.pdf

What to *Standardise* ?

Given the size and scope of applying ontologies to data documentation across all domains related to materials and manufacturing, there are a significant number of things that can be standardised. Given the time and effort required in standardisation, it is very important to consider a strategy in terms of what to standardise and in what order.

Broadly speaking, this question can often be broken into:

- Use Cases that describe contexts and goals that a process, product, or service should achieve.
- The description of a process, product, or services.
- Hardware or software architectures that processes, products, or services should conform to.
- Interfaces or data/message formats that processes, products, or services should use to interoperate.
- Taxonomies of terms that describe the meaning and use of languages to describe the above.
- Descriptive frameworks that describe processes, products, or services.
- Examples of mapping a standard to a specific use case.

For all points, this can be further broken or sub-divided into different levels ranging from the abstract and generic to the concrete and use cases-specific. Given the OntoCommons goal of standardisation of data documentation for materials and manufacturing via ontologies, the above standard goals align well. However, it is also important to consider the scope the domain of materials and manufacturing.
It is important to make well scoped decisions on how and what to standardise.

Possibly relevant high-level areas of standardisation for OntoCommons include:

- Ontologies themselves (aligning to the upper, mid, or lower ontologies).
- Principles and methodologies for development of ontologies.
- Tools and processes to support the design, representation, and curation of ontologies.
- Use Cases on the use of ontologies in a given context to achieve a goal.
- Mappings or translations of existing standards to ontologies to explain the process to others.

Member-ship and Costs

Depending on the standards body and the group that is joined, it is mostly the case that membership is required. Membership enables the ability to engage in the standards process, including the submission and review of contributions, as well as voting rights on acceptance or ascent of new standards.

Membership is usually limited to entities (e.g. universities, companies, member states). Individual membership varies per SDO. Membership costs are often related to the entity that requests membership: less for universities and more for companies.

Time & Effort

The engagement required by the standards process is significant. This can be broken into a) the time required to work on the standard itself, including engagement with the relevant stakeholders, and b) the time taken from beginning a standardisation process to its completion. The former is dependent on the level of engagement sought, number of stakeholders involved, and the significance or relevance of the topic under discussion, the latter is often measured in years.

It is important to be aware of the required timescales when preparing and planning for standardisation. This is due to a combination of the pace at which the chosen standards community moves, the elaboration of the proposed standard itself, as well as the various stakeholder engagements that are required.

Community Building

As standardisation is a human-centric activity, it is essential to engage with existing communities to socialise the ideas/concepts/approach that should be standardised. It is unlikely that simply proposing new content to a standards group without any alignment to existing topics or discussion with existing members will be successful. TC members are very busy people and can find it challenging to give equal time and priority to all standards contributions.

As such, engagement with other standards members before any proposals or further elaboration of standards is strongly recommended. A good opportunity to do this is via attendance of in-person standards events. Equally, holding workshops and events with the relevant stakeholders – if appropriate - can also achieve the result. Furthermore, especially since the global pandemic, many groups now hold weekly online or e-meetings. This can also be a source of travel-free engagement.

Please note that, depending on the group, other stakeholders can be in different geographical regions, requiring accommodation of different time zones, cultures, and working practise.

Pre-Standardisation

A less discussed element of the standardisation process is pre-standardisation. Pre-standardisation is an activity performed by various standardisation groups for works that are exploratory or immature in nature.

Outputs from pre-standardisation groups or activities will usually continue towards the formal standardisation process, making working with such groups a good first step to engage with a particular standards community. Pre-standardisation groups are often friendly environments, allowing participants to learn the culture of the community, propose, discuss, and refine ideas, as well as find supporters for contributions.

Relevant Standards Bodies for OntoCommons

Standards bodies are generally broken into three categories:

- **International Standards Bodies (ISB): A standards producing body consisting of two or more countries.**
- **National Standards Bodies (NSB): A standards producing body of a single country.**
- **Domain or Industry-Specific Standards Bodies: A standards producing body consisting of various industrial or (often) non-governmental members.**

The following pages is a sampling of potentially relevant entities that may benefit OntoCommons is in its standardisation goals.

International Organisation for Standards

The International Organisation for Standards (ISO) is an independent, international, non- governmental standards body with members from various NSBs.

It promotes the development of standardization to aid the international exchange of goods and services. ISO's work results in international agreements, which are published as international standards.

ISO works on standardisation in various areas except those of electrical and electronic engineering as these are a related but distinct entity, see below.

Relevance

Given the large scope of the ISO and its goal of supporting international exchange of goods and services, the standardisation of ontologies for data descriptions would be a relevant activity at the ISO.

Participation

ISO has three categories of participation:
• Member Bodies: most prominent NSB representative of a country. These members have voting rights.
• Correspondent Members: Countries without NSBs. Such members are only observers to the standards process.
• Subscriber members: Countries with smaller economies who may observe standards development.

Potentially Relevant Technical Committees

Considering the 345[3] technical committees (TC) of the ISO, there are many potential points of engagement for standardisation of ontologies for standardisation of data documentation in materials and manufacturing.

Notable TCs include:
• **JTC 1: Information Technology** - Standardization in the field of information technology.
• **TC 10: Technical Product Documentation** - Standardization and coordination of technical product documentation (TPD), including technical drawings, model based (3D), computer based (2D) or manually produced for technical purposes throughout the product life cycle, to facilitate preparation, management, storage, retrieval, reproduction, exchange and use.
• **TC 37: Language and terminology** - Standardization of descriptions, resources, technologies and services related to terminology, translation, interpreting and other language-based activities in the multilingual information society.
• **TC 46: Information and Documentation** - Standardization of practices relating to libraries, documentation and information centres, publishing, archives, records management, museum documentation, indexing and abstracting services, and information science.
• **TC 154: Processes, data elements and documents in commerce, industry and administration** - International standardization and registration of business, and

Advantages

ISO is a well-known and trusted name meaning that standards from the ISO would be considered trusted and high quality, increasing the likelihood for adoption.

Disadvantages

• It is important to note that ISO standards must be purchased for a fee in the general case. This may limit adoption of standardised ontologies or their associated tools or data.
• ISO has received criticism[4] for the slow process of developing new standards. This may lead to lost momentum in ontology standards.

3. www.iso.org/technical-committees.html
4. www.jtc1sc34.org/repository/0940.htm

International Electro-technical Commission

The International Electrotechnical Commission (IEC) is the complement to the ISO, publishing international standards in the areas and related to electrical and electronic technologies.

Relevance

Given the reduce scope of the IEC, compared to the ISO, it may be of less relevance for OntoCommons. However, the areas themselves are relevant. The answer would depend on the desired standardisation starting point and strategy.

Participation

The IEC is made up of members, called national committees (NC), and each NC represents its nation's electrotechnical interests in the IEC. Individuals or companies can't become a member of the IEC[5]. They can only participate in the IEC via their NC. IEC members or some organisations with formal relationships with the IEC may send experts to participate.

Potentially Relevant Technical Committees

Considering the 224[6] technical committees (TC) of the IEC, there are many potential points of engagement for standardisation of ontologies for standardisation of data documentation in materials and manufacturing.

Notable TCs include:

- **TC 1: Terminology**
- **TC 3: Documentation, graphical symbols and representations of technical information**
- **SC 3d: Classes, Properties and Identification of Products – common Data Dictionary**
- **TA4: Digital System Interfaces and Protocols**

Advantages

IEC is a well-known and trusted name meaning that standards from the IEC would be considered trusted and high quality.

Disadvantages

• It is important to note that IEC standards must be purchased for a fee in the general case. This may limit adoption of standardised ontologies or their associated tools or data.
• IEC is heavily industry dominated (~90%[7]). This may act as a barrier to adoption of proposals without industry support.

5. www.iec.ch/national-committees
6. www.iec.ch/technical-committees-and-subcommittees
7. https://www.iec.ch/national-committees#nclist

European Materials Modelling Council

The European Materials Modelling Council (EMMC) is a community of practise that supports the integration of materials modelling and digitalisation. To achieve this goal, EMMC acts as a network building 'think tank'.

Relevance	As EMMC is a former EU CSA and has high overlap of members with OntoCommons, it is very relevant in terms of topic and goal. However, as EMMC is not a standards body, participation may not support standardisation directly, but rather benefit as a pre-standardisation activity and community building platform.
Participation	There are 3 membership categories[8]: • Associate member: free to join, can engage with activities, but no voting rights. • Full Individual Member: 150 EURO / year, can engage with activities and vote. • Organisational Member: Relative to company size, can engage with activities and vote.
Potentially Relevant Technical Committees	At present, there is only a single TC listed on the public website: • **TG 1.1** – Linking and Coupling Computational Chemistry to Electromagnetics
Advantages	• Pre-existing relationships between EMMC and OntoCommons (e.g. Nadja Adamovic). • High overlap in relevance and domains of interest. • Non-profit association. • Given past activities of engagement with stakeholders, presents a highly connected group. • Can serve as a pre-standards group.
Disadvantages	• Not a standardising body. • Relatively young organisation (created in 2014), so possibly limited impact.

8. emmc.eu/wp-content/uploads/2020/05/EMMC-ASBL-Membership-Categories-and-Fees-april2020-V3a.pdf

Industrial Ontology Foundry (IOF)

The Industrial Ontology Foundry (IOF) was formed to address the consistency and inter-operability between different viewpoints and principles that underpin the design of manufacturing related ontologies[9].

Since 2019, IOF is part of the Open Application Group (OAGi). OAGi is a non-profit standards organisation focusing on standards to address inter-operability challenges.

Relevance

Given the goal of creating ontologies for the manufacturing and engineering industry, there is clear alignment between IOF and OntoCommons. As with EMMC, there is also overlap of members in IOF and OntoCommons. As IOF is part of a standards body, engagement would support the goals of OntoCommons.

Participation

From 1st October 2023, IOF participation will require paid membership, however, precise costs are not yet clear[10]. Until then, membership is free but required[11].

Potentially Relevant Technical Committees

At present, there are 8 WGs listed on the public website, all of which would seem relevant:

- The Material Science and Engineering (MSE)
- IOF Core
- Maintenance
- Production planning and scheduling
- Supply Chain
- Product Service System
- MTConnect
- Systems Engineering

Advantages

- Good alignment on goals with OntoCommons.
- Active community with events & resources and relevant stakeholders from different sectors[12].
- Pre-existing relationships between IOF and OntoCommons.
- Part of a standards producing entity.
- Has already produced the IOF Core Ontology.

Disadvantages

Relatively young organisation (created in 2016), so possibly limited impact, however, there seems to be momentum based on the activity of the group.

9. www.nist.gov/publications/industrial-ontologies-foundry-iof-core-ontology
10. www.linkedin.com/feed/update/urn:li:activity:7089773905090908160/
11. industrialontologies.org/participation-request/
12. app.smartsheet.com/b/publish?EQBCT=51ec8cc5ed394264b1d4440ab76c47fa

European Committee for Standardization (CEN)

Founded in 1961, the European Committee for Standardization (CEN) is a private non-profit standards organisation tasked with fostering the EU economy.

Relevance

As a European-focused organisation with an established history and topic coverage, this group would seem very relevant to OntoCommons.

Participation

Participation at CEN is via one of the following memberships:
• National member counties and affiliates NSBs.
• Affiliates countries being considered for EU membership.
• Companion standardisation bodies.
• European partners.

Potentially Relevant Technical Committees

Considering the 386[13] technical committees (TC) of CEN, there are many potential points of engagement for standardisation of ontologies for standardisation of data documentation in materials and manufacturing.

Notable TCs include:
• CEN/CLC/WS MADRAS: Advanced materials and processing in organic electronics
• CEN/CLC/WS Monsoon: Predictive management of data intensive industrial processes
• CEN/CLC/WS EFPFInterOp: European Connected Factory Platform for Agile Manufacturing Interoperability
• CEN/TC 304: Information & communications technologies - European localization requirements
• CEN/TC 310: Advanced automation technologies and their applications
• CEN/TC 468: Preservation of digital information
• CEN/WS MODA: Materials modelling terminology, classification and metadata
• CEN/WS OYS: OYSTER on Materials characterisation - Terminology, classification and metadata
• CEN/WS DBCAM: Definition of parameters required for modelling of the material, cell and manufacturing process behaviour for battery cells for the automotive market

Advantages

• Large, well-known, and influential standards producing body with over 200,000 contributors across all sectors.
• Many active topics and groups that can be engaged with.
• Strong integration and cooperation with ISO.

Disadvantages

• European focus may not be attractive for global impact
• As a large body with established areas, may be challenging to build consensus on new, potentially disruptive, contributions.

13. standards.cencenelec.eu/dyn/www/f?p=CEN:6

American Society for Testing and Materials

The American Society for Testing and Materials (ASTM) develops and publishes standards for many products, materials, systems, and services.

Relevance

An established International Standards organisation (ISO), the ASTM covers voluntary standardisation of topics related to the materials themselves. This can be relevant for the application of ontologies, rather than the ontologies themselves.

Participation

Membership requires a fee[14] and is organised as follows:
- Participating Members: 75 USD per year, can participate in technical committees.
- Organisation Members: 400 USD per year, can participate in technical committees.
- Informational Members: 75 USD per year, choose to be informed but not participate in technical committees.
- Student Members: 0 USD per year, choose to be informed but not participate in technical committees.

Potentially Relevant Technical Committees

Considering the 149 TCs[15] technical committees (TC) of the ASTM, there are many potential points of engagement for exploring the topic-specific application of ontologies in standardisation, however, there are no broad categories relating to data documentation in materials and manufacturing specifically.

Advantages

- Active body with good history (125 years) and large membership (30,000 members).
- Published standards are linked to ISO.
- Has cooperation with CEN.

Disadvantages

- Possibly limited global adoption as the body is America-centric.
- Standards have no enforcement in the general case, so may see limited impact for engagement.
- No specific broad categories for ontology description.

14. www.astm.org/get-involved/membership/membership-types.html
15. www.astm.org/get-involved/technical-committees/committee-all

ECLASS

The ECLASS e.V. association is an industry consortium for the classification of products and services. Is it manifest in ECLASS, a classification system based on hierarchical grouping of products and services.

Relevance

There may be potential to explore synergies between the classification of products and services in the annually released ECLASS dictionary and an ontology-based description as explored by OntoCommons.

Participation

Membership is fee paying, but the fee information is not publicly available. Member positions[16] are as follows:
• Steering Committee Members: full voting rights
• Ordinary Members: limited voting rights
• Supporting Members: no voting rights
Engagement is possible on a free basis via the "ContentDevelopmentPlaform", however, it does not seem that this comes with a voting position.

Potentially Relevant Technical Committees

As ECLASS focuses on a single standard, there is no publicly visible breakdown of different TCs or working groups.

Advantages

• As ECLASS itself is based on standards (DIN 4002, IEC 61360 and ISO 13584), engagement may help show the pathway towards ontology-based standards.
• Annual release of ECLASS shows that the community is active and engaged.
• ECLASS actively collaborates with other standards groups relevant to materials and manufacturing (ETIM, proficl@ss, bau:class, PROLIST, CECED/PI, IMT, EDMA, eCALS).

Disadvantages

• A fee is required to access a licence to use ECLASS, although free access is available for educational institutes.
• The organisation was founded in 2000 and may not have a sufficient presence in the standards community yet for the needs of OntoCommons.

16. eclass.eu/fileadmin/Redaktion/pdf-Dateien/Sonstige_Dateien/ECL-benefits_for_members-en.pdf

Specific Challenges in the Adoption of OntoCommons in Standards

The following lists potential challenges in OntoCommons standardisation goals.

Specific Challenges in the Adoption of OntoCommons in Standards

Standardisation Goals

Considering the high, mid, and low-level ontologies coupled with the large domain of materials and manufacturing and associated supply chain, a challenge is the scope and scale of standardisation desired. Put simply, where is the right place to start. OntoCommons should consider which are priority topics, coupled with relevant TCs and formulate a standardisation strategy. Given the significant amount of time and effort required for standards, this is an important first step.

Timing

When engaging in standards it will be necessary to answer the question of "why now". In this case, why is now the right time to perform standardisation of ontologies and surrounding technologies for manufacturing and materials.

In this case, it is necessary to show as much evidence as possible. Common motivations for response include:
• Maturity of technologies involved.
• Meaningful support from different sectors
(industrial, academic, policy, standards bodies themselves)
• Clear need or lack of suitability of existing approaches.

Stagnation or Maintenance

As ontologies in different domains have continued to develop over time, a possible risk is the need to update any standardised ontology. Given the significant timelines involved in such a process, this can become a blocker to adoption, in particular from industry partners.

This is embodied in the question of "why should we support of adopt this standard if it will become out of date relatively quickly". For example, recent work from the European Union Observatory for ICT Standardisation (EUOS)[17] notes the need for "sustainability through continuous maintenance".

It is recommended for OntoCommons to consider appropriate responses to this question based on technical expert domain knowledge.

17. zenodo.org/record/7907025#.ZHbTi3ZBy39

Comprehension

Given the strong theoretical basis, especially in the upper-level ontologies, a risk is a lack of understanding of the ontologies, how they map to use cases, and their role is complementing or even replacing existing standards approaches.

Although OntoCommons has good engagement from industry, as the work moves towards the more formal standardisation process, there exists a challenge of getting acceptance of this new approach from the standards community. Possible questions or concerns may include:

- Who will do this work?
- The proposed ontology (especially the high-level one) is too abstract and doesn't help.
- How does this Ontology integrate with existing approaches?
- Why do we need this, as we already have a solution?

In this regard, two proposed actions are suggested:
First, engagement with pre-standardisation is recommended to help build "buy in" from the relevant communities. This will help to advocate the use of ontologies slowly, generating understanding.
Second, PoC, demonstrators, or mappings to relevant use cases. This activity is already underway within OntoCommons. It is suggested that once the relevant standards community to work with is identified, existing use cases be taken and mappings of how different levels of high, mid, and low level ontologies are made. This will aid in understanding and also encourage engagement from other stakeholders to contribute to both development of the standards, as well as adoption in industry and policy.

Harmonising

It is essential to consider existing works of other groups before proposing or engaging. To do so runs the risk of encroaching on the (perceived or actual) territory of other WGs/TCs. Not only does this lead to duplication of effort but can also create active resistance when seeking support for any proposed standard.

Landscape and potential gap analysis can help, as well as engagement and discussion with the community.

Scope

It can be said that much of the work in standards is use case-driven, meaning that standards are closely related to a specific process, product, or service and often in a well-known context. Accordingly, mid and lower-level ontologies can be more intuitively mapped to TCs or WGs in the various standards bodies. However, this presents a possible challenge for upper-level ontologies as their fundamentally abstract nature creates a disconnect from much of the existing standards efforts across the SDOs.

Two possible outcomes may form: a) focus on the standardisation of the mid and lower-level ontologies, with eventual adoption of the upper-level at a later date, or b) accept that the upper-level ontology will be standardised in a WG/TC that does not show a natural fit. An important consideration for b) is that it may create friction between groups.

Again, community engagement, awareness of the relevant landscape, industrial support, and exemplar use cases will help on these points.

Referen-cies

[1] M. Drobnjakovic, B. Kulvatunyou, F. Ameri, C. Will, B. Smith, and A. Jones, "The Industrial Ontologies Foundry (IOF) Core Ontology," 2022.

[2] H. Bourbouh et al., "Integrating formal verification and assurance: an inspection rover case study," in NASA Formal Methods Symposium, 2021, pp. 53–71.

[3] M. D. Wilkinson et al., "The FAIR Guiding Principles for scientific data management and stewardship," Sci Data, vol. 3, no. 1, pp. 1–9, 2016.

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