MareGraph
Towards an Interoperable Marine Knowledge Graph

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D2.2 Guidelines on process and methodology for organisational interoperability (Version 1)

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Work Package	**WP 2, Process tuning, community building and dissemination**
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X	PU: Public
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	RE: Restricted to a group specified by the consortium (including the Commission)
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Version	Date	Author	Notes
0.2	28.03.2024	Lorenzo Vylders (Digitaal Vlaanderen), Lucas Cornette (Digitaal Vlaanderen)	Revision after General Assembly 22 and 23 February 2024
0.1	29.01.2024	Lorenzo Vylders (Digitaal Vlaanderen), Lucas Cornette (Digitaal Vlaanderen), Raf Buyle (Digitaal Vlaanderen)	Copy for D2.2 + adding vision and making adjustments to process and method

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Terminology

Terminology/Acronym	Description
Application profile	Describes which specifications can be used for certain appliobscations of an ontology. The ontology is taken as a basis and supplemented with context-specific additions. Examples are the application profiles developed within the OSLO² project or DCAT-AP for exchange of data between Open data portals.
Domain model	A domain model is a conceptual model of a certain domain that represents both behavior and data. It is a formal representation of knowledge domain with entities, relationships, data types, etc.
Controlled vocabulary	Umbrella term for code lists, taxonomies and thesauri, among others. Controlled vocabularies, on the other hand, are used for filling in specific data attributes with standardized values. An example of a controlled vocabulary is the Language Named Authority List of the Publications Office of the European Union (OP).
High level domain model	A high level domain model describes the relevant entities in a domain with a high level of abstraction. It is the result of a first step towards the formalization of domain knowledge and the analysis of information needs.
Declaration of Intent	A declaration of intent describes the domain and purpose of the ontology to be developed and is communicated to various relevant stakeholders at the start of the process.
JSON-LD	JavaScript Object Notation for Linked Data is a way to represent Linked Data in JSON.
SHACL	Shapes Constraint Language is a way to describe and validate data graphs (in RDF).
Specification	A specification is a technical document that gives substance to the ontology. Specifications can be adjusted based on advancing insight without changing the corresponding ontology.
Ontology	An ontology is a conceptual framework, developed through collaborative efforts and consensus among various interested parties and stakeholders, that provides a structured representation of knowledge and defines the relationships between different entities. It is designed to describe a consistent and reproducible way of organizing and categorizing information, enabling the classification, retrieval, and interpretation of data within a specific domain or subject area.
UML class diagram	A static diagram that describes the structure of a system based on classes, attributes, relationships, and operations.

Terminology/Acronym	Description
Graffoo	Graffoo is a visualization technique used in drafting ontologies, providing a concise and graphical representation of complex concepts, relationships, and hierarchies. It helps ontology designers to gain a better understanding of their models and facilitates communication and collaboration among stakeholders in the ontology development process.
Vocabulary	Describes a shared conceptual framework for certain concepts with a focus on data exchange
Working Group Charter	Documents the expectations on the outcomes of the work of the thematic working group and describes how the working group will be organized. This document serves as a starting point for starting the development process.

Executive Summary

This executive summary provides an overview of the guidelines on process and methodology for interoperability, focusing on the creation of knowledge graphs and the management of related semantic assets. The guidelines are based on the OSLO framework and are the first step towards establishing collaborative governance between Belgium and Italy. The document outlines the processes and guidelines necessary for achieving organisational interoperability in the creation of ontologies, from the establishment of a formal governance structure to community building and the development of a semantic specification for publication.

The guidelines emphasize the importance of collaborative governance in promoting interoperability between organizations. By establishing a formal governance structure, stakeholders from both Belgium and Italy can actively participate in decision-making processes and contribute their expertise to ensure the effective development and maintenance of knowledge graphs and semantic assets. Community building also plays a crucial role in the successful implementation of the guidelines. The document highlights the need to engage relevant stakeholders, including domain experts, data custodians, and technology providers, in the development and adoption of ontologies.

The document concludes by identifying challenges that need to be addressed to fully realize the goals outlined in the guidelines. These challenges, at the end of this deliverable, serve as a roadmap for future actions towards D2.2, including overcoming technical challenges, addressing cultural and organizational barriers, and promoting awareness and understanding of the benefits of organisational interoperability. The goal of this deliverable is identifying the challenges that arise when trying to establish a collaborative governance between Belgium and Italy, while the next deliverable will propose solutions on how to solve them.

In summary, the guidelines on process and methodology for organisational interoperability presented in this document provide a comprehensive framework for creating knowledge graphs, including the management of the related semantic assets. By following these guidelines, organizations can enhance data interoperability, promote cross-border cooperation, and contribute to the advancement of knowledge and innovation.

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1 About

MareGraph aims to bring together and collaborate with highly diverse national and regional Research Infrastructure (RIs) in Europe. To maximize the impact of MareGraph and its results, the project implements effective communication, dissemination and knowledge transfer methodology and strategies. Having a defined process and methodology for organizational interoperability is crucial as it ensures seamless communication, data exchange, and collaboration between different departments, systems, and organizations, thereby enhancing efficiency, reducing errors, and enabling effective decision-making.
This document stems from the ICEG process and methodology, which in turn was the English translation of the OSLO process and methodology. The process focuses on the harmonization and alignment of initiatives with the goal of developing ontologies across borders in the EU.

2 Retrospective at D2.1

What did we do in D2.1?

For the D2.1 deliverable of the MareGraph project, a first version of a governance framework was made that would enable effective collaborative decision-making and encourage the development of a stakeholder community integral to the success and broad adoption and reuse of ontologies. This deliverable was characterized by applying the OSLO Process and Method and assisting our partner, CNR, in going through this process of creating semantic specifications within the MareGraph project. By doing this we aim to establish guidelines on ontology creation to reach a widespread consensus and promote interoperability between member states in the European Union.

To promote transparency and ensure clarity in our approach, extensive documentation was prepared, outlining the methodologies and processes used during this period as well as the related technical and organizational challenges identified. These findings from D2.1 are now shaping the direction of the subsequent D2.2 phase, as we attempt to outline and address the challenges identified.

The establishment of guidelines on process and methodology for organizational interoperability has been a hallmark of D2.1, providing a framework for organizations to improve data interoperability and support cross-border cooperation. During the phase, several key challenges were pinpointed, such as technical constraints and organizational hurdles, and the need to elevate awareness of the benefits of interoperability.

Building upon the groundwork established in D2.1, the MareGraph project has developed a roadmap for future actions, clearly identifying the specific challenges to be addressed in the D2.2 phase. This roadmap is critical in steering the project's forward momentum, ensuring that all forthcoming efforts are concentrated and effective in addressing the challenges laid out. With this structured approach and the guidelines in place, the MareGraph project is strategically positioned to address the complexities of organizational interoperability, advancing towards its ultimate aim of enabling seamless data exchange and collaboration across European borders.

Identified challenges

The collaborative initiative between Belgium and Italy within MareGraph is dedicated to establishing a unified methodology rooted in the OSLO framework, with the goal of creating knowledge graphs including the management of the related semantic assets. The focus lies on defining processes and guidelines to achieve organizational interoperability in ontologies. Throughout this process, various challenges have been encountered. During deliverable D2.1, the following challenges were identified regarding the OSLO Process and Methodology.

Topic	Description
Working group on data standards	The establishment of a working group on data standards plays a crucial role in the central coordination and oversight of information standardization efforts. Currently, there still is a need to find a European-level solution for this body, which ideally comprises experts from various member states.
Endorsement group	Ratification of the endorsed ontologies should be carried out by a designated body in the member state where the contracting party originates from. However, the challenge lies in verifying the existence of a relevant party or body within each member state that can fulfill this endorsement role. It is important to note that, to the best of our knowledge, there is currently no equivalent European-level body which can be responsible for endorsing ontologies.
OSLO process	In the process of developing ontologies, OSLO aims to reach a point where the ontology can be registered in their own standards registry. However, determining the appropriate timing to initiate this inclusion and addressing any discrepancies that may arise, such as variations in the development process and tooling or the required use of UML models for OSLO, become crucial considerations.
Scalability	Scalability is a key objective in developing a process and methodology for ontologies that can be effectively reused by other member states. Addressing this challenge is closely intertwined with the issues surrounding the working group on data standards and the endorsement group. The ultimate goal is to establish a document that is as generic as possible, allowing for easy adoption by other member states.
Publication of the ontology and documentation	The challenge of where to publish the ontology and the accompanying documentation is closely linked to both the 'OSLO Process' and 'Scalability' topics mentioned above. To overcome this challenge, it is crucial to establish a clear process for determining the appropriate platform or

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	repository for publication. Avoiding scattered repositories and ensuring easy accessibility and discoverability of the models and documentation are key objectives. By defining clear guidelines and identifying a centralized and easily accessible platform for publication (e.g. LOV), stakeholders can locate and access the different standards and ontologies and their documentation more efficiently.
Maintenance of recognized ontologies	Maintenance of recognized ontologies is essential once they have been adopted. Establishing the right responsibilities for conducting regular reviews, engaging stakeholders when needed, documenting changes, and fostering user feedback are key aspects of ensuring the ongoing relevance and effectiveness of recognized ontologies.

Moving forward

In D2.2 we aim to further improve the guidelines set out below to promote collaboration in ontology creation throughout the European Union, doing this by further addressing the identified challenges and where possible coming up with proposed solutions. One part of the proposed solution is a vision for collaboration and a shared repository on European level, this vision is described in the section below, '3 Vision for co-creation of ontologies'.

3 Vision for co-creation of ontologies

Given the obstacles discussed in 'Retrospective at D2.1', striving towards a vision where collaboration is promoted instead of a shared governance is favorable given the diverse needs, political landscape, and way of working in public administrations of different European countries. The focus should therefore be on identifying common goals, share best practices and develop flexible solutions that can be adapted to individual contexts while maintaining a transparent process to promote reuse and credibility.

To establish common standards, we first need a platform where standards, vocabularies, datasets, best practices, and solutions can be shared and accessed by all member states that are part of the project. For this, we propose using LOV as a repository and Joinup for the community.

Joinup, the collaborative platform established by the European Commission's Interoperability Solutions for Public Administrations Programme (ISA Programme), plays a crucial role in enabling the sharing of vocabularies and application profiles. To further enhance semantic interoperability, a significant advancement could involve the development of a framework focused on leveraging semantic assets for inspiration, adoption, and contribution. This section explores the potential of such a framework and its key components.

Inspiration

To promote the reuse of existing assets and assess their quality, an EU-wide registry for vocabularies and application profiles could be established. This registry would provide a comprehensive overview of available resources, allowing for immediate assessment. A valuable resource in this regard is the Linked Open Vocabularies (LOV) platform, which offers a visual interface to gauge the extent of reuse and the vocabulary's existing employment in other contexts and explore a compilation of vocabularies published using open standards, with interconnections to other web resources.

Adopt

To facilitate the smooth contextualization of vocabularies within local settings and promote a decentralized approach in ontology creation, a standardized process for collaboration and a method for modelling and dissemination could be developed. This collaborative workbench would provide a structured environment for stakeholders to contribute their expertise and align the vocabulary with specific requirements. By following a shared process and method based on best practices, see 'Guidelines in creating ontologies', the adoption of vocabularies becomes more efficient and consistent across different contexts.

Contribute

Building upon the established process and method, the framework should include an automated mechanism to publish the finalized vocabulary in the standard registry on Joinup. This ensures that the vocabulary becomes readily available for others to engage with and

apply effectively. By streamlining the publication process, the framework encourages active participation and contribution from a wider community of stakeholders.

Conclusion

The proposed framework for collaborative vocabulary sharing on Joinup presents a significant opportunity to advance semantic interoperability. By inspiring, adopting, and contributing to vocabularies and application profiles, public administrations can enhance their ability to communicate and exchange data effectively. The establishment of an EU-wide registry, a collaborative workbench, and an automated publication process would provide the necessary infrastructure to support this framework. Ultimately, this initiative would contribute to the harmonization of semantic assets and foster greater interoperability across European public administrations.

4 Guidelines in creating ontologies

Overview

In the first section, we aim to give an overview of what the process and methodology looks like before exploring these topics deeper in the subsequent sections. For applying the vision through the process and method for ontology creation we have defined 4 high level steps, based on the paper of Raf Buyle 'Raising semantic and technical interoperability in the public sector'[1]. Our technique for improving interoperability incorporates the procedure of achieving both technical and semantic consensus, along with an end-to-end method that follows the principles of Linked Data. This method ensures the maintenance of semantic agreements within a functional public sector context. When this approach is applied across the different member states within the EU to the development of semantic assets, we can collaborate and reuse more effectively as semantic assets have undergone a process that includes the necessary alignments with relevant stakeholders and sufficient harmonization with other standards and ontologies. The application of this approach can be broken down into four steps:

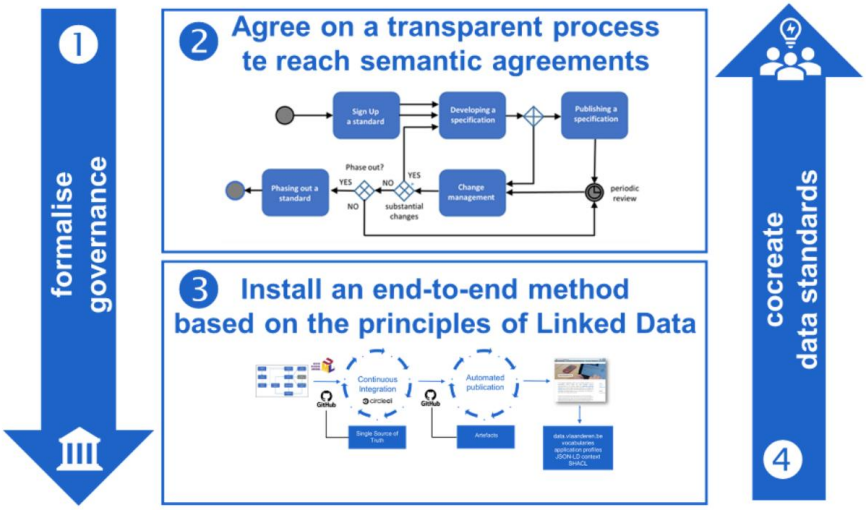
1. Establish a formal governance locally: The standardization process should be anchored at an existing governance body or initiate a new one. This step is critical as it builds trust among various stakeholders and influences the adoption of data standards. This governance body is described further in this document as the peer review community, they consist of experts and stakeholders tasked with reviewing and providing constructive feedback on the development of ontologies, standards, and semantic agreements.

2. Create a clear process for achieving semantic and technical agreements: The process should define the roles of different actors and describe how a consensus can be achieved among stakeholders. This process has been successfully implemented and documented in Flanders and at the Belgian interfederal level. This process has also been used by CNR during the MareGraph project, during which the process and method has been adapted to fit the different contexts within governments in the EU.

3. Implement an end-to-end method based on Linked Data principles: This means that all decision records, discussions, and models should be publicly accessible, with the latter documented using a formal language based on RDF. The method should include an implementation framework that ensures the traceability and alignment of semantic agreements to suit various stakeholders such as policy makers, domain experts, analysts, and developers. This process has been applied and documented in Flanders and at the Belgian interfederal level.

[1] https://biblio.ugent.be/publication/8712631

4. Co-create data standards: The semantic agreements should be achieved in open thematic working groups that include domain experts from the public sector, private sector, and academia. These groups should follow the process and method within a formal governance framework.



Introduction

This section provides a more in depth description of the guidelines for ontology creation as described in the overview above, drawing upon the best practices derived from the OSLO Process and Method in Flanders. These guidelines have been further refined and adapted based on the valuable insights gained during the MareGraph project. By following these guidelines, organizations can ensure a systematic and effective approach to ontology development, fostering interoperability and facilitating knowledge sharing.

Context

Governments at local, regional, inter-federal and European level often have to cooperate in the context of their services. In practice, a great deal of data must therefore be exchanged between the various administrations. This data comes from different systems, may not be available in the same technical format, and does not necessarily follow the same semantics. High quality data exchange becomes extremely difficult without making agreements. These agreements must be anchored as broadly as possible and, where relevant, lead to an ontology with a voluntary, 'comply or explain' or mandatory nature, in order to avoid unnecessary costs for data exchange.

When ontologies are developed by governments, it is important that the goals of the various stakeholders are aligned, as well as inside the hierarchy of an organization. All parties involved must be aware of the benefits entailed by effective and efficient use of the ontologies. The stakeholders must be convinced of the usefulness of the ontologies, whether it benefits them directly. The development process set out in this document is based on international standards and ontologies, guarantees sufficient support among stakeholders, and provides for coordination with experts both within their own organization and from the professional field.

The process and method are based on principles of openness and transparency, the stimulation of high involvement, and offering the necessary guarantees in terms of stability, quality and applicability. Moreover, standards and ontologies exist in a changing environment, so there must be room for managing changes and maintenance of agreements and standards.

Scope

This document describes a scalable process and method for developing and modifying ontologies, as well as managing their life cycle. This process and method are largely based on the OSLO process and method, which in turn are based on international best practices from ISA[2], W3C[3] and OpenStand[4], among others. This process is aimed at building consensus

[2] https://joinup.ec.europa.eu/document/process-and-methodology-developing-semantic-agreements

[3] https://www.w3.org/2017/Process-20170301/

[4] https://open-stand.org/

between different public administrations, as well as facilitating semantic, syntactic, and technical interoperability. How this process can be organized is supported by means of a method. This method describes a way of working to ensure clear communication and clear documentation throughout the process, so that the ontology can be implemented by all stakeholders such as project managers, business analysts, developers, etc.
The process and method described in this document form the basis for the development of a new ontology, adoption and modification of existing ontologies, and the possible phasing out of those ontologies. In particular, this document is aimed at ontologies for which a recognition procedure is intended.

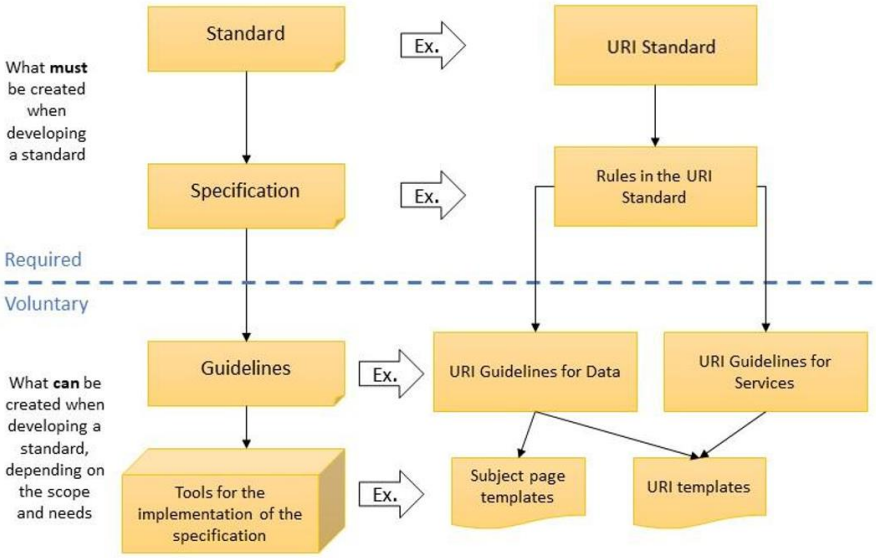


Figure 1: What must and what can be delivered in the context of the development of an ontology

Principles

The process and method explained in the following chapters follow a number of fundamental principles for the development of ontologies, which are based on the principles for standards development of OpenStand[5]. These principles apply as best practices and have already been endorsed by, among others, W3C, IEEE, IETF, IAB and Internet Society.

1. The ontology is developed in **collaboration with all stakeholders** and respecting everyone's autonomy, integrity, processes, and intellectual property. Moreover, participation stands free to all interested and informed parties.
2. The process is aimed at finding a **broad consensus**. Decisions are made in a **fair and transparent way**. Mechanisms are provided for appealing against decisions, as well as for a periodic assessment of the ontologies. Furthermore, all decisions and relevant documentation are made **publicly available**.
3. The ontologies being developed strive for **technical merit, interoperability and scalability**.
4. Ontologies together with their relevant documentation are **made available for implementation** by all parties. Specifications are being developed that allow implementation in a reasonable manner.

Process

The process for developing and maintaining ontologies is divided into three high-level phases. These phases are further explained in sections 4.2, 4.3 and 4.4. First attention is drawn to the various actors and their responsibilities (4.1). The change management is explained in section 4.5. Finally, section 4.6 provides an explanation of the phasing out of an ontology. How the processes explained in this chapter, in combination with the methods from chapter 5, are used throughout the lifecycle of an ontology, is summarized in chapter 6: the lifecycle of an ontology.

[5] https://open-stand.org/about-us/principles/

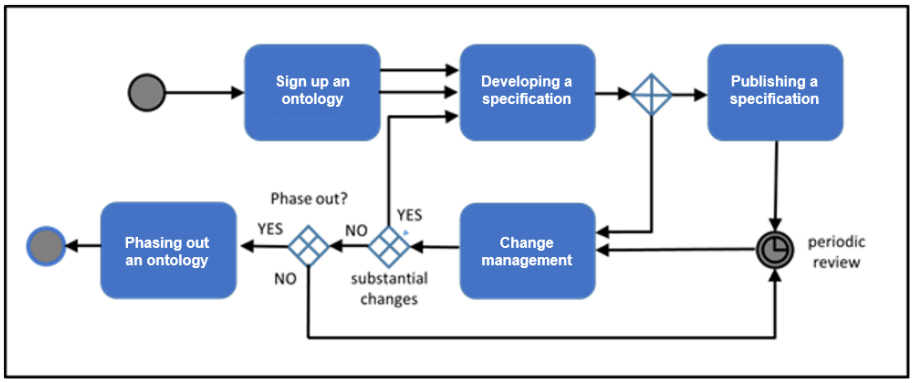


Figure 2: High-level overview of the different processes

Actors and responsibilities

The table below provides an overview of the actors participating in the process and their responsibilities. Each of these actors has an equivalent in the ISA methodology for developing semantic agreements[6].

Actor	Responsibilities
Thematical Working group(s)[7]	This group of people with knowledge about the topic and/or existing data models and implementations is responsible for the development of the domain model.
Editors of thematical working group(s)[8]	They are responsible for facilitating the working groups and the technical elaboration of the domain model in the form of diagrams and specifications.
Peer Review Community	A best practice for the standardization of information is to establish a community of peers within the field of ontology creation. This community, comprising sufficient actors to represent the whole community, plays a crucial role in assessing new ontologies to be created and evaluating ontologies that are ready for publication. They are responsible for the review of work with regard to the standardization of information. This group should have sufficient knowledge about mutual consistency (system operation) in the recognition of new ontologies, international standards and

[6] https://joinup.ec.europa.eu/sites/default/files/document/2015-03/Process%20and%20methodology%20for%20developing%20semantic%20agreements.pdf

[7] ISA: Domain Model Working Group

[8] ISA: Expert Pool

	ontologies that have an impact on local governments and advises on the generic development and change process. This role is based on the OSLO working group 'data standards'[9]
Product owners	Product owners are responsible for managing an ontology after its development. In concrete terms, they monitor problems or questions that are asked with regard to the ontology, call the working group together in function of the questions asked, and are responsible for the further development of ontologies in the context of new use cases or changes in underlying standards or ontologies (dependencies).
Project Management Data Standards[10]	Responsible for organizing working groups and inviting experts, as well as communication with various stakeholders.

Announce an ontology

In line with the basic principles for ontologies development, it is best practice to report ontologies to the Ontology Peer Review Community in time and to reach a broad consensus. To ensure a widely supported ontology, early involvement of the business is needed. Their knowledge makes it possible to map existing processes - together with the terminology used - and formulate use cases for the ontology to be developed. Moreover, a first High Level Domain Model can be drawn up together with the business. This information forms the basis for recording semantic agreements and already provides an insight into the relevance of the ontology in the initial phase.

[9] ISA: Review Group

[10] ISA: Secretariat & Activity Leader

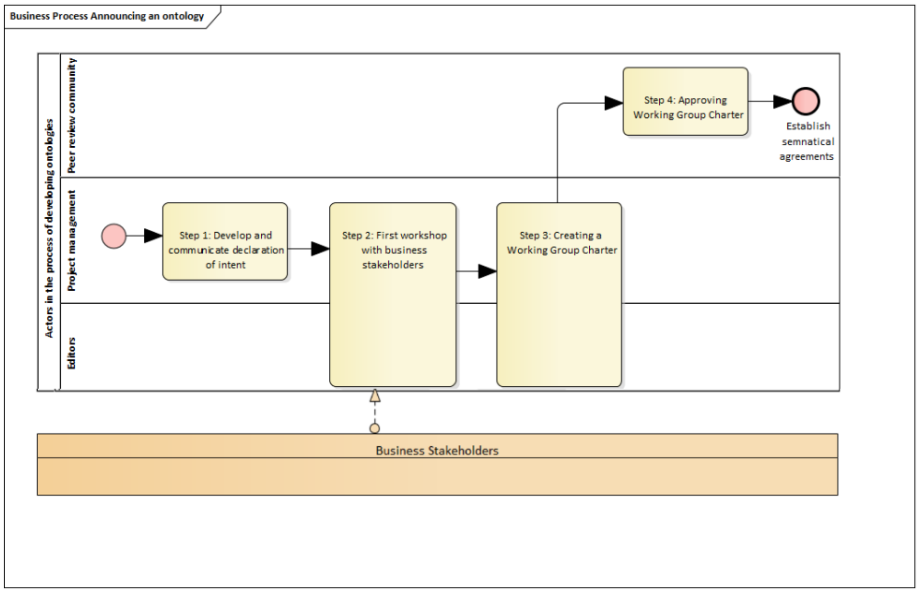


Figure 3: Process for the announcement of an ontology

Step 1. Develop and communicate a declaration of intent that describes the scope of the to-be-developed ontology

The purpose of the declaration of intent is to answer a number of basic questions:

- Why is it important to develop this ontology? What is the added value?
- What is the interface with existing standards and ontologies at a national[11], European or global level?
- Which standards, ontologies and other sources already exist in this domain?
- Who are the stakeholders that need to be involved and why do they need to be involved?

The declaration of intent is prepared by the project management. As an example, we refer to the project charter[12] of Maregraph and the registration form[13] regarding the business workshop for MareGraph.

[11] By 'national level,' we refer to the country where the contracting party originates from, as well as the country where the party in charge of developing the data standard originates from.

[12] https://www.maregraph.eu/files/Charter_Maregraph_OSLO.pdf

13 Registration form business workshop

Step 2. Invite relevant and interested business stakeholders to a workshop meeting to identify processes and use cases

The declaration of intent forms the basis for a first meeting with an initial group of stakeholders to identify different use cases[14] to which this ontology can serve, starting from the processes. This session is organized by the project management and the editors and serves as preparation for the further development of the process for ontology development, on the basis of which an official Working Group Charter is elaborated in the next step. If a thematic working group has already been established, the members of this group can also be invited to this workshop.

Step 3. Further develop declaration of intent into a Working Group Charter by adding requirements and conditions based on input from the business

The Working Group Charter sets the expectations for the deliverables that the thematic working group will produce. It allows the Peer Review Community data standards to evaluate the relevance and applicability of the ontology to be developed. For practical guidelines regarding the preparation of a Working Group Charter, see "5.1. Drawing up a Working Group Charter".

Step 4. Present the Working Group Charter to the Peer Review Community for approval for starting a thematic working group

The charter is submitted to the peer review community for approval before the public working groups can start working on the development of a specification. Once this has been approved by both bodies, the registration of the ontology is successful, and the ontology is entered in the relevant registry with the status "under development". As part of the treatment of the charter, it is decided in consultation with the thematic working group whether the ontology to be developed aims for a voluntary, "comply or explain", or mandatory nature.

[14] See for example the process workshops that were held in the context of the project of "Lokale Besluiten als Linked Open Data". The report on this workshop can be found on:

Announce an ontology

A specification is a technical document that gives substance to the ontology. In practice it is often difficult to distinguish the specification from the ontology itself. Typical examples in this regard are PDF-A, DCAT and RDF. In some cases, multiple specifications are part of an ontology. These specifications then each give a domain-specific interpretation to the ontology. An example of this is the INSPIRE Data Specifications[15], which provide a domain-specific interpretation of the "INSPIRE Implementing Rules" (the standard) for each of the INSPIRE themes.

The process for developing a specification is based on the process for the ISA process for developing semantic agreements[16]. This process must be followed for the development of a specification for ontologies such as domain models and controlled vocabularies.

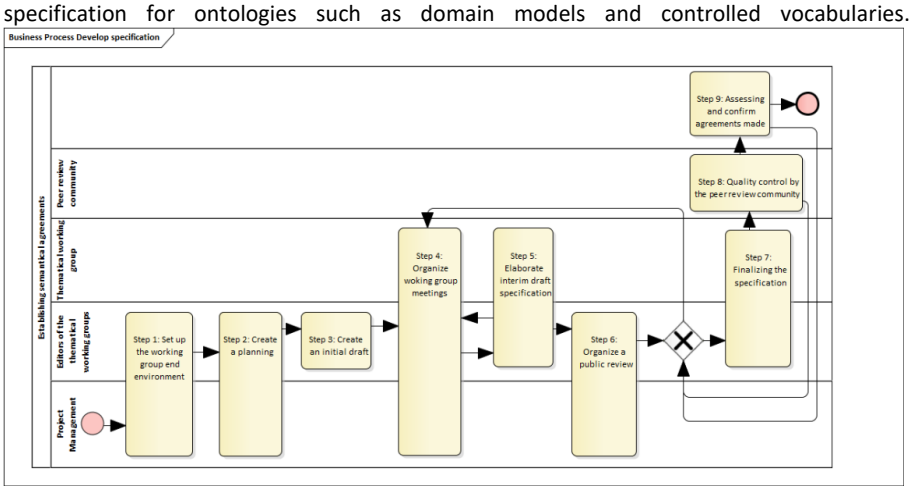


Figure 4: process for the development of an ontology

Step 5. Set up the working group and environment

In this step, the practical side of the organization of the working group is set up. This means that a project environment is set up, the members of the working group are invited, and the composition and assignment of roles is recorded. The ontology to be created is now in the "in development" phase. Furthermore, the planning for organizing the working group meetings, the public review and finalization is created.

Step 6. Creating an initial draft

Based on the knowledge at the start of the process, for example based on available project documentation, wireframes, process descriptions, elaborated use cases and existing models and standards, a specification version is prepared. Questions and any problems that arise

[15] http://inspire.ec.europa.eu/data-specifications/2892

[16] https://joinup.ec.europa.eu/sites/default/files/document/2015-03/Process%20and%20methodology%20for%20developing%20semantic%20agreements.pdf

from the analysis are listed in an action list. A proposal for a solution is created for as many listed action points as possible. This will serve as a starting point for discussions in the working group meetings.

Formalizing semantic agreements
Formalizing semantic agreements is a specialization of the process for developing a specification. When creating an initial draft, the method for developing a domain model as described in section 5.3 is used.

Step 7. Organizing the working groups

The project manager and editor together prepare the agenda for the working group meeting, based on open points that arise from the analysis and/or the previous working group meeting. During the working group meetings, the members of the working group go through the initial or intermediate draft of the specification, and through the various items on the agenda that are listed in the action list and try to reach a consensus.

Step 8. Elaborate interim draft specification

The conclusions of the working group meeting are processed in a new interim draft. Any new points that were identified during the working group or during the development of a new draft are added to the action list and serve as input for creating the agenda for the next working group meeting.

Formalizing semantic agreements
Formalizing semantic agreements is a specialization of the process for developing a specification. When creating an interim draft, the method for developing a domain model as described in section 5.3 is used.

Step 9. Mid-term evaluation by the Peer Review Community

A stable interim draft specification is proposed to the Peer Review Community, together with an overview of the organized working group sessions and the parties involved. The Peer Review Community decides whether the specification is sufficiently mature to switch to a public review period and uses the criteria for promotion to a proposed ontology for this. The duration of the public review period is determined in consultation between the thematic working group and the Peer Review Community.

Step 10. Organizing a public review

After completing various iterations of steps 4 and 5, and once there is sufficient consensus around the specification, a public review period is organized, in which the general public is asked to provide feedback. This public review can be accompanied by the organization of

extra public workshops to capture feedback. Based on the feedback received, there are two options:

1. The feedback received is editorial or results in minor semantic changes (see 4.5. Change management related to receiving and classifying feedback): The final version of the model can be prepared and publication can be made, provided that a short validation is possible by the thematic working group.
2. The feedback received includes proposals for major semantic changes: one or more additional working group meetings are needed to clarify the new actions and reach consensus again. If this is deemed necessary by the working group, a new public review can be organized again.

The ontology ends up in the "pending" phase at the start of the public review period and receives a publication status of "proposed ontology". Before this phase can be started, the project management together with the editors of the working group and the working group must test ontologies to see whether all criteria for promotion to proposed ontology have been met (see step 5). The public review period is ideal for creating and evaluating proof-of-concept implementations of the specification. These proof-of-concepts can be carried out by members of the thematic working group or by external interested parties.

Step 11. Finalizing the specification

The editors process, when necessary, in consultation with the thematic working group, all feedback received. This results in a final, stable version of the specification and accompanying documentation.

Step 12. Quality control by the Peer Review Community

The Peer Review Community performs a quality check to ensure that the process has been followed correctly and whether the objectives described in the Working Group Charter have been achieved. If the work is assessed positively, it can be published to the proper channels, otherwise the thematic working group may be asked to go through (part of) the process again. The Peer Review Community should use the criteria for promotion to a recognized ontology for this quality control.

Step 13. Assessing and confirm agreements made

After the assessment, the domain model can be promoted to a recognized ontology (see criteria for promotion to a recognized ontology), the ontology is then in the “in use” phase, or the thematic working group can go through (part of) the process again.

Publication

To promote the adoption of the ontology, it is necessary to provide technology as an aid to start using it. Therefore, following the development of a specification, at least the following steps are taken that are aimed at providing developers, information architects and other stakeholders with the necessary documentation and resources to implement the ontology:

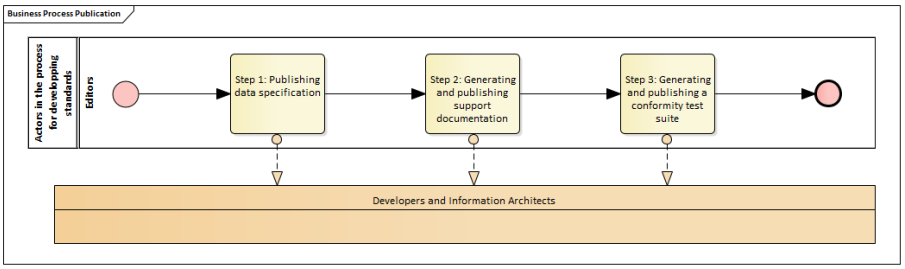


Figure 5: process for the publication of an ontology

Step 1. Publishing specification in both human and machine readable format

The data specification allows developers and information architects to estimate the impact on existing and new applications. It provides insight into how an ontology can be used. Finally, a machine allows readable data specification to automate certain aspects of the adoption. The ontology is included in the registry with the status “in use”, with a reference to the specification that is published.

Step 2. Publishing reusable elements that project teams can make use of

Reusable elements, such as a JSON-LD context file in which a data specification (eg in the case of OSLO a vocabulary) is translated into a list of terms, along with their identifier, that can be used to create a compliant JSON payload [17]. Other examples are the "subject pages[18]" that are made available as standard to support the URI.

Step 14. Publishing a conformity test suite

A conformity test suite allows you to validate implementations and ensures correct adoption of standards and ontologies. Examples are the SHACL [19]validator for OSLO and the "INSPIRE Validator" of the European Commission[20].

Change Management

An ontology no matter in what of its lifecycle, can be subject to feedback and necessary changes. It is important that this feedback is captured and evaluated in a structured way, and a clear, repeatable and transparent process to deal with it.
Change management ensures that there is the necessary guarantee that changes, if necessary, are coordinated with the necessary stakeholders and that the impact of changes is taken into account.

[17] http://data.vlaanderen.be/doc/applicatieprofiel/persoon#jsonld

[18] When a data URI is entered into a browser, a subject page can be displayed that displays a description of the data resource in man and machine readable format.

[19] https://www.w3.org/TR/shacl/

[20] http://inspire-sandbox.jrc.ec.europa.eu/validator/

The change management process is aligned with the corresponding process[21] developed by the ISA Program, and is based on the following principles:

- **Openness**: Openness means that feedback can be given on the ontologies and their underlying specifications by anyone and that logging, analysis and decisions are done in complete transparency.
- **Controlled change**: Changes must be step-by-step and traceable, taking into account the possible impact for those parties who have already implemented the ontology.

Change management applies to those phases of the lifecycle where the ontology is "stable":

- Candidate ontology
- Recognized ontology
- Candidate revised ontology

Feedback can be given at any time, and is evaluated, logged and treated according to the process described below. Feedback while the ontology is "under development" or "under review" is immediately taken into account during the (re) definition according to the process described in the section "developing a specification", unless the Peer review community decides to park it and to include it in a next release. We also refer to the method for managing issues and errata.

The change management process consists of the following major steps or sub-processes:

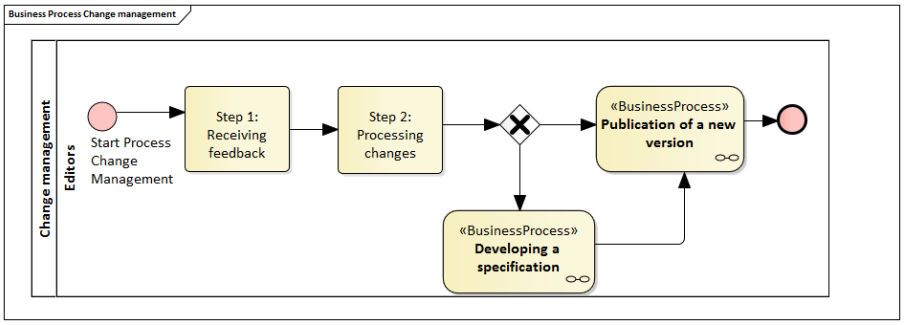


Figure 6: Process for change management

Step 1. Receiving feedback

In this step, the feedback received is captured and evaluated for relevance. This is the responsibility of the product owner. If the feedback is assessed as relevant, it is logged. If not, the relevant stakeholder will be notified and the feedback will not be logged. The feedback can come from, among others, people or organizations that implement the ontology in their applications, see conflicts with other standards/ontologies or provide new use cases that the ontology must accommodate.

The logged feedback is then subjected to an evaluation to determine further processing. In particular, an evaluation is made of the type of change that may be required to the ontology and its underlying specifications:

[21] https://joinup.ec.europa.eu/document/description-change-management-release-and-publication-process-structural-metadata

- **Editorial changes and errors**: These are changes that have no impact on the applications that have implemented the ontology, for example additional clarification, typing errors, etc.
- **Minor substantive changes**: Examples of minor substantive changes in the context of ontologies or semantic data standards such as OSLO are: the addition of a property and making certain restrictions stricter or less strict. These changes have a (possible) impact on implementations, but a small impact.
- **Major substantive changes**: These changes impact fundamental matters in the specification and underlying specifications, for example by changing a definition, adding classes, removing properties or fundamentally changing audited vocabulary. Existing implementations will be forced to analyse the impact and, where necessary, make changes in order to remain in conformity with the (new version of the) ontology.

Step 2. Processing changes

The processing of changes depends on the type of change listed above:

- **Editorial changes and errors:** These changes can simply be implemented. A new version does not necessarily have to be published and, for example. erratum to be published.
- **Minor substantive changes:** For these changes, the process for developing a specification must be followed. However, for minor changes this can be a shortened procedure, in which the thematic working group is convened to discuss the issues and then implement the changes in a new version of the specification. When it comes to an ontology that is already "in use" (cf. lifecycle of an ontology), a period of public review is started and the specification receives the publication status "Candidate Revised ontology".
- **Major substantive changes:** For these changes, the entire process for developing a specification must be run through, including a new public review period, regardless of the lifecycle phase in which the ontology is located.

It is important to note that logged changes should not be treated one by one. Once logged, these can be bundled and included in the specification according to a predefined release cycle. The frequency or the criteria with which a new release is carried out must be laid down in the Working Group Charter.
When it is decided to process the feedback received in a new version of the specification (in the case of small or large substantive changes), the lifecycle phase starts "in revision". The feedback can also trigger the phasing out of an ontology, for example when it appears that it has been completely surpassed by technological changes. We refer to the process for phasing out of an ontology.

Step 15. Publication of a new version

After analysing and implementing the changes, according to the processes required according to the type of change, a new version of the ontology, the underlying specifications and the supporting documentation must be prepared and finally published. Older versions of the ontology and the underlying specification remain available and contain references to the most recent version. The version is determined by the publication date and not by incremental version numbers.

Phasing out an ontology

An ontology can be phased out, for example when it is outdated by technological evolution or when significant errors are found in the specification.

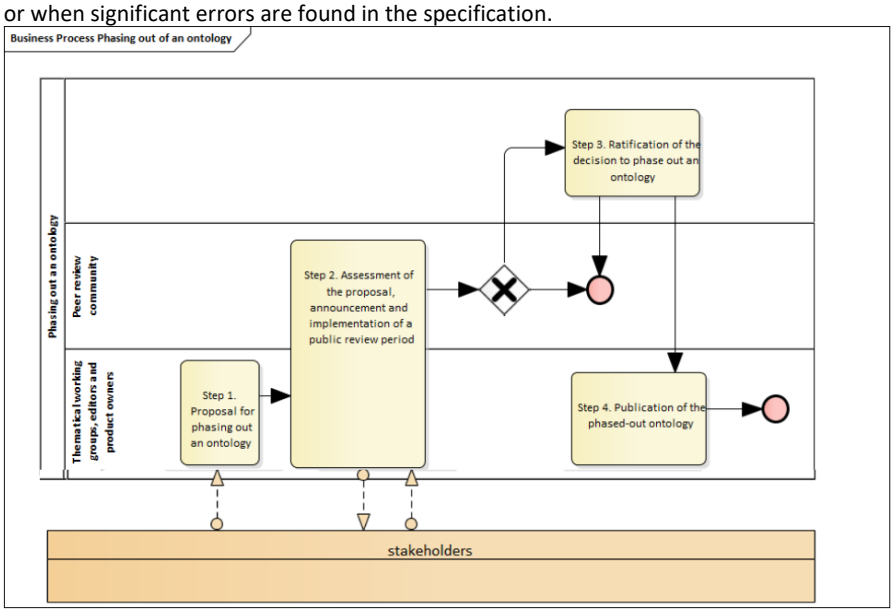


Figure 7: Process for phasing out an ontology

Step 1. Proposal for phasing out an ontology

When feedback received from stakeholders shows that an ontology is obsolete, or when significant errors are found, the product owner of the ontology can decide to submit a proposal to the Peer Review Community, in consultation with the editors and the members of the thematic working, for phasing out the ontology.

Step 2. Assessment of the proposal, announcement and implementation of a public review period

The Peer Review Community evaluates the proposal and, if admissible, announces a public review period, during which all interested stakeholders can provide feedback on the proposal to phase out the ontology. This public review period lasts at least four weeks and is also intended as a transitional period, during which the ontology is still in use.

Step 16. Ratification of the decision to phase out an ontology

If no valid objections were raised during the public review period, the ontology can be phased out.

Step 17. Publication of the phased-out ontology

The product owner, editors and thematic working groups publish a version of the specification with the publication status “phased-out ontology”. This publication also includes the reason for phasing out the ontology.

Method

The method describes how the process can be set up based on a number of (technical) documents to ultimately result in an ontology. First the method is explained to arrive at a domain model. It is then explained how the transparency of the process can be guaranteed by producing relevant documentation. The following chapter provides an overview of the tools that can be used to generate the documents listed.

Setting up a working group charter

The Working Group Charter is based on an artifact from the W3C Standardization process[22]. This document is created in the first phase of the development process of an ontology and sets expectations for the deliverables that the thematic working group will produce. The charter contains the following information:

- The objective and scope of the thematic working group (eg the development of an ontology for domain X).
- The evaluation criteria that are used during the development process. For example, whether and how many implementations have to exist before the ontology can be approved and the nature of these implementations (proof -of- concepts or production implementations).
- The duration of the working group (e.g. 6 months).
- The type of deliverables (eg specification document, software component).
- Expected milestones (dates), when known.
- The internal process of the thematic working group for approving deliverables (for example, unanimity, or unanimity minus one).
- Dependencies between these and other thematic working groups.
- Modalities for the working group meetings such as location and frequency.
- If available, the date of the first face- to- face meeting.
- Communication mechanisms (eg GitHub repository, mailing list , Google Drive folder, etc.)
- Information regarding intellectual property and licenses.
- The frequency that the criteria based on which issues after the publication of an ontology will be dealt with and new releases will be prepared. In other words, how are change management and release management arranged in a practical way?

[22] https://www.w3.org/2017/Process-20170301/#WGCharter

Organising and facilitating working group meetings

The working group consists of a collection of domain experts and stakeholders with knowledge of existing use cases and implementations. Invitations to working group meetings are issued by the project management which have a view of relevant stakeholders based on previous experiences, existing contacts and a relevant stakeholder list provided by the contracting party.
A typical development process will require at least three working group meetings, which can be structured as follows:

Working group meeting 1. Become familiar with use cases and existing standards

- Explain the working group structure and used tooling for communication and follow-up.
- Explaining existing use cases, e.g. based on a few guest speakers.
- Brainstorming session (possibly in subgroups) around other relevant use cases and information needs.

Working group meeting 2. Substantive discussions concerning the thematic domain

- Discussing draft specification
- Discussing open issues
- Preparation of action and discussion points

Working group meeting 3. Finishing and concluding specification

- Discussing remaining discussion points
- Discussing final specification
- Testing of specification against use cases

Additionally, extra working group meetings can be scheduled for substantive discussions, with the entire working group or with a subset of this group to discuss specific topics. It is the role of the editors of the working group to prepare and moderate the meetings, their tasks include:

- Preparing agenda items
- Timekeeping during working group meeting
- Taking minutes of the working group meeting
- Facilitating discussions

Prior to each working group meeting, the following documents are forwarded to the participants in preparation:

- Latest version of the domain model with a summary of any changes.
- Up-to-date overview of action and discussion points (consolidation of previous working group session + online discussions between the working group sessions)
- Report from previous workgroup session
- Practical information and agenda for the next working group

Following each working group session, the following information is sent to the participants:

- Report of the meeting including links to the documents that were used (eg draft specification)

Invitation for participants to continue discussions via GitHub.

Developing a domain model

The development of the domain model takes place in thematic working groups and requires input from various stakeholders. The figure below provides an overview of the various steps for developing a domain model. This method is based on the ISA process and method for recording semantic agreements[23] and the W3C Process Document[24].

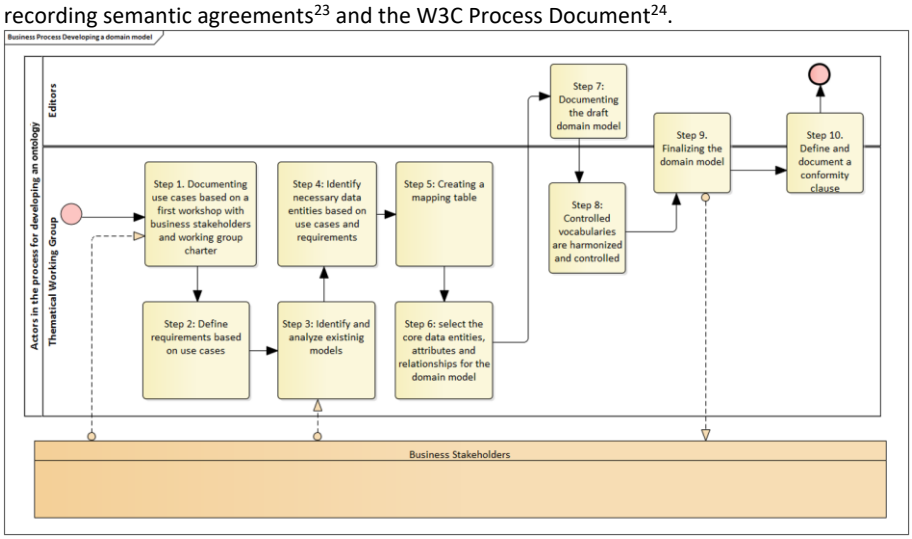


Figure 8: Developing a domain model

Step 1. Based on a first workshop with Business Stakeholders and the information in the working group charter, use cases and competency questions are created to accommodate the data as an ontology. These can be documented in a separate document or later contained in the specification of the domain model or the definitions and description of the data entities.

Step 2. Requirements are distilled from the use cases with which the data must comply as an ontology. For example, based on Use Case X we can deduce that the following data entities, attributes and relationships are needed.

Step 3. The Use Cases and Requirements make it possible to make an overview of the information needs (data entities, attributes and relationships) that are required in the domain model.

Step 4. The working group identifies and analyses existing models (and data standards), both at the level of individual business applications and applicable international standards (W3C, ISA, IETF, etc.)

Commented [A7]: we also identified competency questions. We should consider this in the upcoming deliverable

Commented [A8]: this sentence seems not finished.

[23] https://joinup.ec.europa.eu/document/process-and-methodology-developing-semantic-agreements

[24] https://www.w3.org/2017/Process-20170301/

Step 5. A mapping table is prepared to compare the information needs with existing models and data standards. This is done based on the SKOS matching principles[25] . An example and template of such a mapping table can be found on the OSLO Google Drive or on the following link where an example of a mapping can be found for OSLO: Mobiliteit: Trips en Aanbod.

Step 6. The mapping table from the previous step makes it possible to select core data entities, attributes and relations for the domain model. Where possible, existing models and data standards are reused, and sufficient attention is paid to the elaboration of the new elements.

Step 7. A draft domain model is created and documented. This leads to (1) a graphical representation (e.g. UML class diagram, graffoo diagram, …) of the domain model and (2) a data specification in the form of a vocabulary in both human and machine-readable formats. Examples of this can be found on https://purl.eu/, section 4.4 explains which tools can be used to generate these artifacts.

Step 8. Controlled vocabularies (code lists, taxonomies, thesauri, etc.) are harmonized and recorded.

Step 9. The domain model is finalized. Furthermore, controlled vocabularies, along with any other restrictions such as cardinalities, can also be included in the specification. This leads to a new version of (1) the graphical representation, (2) the vocabulary document and (3), if controlled vocabularies and other restrictions were added, an application profile. Examples of application profiles can also be found on https://purl.eu/, the relevant tooling is explained in section 4.4.

Step 10. Finally, a conformity clause must be determined and documented. This determines what demands an implementation of the ontology must meet in order to conform to the data specification. Examples of this can be found in the vocabulary and application profiles at https://purl.eu/.

Supporting transparency during development

To support transparency of the development process of the ontology, the following documents or resources are made publicly accessible:

- The Working Group Charter will be published on the registry on a dedicated online repository (e.g. GitHub) as well as on relevant standards registers such as https://purl.eu/.
- Reports of meetings held by the working group are made publicly available in HTML format on the dedicated online repository as well as on relevant standards registers such as https://purl.eu/.

Commented [A9]: we definitely do not follow such a methodology when we create ontologies :)

Commented [A10R9]: Good remark, that seems like something that should be discussed towards D2.2. I will however leave it as it is for now.

Commented [A11]: what we reported about the reuse of existing standards should be properly reported in the deliverable. d2.2

Commented [A12R11]: @giorgia.lodi@cnr.it can you please provide us with a link on where we can find this?

Commented [A13]: what is a vocabulary document?

Commented [A14R13]: please refer to the glossary, I will change this to vocabulary

[25] https://www.w3.org/TR/skos-primer/

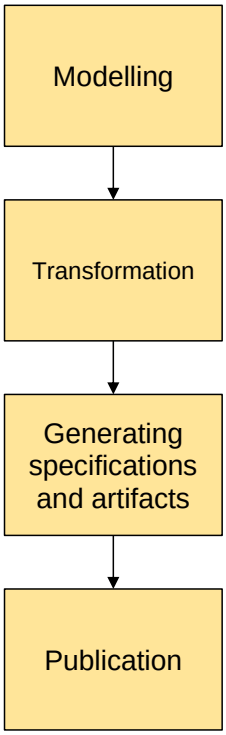
- Design documents (draft domain model, design data specification, etc.) are published with each new version on the dedicated online repository as well as on relevant standards registers such as https://purl.eu/. The latter always refers to the most recent version.
- Final domain models, in the case of standard semantic data, are included in the dedicated online repository.
- All interested parties can provide feedback on the ontology and the developed specifications. This can be done via an easy-to-use and publicly accessible mailing list and / or issue log, which is kept in a GitHub repository.
- Publish design documents for each new version on the dedicated online repository.

Generation of the data specification and documentation

A specification is a technical document that gives substance to the ontology. Specifications can be adjusted based on advanced insight without changing the corresponding ontology. It is often difficult to distinguish a specification from the ontology itself. Typical examples in this regard are PDF-A, DCAT and RDF. In some cases, multiple specifications are part of an ontology. These specifications then each give a domain-specific interpretation to the ontology. An example of this are the INSPIRE Data Specifications, which provide a domain-specific interpretation of the 'INSPIRE Implementing Rules' (the standard) for each of the INSPIRE themes.

To give an example on how to generate data specification and documentation, the following method and toolchain were developed in OSLO and can be reused[26]. This method uses the Resource Description Frame (RDF) as the underlying data model but can also be serialized to a traditional XML.

[26] Related to the OSLO Toolchain there are some identified obstacles, these are further described in 'Identified Challenges and proposed solutions'



All models are modeled in UML. All models are managed in a central repository to expose dependencies and perform quality control. You can find the most recent version on GitHub.

The UML models are transformed into an ontology in Turtle[27] syntax, using RDF, the EA tool to -RDF. This is the machine-readable version of a vocabulary. In addition, this tool can export a UML model of an application profile to a .TSV file for further processing. More information about the tool and the configuration used for the models can be found on GitHub. Furthermore, the output is easy to convert to other formats such as XML or JSON.

Based on this machine-interpretable version of the vocabulary, a number of artifacts are then generated with a Specification Generator tool. Successively with this tool the following documents are generated: HTML version of the vocabulary, HTML version of the application profile and the JSON-LD context definition. An XML schema can also be defined from this.

The output is subjected to a review using the Ontology Pitfall Scanner[28], Turtle syntax validator [29]and JSON-LD validator[30]. The models together with their documentation are then published on the Vocabularies GitHub repository, after which they are also made available automatically via the dedicated GitHub repository.

[27] https://www.w3.org/TR/turtle/
[28] http://oops.linkeddata.es/response.jsp#
[29] http://ttl.summerofcode.be/
[30] https://json-ld.org/playground/

Management of issues and errors

All interested parties must be given the opportunity to log issues related to the ontology and the specification. This must be done in an open and transparent manner.
The product owner of the ontology monitors the issues. This means he is responsible for answering questions and, where necessary, calling in experts to answer specific questions. Furthermore, it is also the product owner who, based on the frequency and / or the criteria with regard to new releases of the ontology, as stated in the Working Group Charter, convenes the members of the thematic working groups to discuss the issues and changes to the ontology and to prepare its specification (see change management).
Changes to the ontology must be documented on a webpage that was provided for this task. The minimum information per release includes:

- The date of the release.
- A textual description of the change.
- Where possible, references to the issues that were dealt with and processed as part of the release.

Lifecycle of an ontology

The life cycle of an ontology, and the status that the ontology has in the registry is based on the W3C Recommendation Track[31]. The table below provides an overview of the life cycle of an ontology and the link with process and method.

Lifecycle phase	Publication status	Process	Method
N / A	Working Group Charter[32]	Registration of an ontology	Setting up a Working Group Charter
In development	Draft document[33]	Development of a specification	Development of a domain model
In treatment	Candidate ontology[34]	Change Management	Generate data specification and documentation
In use	Recognized ontology (+ Errors) [35]		
In revision	Draft document	Development of a specification	Management of issues and errors

[31] https://www.w3.org/2017/Process-20170301/
[32] Analog to the W3C Working Group Charter
[33] Analog to the W3C Working Draft
[34] Analog to the W3C Candidate Recommendation
[35] Analog to the W3C Recommendation

	Candidate Revised Ontology[36]		
Phased out	Phased-out ontology[37]	Phasing out an ontology	N / A
Working group ended (work stopped before the "in use" phase was reached)	Working group Report	N / A	N / A

Criteria for promotion to candidate ontology

- All documented use cases and requirements in the Workgroup Charter at the start of the work have been met.
- Any changes in dependencies were documented.
- The criteria for evaluating the implementation experience were defined and approved by the Peer Review Community (eg, minimum two implementations or proof -or- concepts).
- A deadline for giving feedback must be specified.
- Demonstrate that the specification has already been assessed by a wide audience based on those involved in the working group and receive feedback via the mailing list and / or issue log.
- Certain data entities may be labeled as "at risk". These may be removed before the candidate ontology is promoted to ontology.

Criteria for promotion to candidate ontology

- All issues that have been documented must be processed.
- There must have been 'sufficient' implementation experience during the public review period.
- The final specification may not contain significant differences in relation to the candidate ontology.
- The Peer Review Community has approved the promotion to ontology.
- A place (eg GitHub) is specified to keep track of errors and issues after publication as an ontology.
- A product owner has been specified who is responsible for change management.

Toolchain

The ~~toolchain used under the~~ OSLO ~~project~~ toolchain in itself is primarily open-source, thus providing a flexible framework for software development. However, it incorporates a commercial tool, Enterprise Architect (EA), which~~, although~~ is in itself a closed system. The reason that the toolchain is based on Enterprise Architect ~~,~~ is because it is recognized for its cost-effectiveness in comparison to other commercial tools available in the market and allows to provide semantic assets to the ontology,

[36] Analog to the W3C Revising a Recommendation

[37] Analog to the W3C Obsoleted or Rescinded Recommendation

something that usually is not possible within open-source programs which are often primarily used for drawing and semantic information has to be defined separately.

The current implementation of the toolchain has many strengths. It is capable of managing a decentralized knowledge base, caters to a diverse group of editors with varying expertise, and allows the collective creation and discussion of a vast volume of documents. Furthermore, it is integrated with a publication platform governed by a stringent flow, ensuring the coherence and integrity of the created content.

However, the toolchain does face challenges. The diverse contributions can lead to conflicts, making it difficult to achieve a consistent version of the OSLO graph. Additionally, while standardizing an intermediary format is possible, it could require significant modifications to existing tools, raising concerns about their adoption. Despite these challenges, the toolchain is noted for its simplicity, stability, and clarity. These characteristics distinguish it from other standards like LinkML.

Peer review community

Context

Citizens and businesses across Europe expect consistent and efficient services from their respective governments, similar to the standards and ontologies followed in the private sector. Governments throughout Europe provide a wide range of public services, supported by various specialized applications from different software suppliers. However, the data within these applications is often modelled from specific perspectives, hindering its reuse across different applications and processes. Consequently, transforming the data for reuse incurs high costs. This results in citizens and businesses having to repeatedly provide information, leading to duplicated investments, errors, and frustrations. The objective is to establish greater coherence in system operations, improved semantic understandability, and enhanced metadata findability, enabling easier access to data. Furthermore, the use of technical standards for information exchange (APIs) helps avoid redundant technical investments.

Order description, composition, and responsibilities

The peer review community can be an existing governance body or a new one responsible for the central coordination and oversight of efforts related to standardizing information across Europe. The activities involve standardizing the meaning (semantics), syntax (grammar), technical standards and ontologies for information exchange, and metadata ("data on data"). To ensure stability and mutual consistency of ontologies, a generic development and change process is employed.

The development process should be based on international standards, guarantee sufficient support from stakeholders and provide for coordination with experts, both within their own organization and from the professional field. All European governments have the option to participate in the development process.

It is also advised for a formal process to be set up to change ontologies maintained at federal or regional entities, or local authorities. Changes can have a major impact on existing information systems and must therefore be carefully evaluated. A registry should be established, overseen by agreements made within the endorsement group regarding its management. In addition, the working group is responsible for monitoring international standards that have an impact on European governments and monitoring the generic development and change process.

The various ontologies (such as MareGraph) are developed in sub-working groups that are of a temporary nature. In addition, the following actions are carried out in temporary sub-working groups: (1) drawing up a generic development and change process for ontologies managed by federal or regional entities and local authorities and submitting them to the endorsement group for approval, (2) draw up a procedure for the recognition of ontologies and submit it for approval and (3) define and set up a registry.

Each participant within the peer review community who is responsible for one or more sub-working groups is responsible for the coordination, follow-up and implementation of the instructions and agreements of the data standards working group within his / her sub-working group.

Reporting

The review community provides regular reports on the progress of ontologies development to the relevant European oversight committee at their meetings.

Assignment description of the peer review community
The peer review community in ontology development will focus on how ensuring the quality, relevance, and applicability of ontologies through rigorous quality assurance measures, consensus-building, and alignment with working group objectives. It is also involved in handling appeals, conducting periodic assessments, and endorsing the final version of ontologies for publication. In general, they will play an important role in the governance of ontology development and the management of semantic assets.

Exploring the Landscape: Perceptions and Views on EU-wide Ontology Creation

OSLO Toolchain

The toolchain, while robust and flexible, does have certain limitations. The inclusion of the commercial tool, Enterprise Architect (EA), can be a hurdle for some users, particularly those who prefer open-source alternatives. EA's nature as a closed system can limit adaptability and customization, contrasting the otherwise open-source nature of the toolchain.

Another limitation lies in the management of a decentralized knowledge base. While this setup allows for diverse input and collaboration, it can lead to potential conflicts due to the patchwork nature of document creation, impeding the formation of a unified version of the OSLO graph.

Standardization also presents a challenge. While it's possible to standardize an intermediary format, it may require significant adjustments to the existing tools. This could lead to adoption hesitations among users. Lastly, the toolchain's focus on semantics can be limiting for users who are more oriented towards implementation, as business analysts typically are not trained to look at semantics.

Linked Open Vocabularies (LOV)

Linked Open Vocabularies (LOV) come with a range of limitations that can affect their efficacy and user experience. One of the most notable challenges is the quality and consistency of the vocabularies. Given that there are no universally accepted standards for creating or implementing these vocabularies, it's common to find errors, inconsistencies, or lack of necessary detail in some vocabularies. This lack of uniformity also impacts interoperability, a key aim of LOV. The differing standards and structures of vocabularies can make successful interoperability a challenge.

Another key limitation of LOV is its complexity. The framework is built on Semantic Web technologies, which can present a steep learning curve for those not familiar with them. This complexity can act as a deterrent, hindering widespread adoption of LOV. Additionally, LOV presents usability challenges, particularly for non-English speakers, as most vocabularies are predominantly in English. Furthermore, the metadata provided by these vocabularies is often incomplete, which can affect the discoverability and usability of the vocabularies.

LOV also faces challenges in terms of scalability and maintenance. As the amount of data within the ecosystem increases, managing, updating, and querying this data can become increasingly challenging. Some vocabularies are not regularly updated or maintained, leading to outdated or irrelevant information. Moreover, the LOV ecosystem heavily depends on the community for development and maintenance, which may not always be reliable or consistent. Lastly, ensuring privacy and security of data within this open ecosystem can be challenging, adding to the list of limitations of LOV.