



MareGraph

Towards an Interoperable Marine Knowledge Graph

Project Title	Towards an Interoperable MARinE Knowledge GRAPH
Project Acronym	MareGraph
Grant Agreement No.	101100771
Start Date of Project	23/01/2022
Duration of Project	36 Months

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

Work Package	WP 2, Process tuning, community building and dissemination
Lead Author (Org)	Lorenzo Vylders (Digitaal Vlaanderen)
Contributing Author(s) (Org)	Lucas Cornette (Digitaal Vlaanderen), Liesbeth Van der Haegen (Digitaal Vlaanderen), Laurens Vercauteren (Digitaal Vlaanderen)
Due Date	30.06.2023
Date	23.06.2023
Version	V1.0

Dissemination Level

- | | |
|-------------------------------------|--|
| <input checked="" type="checkbox"/> | PU: Public |
| <input type="checkbox"/> | PP: Restricted to other programme participants (including the Commission) |
| <input type="checkbox"/> | RE: Restricted to a group specified by the consortium (including the Commission) |
| <input type="checkbox"/> | CO: Confidential, only for members of the consortium (including the Commission) |

Versioning and contribution history

Version	Date	Author	Notes
0.1	23.06.2023	Lorenzo Vylders (Digitaal Vlaanderen), Lucas Cornette (Digitaal Vlaanderen)	
0.1	26.03.2023	Giorgia Lodi (ISTC-CNR), Alessandro Russo (ISTC-CNR)	revisions

Disclaimer

This document contains information which is proprietary to the MareGraph Consortium. Neither this document nor the information contained herein shall be used, duplicated or communicated by any means to a third party, in whole or parts, except with the prior consent of the MareGraph Consortium.

Table of Contents

D2.1 Guidelines on process and methodology for organisational interoperability (Version 1)	1
Versioning and contribution history	2
Table of Contents.....	3
Terminology	5
Executive Summary.....	7
1 About	8
2 Introduction.....	8
Context.....	8
Scope.....	9
3 Principles.....	10
4 Process.....	10
Actors and responsibilities.....	11
Announce an ontology.....	12
Step 1. Develop and communicate a declaration of intent that describes the scope of the to-be-developed ontology	13
Step 2. Invite relevant and interested business stakeholders to a workshop meeting to identify processes and use cases	13
Step 3. Further develop declaration of intent into a Working Group Charter by adding requirements and conditions based on input from the business.....	14
Step 4. Present the Working Group Charter to the Permanent Working Group Data Standards for approval for starting a thematic working group	14
Announce an ontology.....	14
Step 1. Set up the working group and environment	15
Step 2. Creating an initial draft.....	15
Step 3. Organizing the working groups	15
Step 4. Elaborate interim draft specification.....	16
Step 5. Mid-term evaluation by the data standards working group.....	16
Step 6. Organizing a public review	16
Step 7. Finalizing the specification	17
Step 8. Quality control by the permanent working group on data standards	17
Step 9. Assessing and confirm agreements made.....	17
Publication	17
Step 1. Publishing specification in both human and machine readable format	18
Step 2. Publishing reusable elements that project teams can make use of	18
Step 3. Publishing a conformity test suite	18
Change Management.....	18
Step 1. Receiving feedback	19
Step 2. Processing changes.....	20
Step 3. Publication of a new version	20
Phasing out an ontology	21

Step 1.	Proposal for phasing out an ontology	21
Step 2.	Assessment of the proposal, announcement and implementation of a public review period	21
Step 3.	Ratification of the decision to phase out an ontology	21
Step 4.	Publication of the phased-out ontology	22
5	Process	22
	Setting up a working group charter	22
	Organising and facilitating working group meetings	23
	Developing a domain model	24
	Supporting transparency during development	25
	Generation of the data specification and documentation	26
	Management of issues and errors	28
6	Lifecycle of an ontology	28
	Criteria for promotion to candidate ontology	29
	Criteria for promotion to candidate ontology	29
7	Working group on data standards	30
	Context	30
	Order description, composition, and responsibilities	30
	Reporting	31
8	Identified challenges	32

Terminology

Terminology/Acronym	Description
Application profile	Describes which specifications can be used for certain applications of an ontology. The ontology is taken as a basis and supplemented with context-specific additions. Examples are the application profiles developed within the OSLO ² 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 incorporates 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 organisational 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.

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 Introduction

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 or not 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. The process and method are based on international best practices from ISA¹, W3C² and OpenStand³, among others. This process is aimed at building consensus 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.

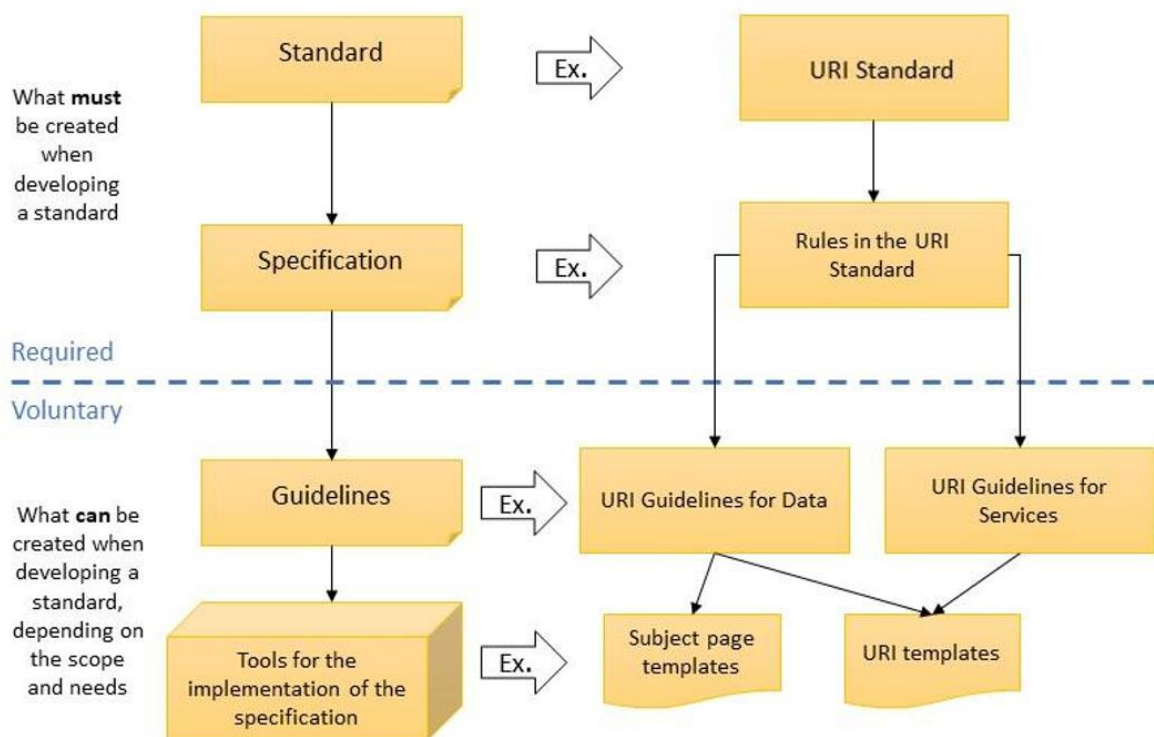


Figure 1: What must and what can be delivered in the context of the development of an ontology

¹ <https://joinup.ec.europa.eu/document/process-and-methodology-developing-semantic-agreements>

² <https://www.w3.org/2017/Process-20170301/>

³ <https://open-stand.org/>

3 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 OpenStand⁴. 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.

4 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.

⁴ <https://open-stand.org/about-us/principles/>

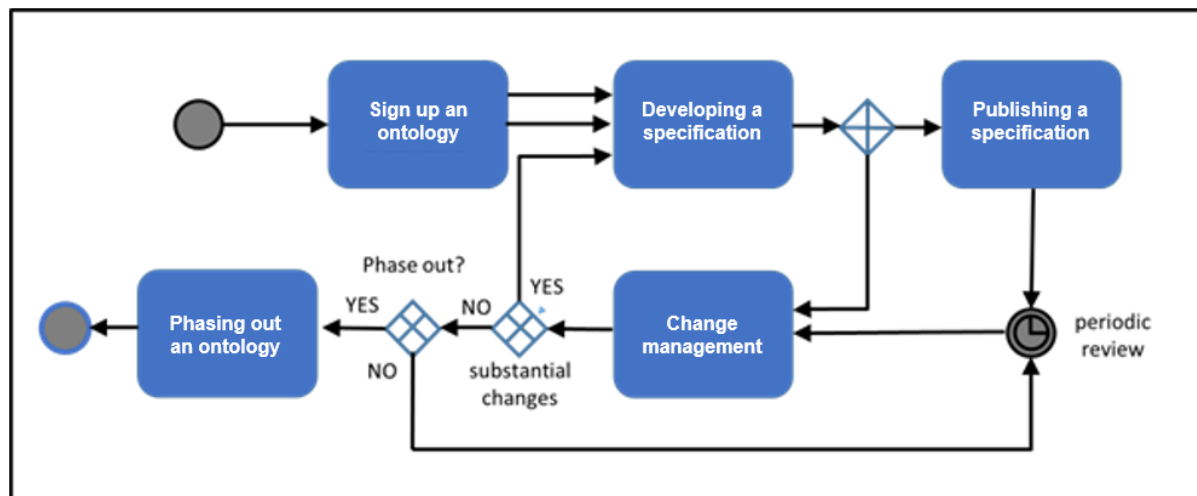


Figure 2: High-level overview of the different processes

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 agreements⁵.

Actor	Responsibilities
Thematical Working group(s) ⁶	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) ⁷	They are responsible for facilitating the working groups and the technical elaboration of the domain model in the form of diagrams and specifications.
Working group 'data standards' ⁸	The working group has a permanent character and is responsible for the central coordination and follow-up of work with regard to the standardization of information. The activities include the standardization of: meaning of the information (semantics), the syntax of the information (grammar), the technical standards for the exchange of information, and the metadata ("data on data"). In addition, the working group monitors mutual consistency (system operation) in the

⁵ <https://joinup.ec.europa.eu/sites/default/files/document/2015-03/Process%20and%20methodology%20for%20developing%20semantic%20agreements.pdf>

⁶ ISA: Domain Model Working Group

⁷ ISA: Expert Pool

⁸ ISA: Review Group

	recognition of new ontologies, monitors international standards and ontologies that have an impact on local governments and is responsible for monitoring the generic development and change process. The data standards working group meets on a regular basis to evaluate the current thematic working groups.
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).
Endorsement Group ⁹	Endorses the ontology after reviewing the documentation of the process followed. Ratification is done by the member state in Europe where the contracting party originates from.
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 necessary to report ontologies to the governing body 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: Endorsement Group

¹⁰ ISA: Secretariat & Activity Leader

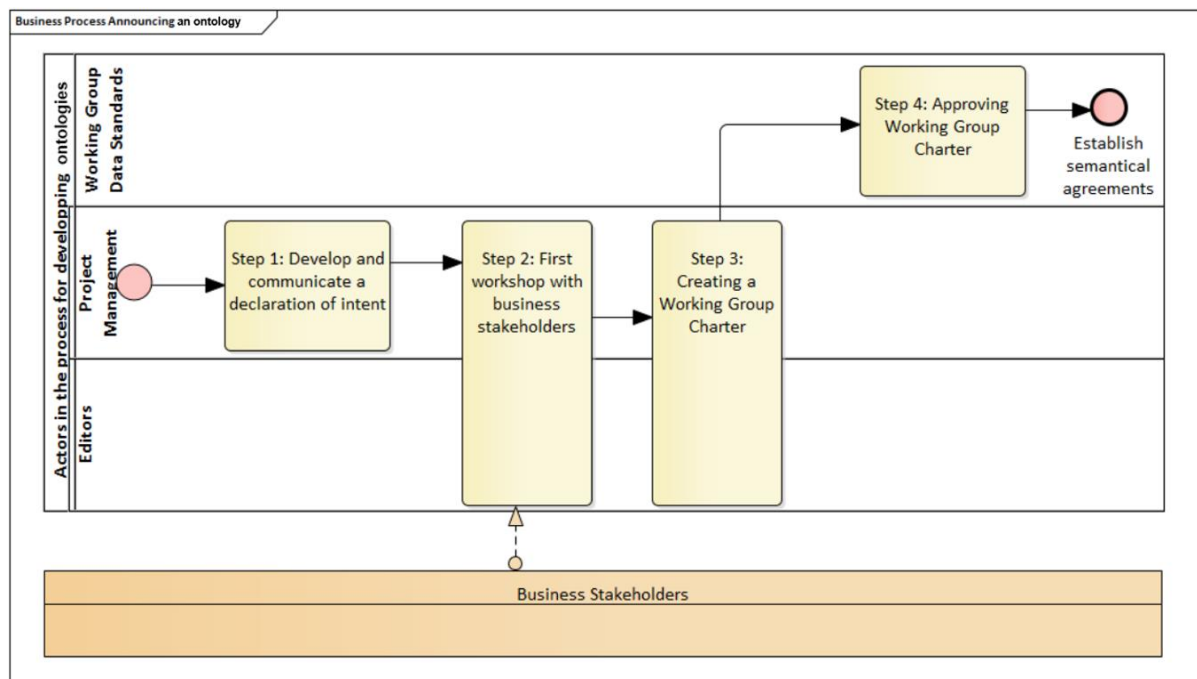


Figure 3: Process for the announcement of an ontology

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 national¹¹, 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 charter¹² of MareGraph and the registration form¹³ regarding the business workshop for MareGraph.

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 cases¹⁴ to which this ontology can serve, starting from

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

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:

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 permanent working group 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 Permanent Working Group Data Standards for approval for starting a thematic working group

The charter is submitted to the permanent working group data standards 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”. The permanent working group data standards and the steering committee meet on a regular basis. The evaluation and discussion of these charters will always be an agenda item. 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.

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 Specifications¹⁵, 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 agreements¹⁶. This process must be followed for the development of a specification for ontologies such as domain models and controlled vocabularies.

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>

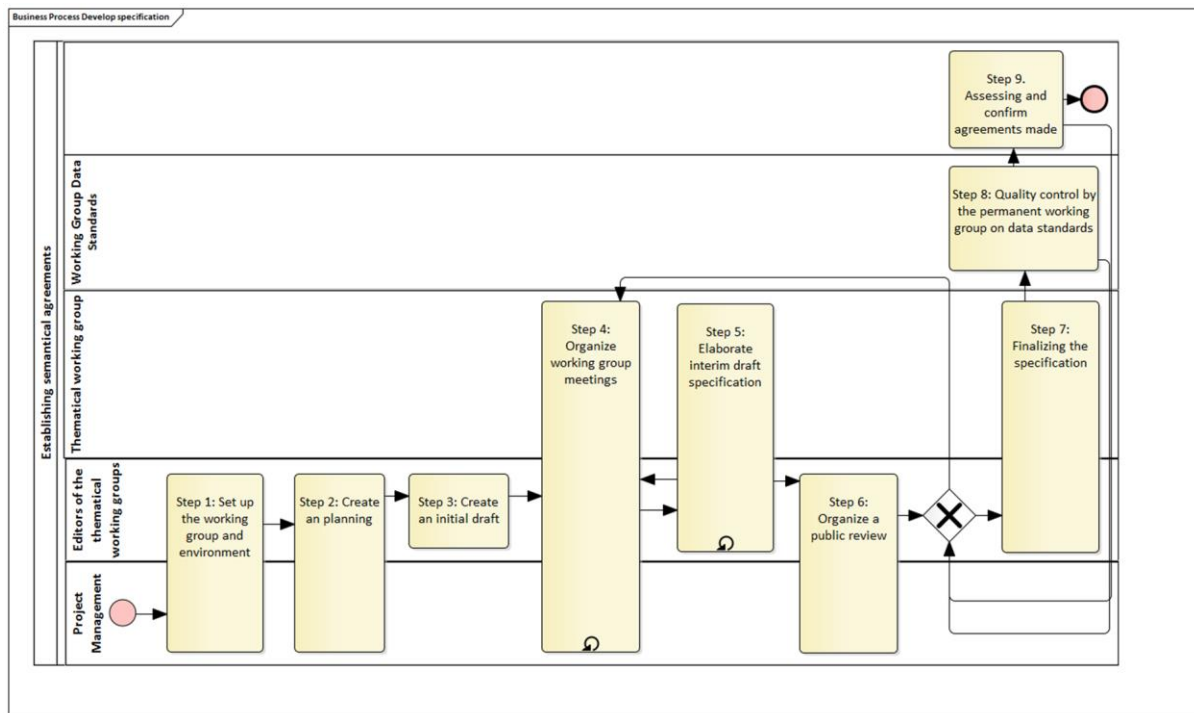


Figure 4: process for the development of an ontology

Step 1. 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 2. 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 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 3. 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 4. 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 5. Mid-term evaluation by the data standards working group

A stable interim draft specification is proposed to the data standards working group, together with an overview of the organized working group sessions and the parties involved. The data standards working group 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 data standards working group.

Step 6. 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 7. 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 8. Quality control by the permanent working group on data standards

The permanent working group on data standards 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 will be submitted to the steering committee for ratification, otherwise the thematic working group may be asked to go through (part of) the process again. The data standards working group uses the criteria for promotion to a recognized ontology for this quality control.

Step 9. Assessing and confirm agreements made

The final domain model, associated specification and documentation is formally submitted to the steering committee by the permanent working group on data standards, together with a report describing the process that has been completed. 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 steering body can ask the thematic working group to 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:

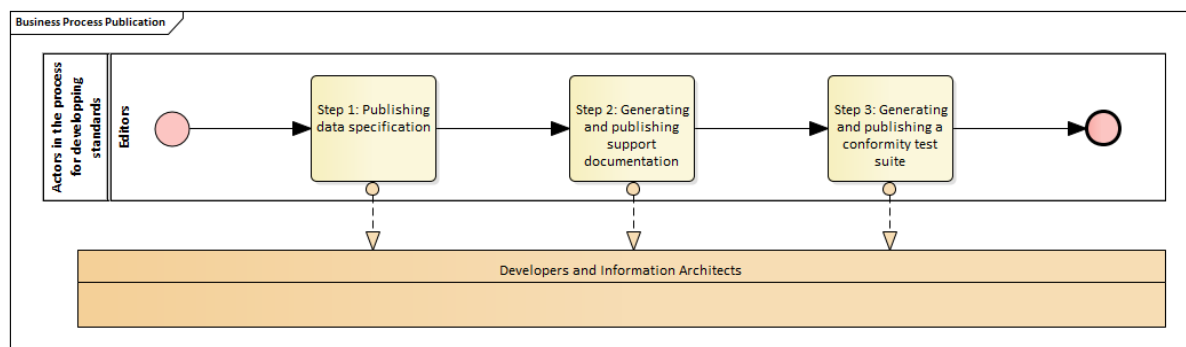


Figure 5: process for the publication of an ontology

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 on belgif.be.

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 payload¹⁷. Other examples are the "subject pages"¹⁸ that are made available as standard to support the URI.

Step 3. 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 SHACL¹⁹ validator for OSLO and the "INSPIRE Validator" of the European Commission²⁰.

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.

The change management process is aligned with the corresponding process²¹ 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

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/>

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

- 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 working group 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:

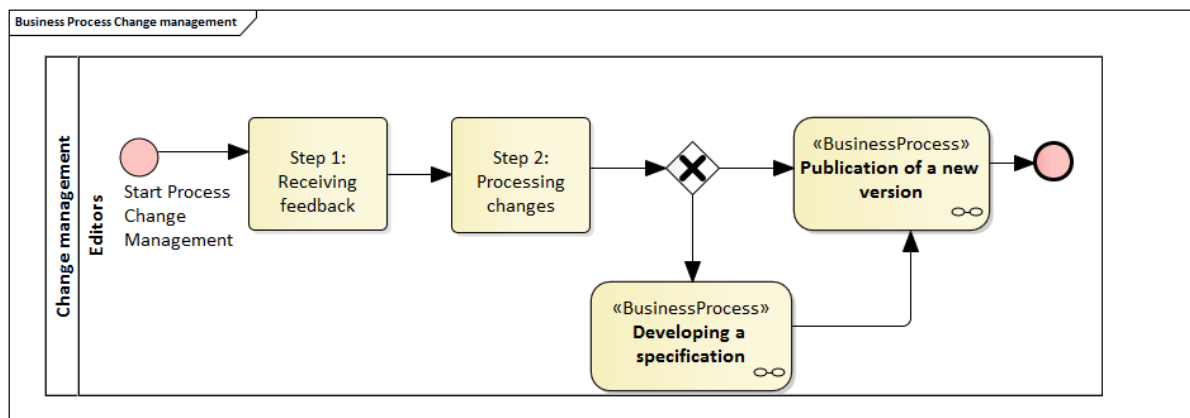


Figure 6: Process for change management

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:

- **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 3. 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.

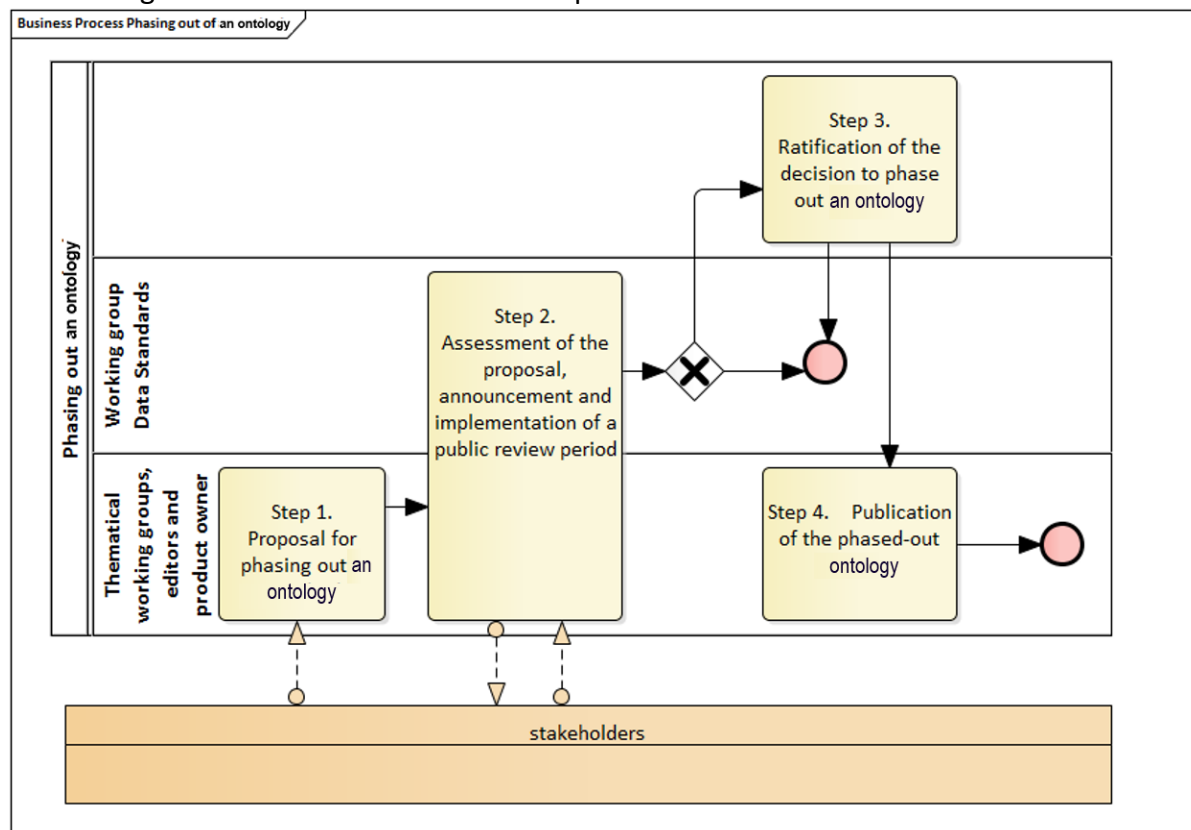


Figure 7: Process for phasing out an ontology

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 working group, 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 data standards working group 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 3. Ratification of the decision to phase out an ontology

If no valid objections were raised during the public review period, the endorsement group can confirm the decision to phase out the ontology.

Step 4. 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.

5 Process

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 process²². 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 (e.g. 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 (e.g. 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 agreements²³ and the W3C Process Document²⁴.

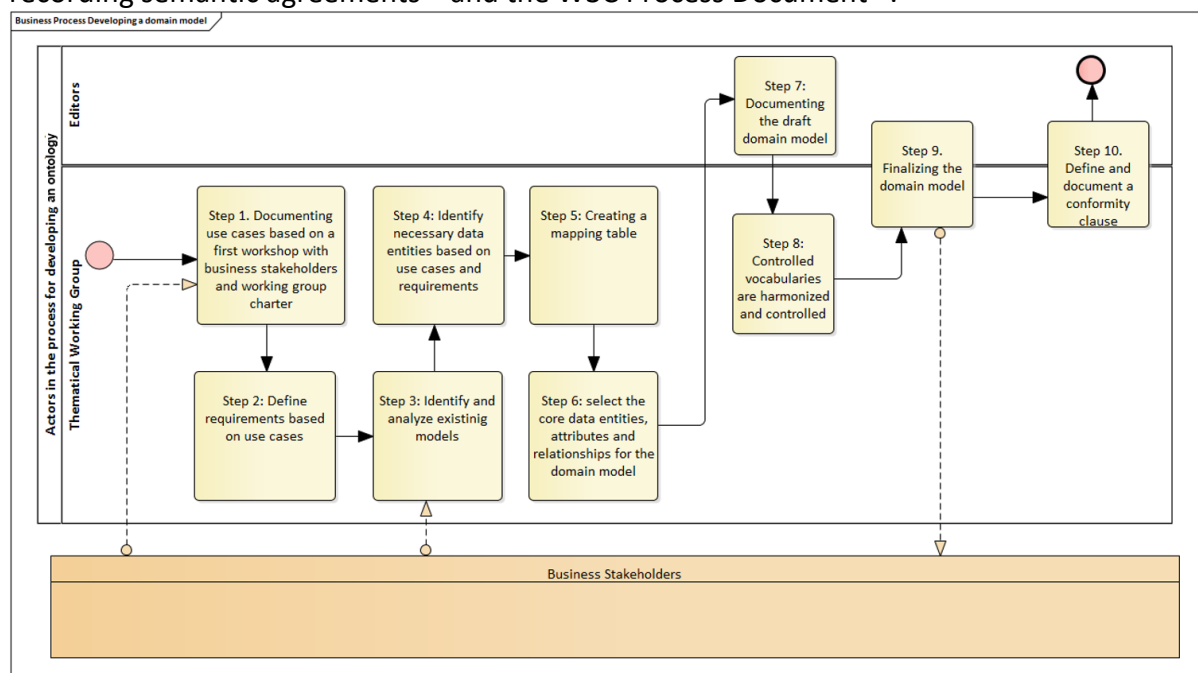


Figure 8: Developing a domain model

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 data model or the definitions and description of the data entities.

Step 2. Requirements are distilled from the use cases and competency questions 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.)

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 principles²⁵. 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/> after approval by the steering body.
- 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/>.

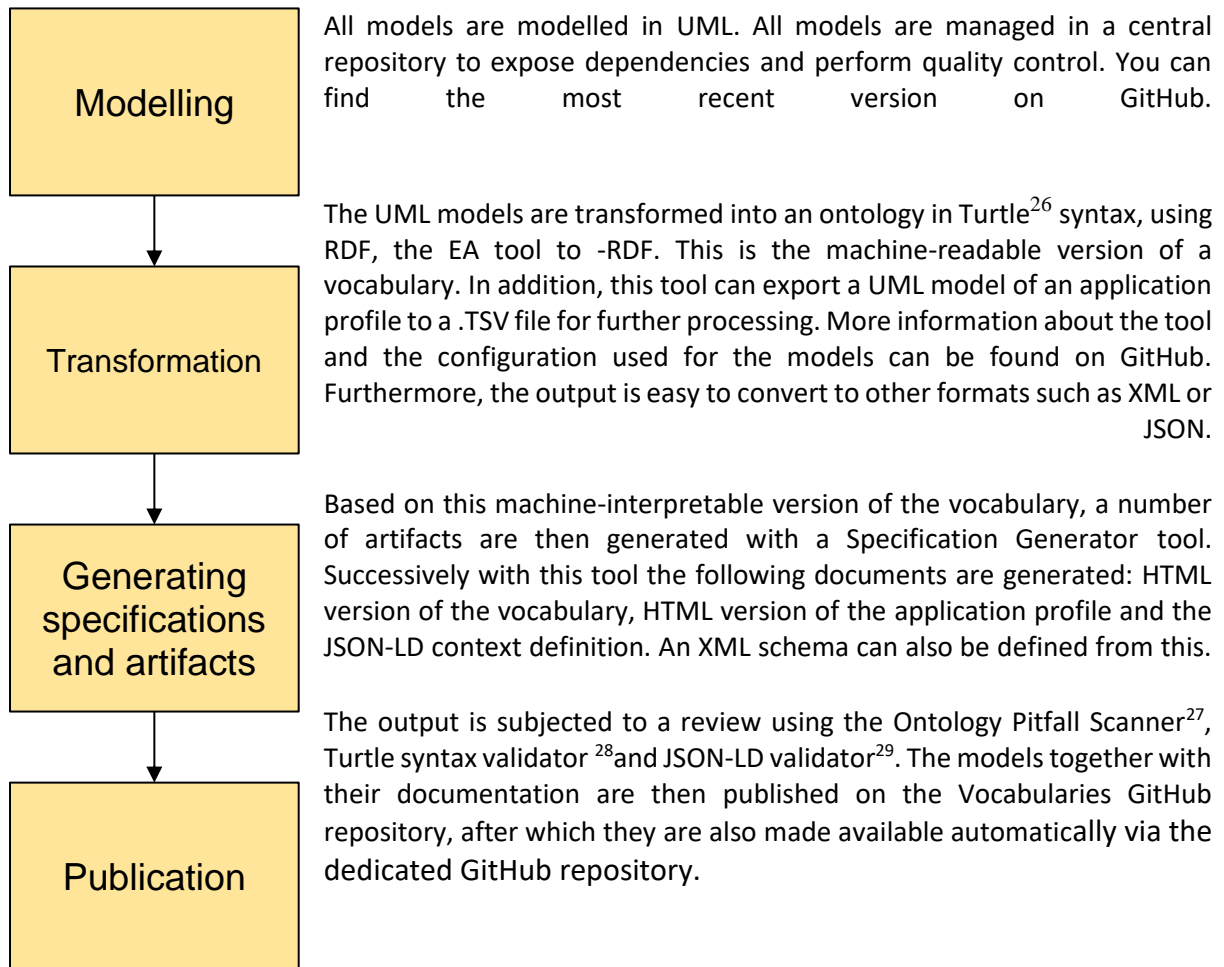
²⁵ <https://www.w3.org/TR/skos-primer/>

- 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. This method uses the Resource Description Frame (RDF) as the underlying data model, but can also be serialized to a traditional XML.



²⁶ <https://www.w3.org/TR/turtle/>

²⁷ <http://oops.linkeddata.es/response.jsp#>

²⁸ <http://ttl.summerofcode.be/>

²⁹ <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.

6 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 Track³⁰. 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 ³¹	Registration of an ontology	Setting up a Working Group Charter
In development	Draft document ³²	Development of a specification	Development of a domain model
In treatment	Candidate ontology ³³	Change Management	Generate data specification and documentation
In use	Recognized ontology (+ Errors) ³⁴		

³⁰ <https://www.w3.org/2017/Process-20170301/>

³¹ Analog to the W3C Working Group Charter

³² Analog to the W3C Working Draft

³³ Analog to the W3C Candidate Recommendation

³⁴ Analog to the W3C Recommendation

In revision	Draft document Candidate Revised Ontology ³⁵	Development of a specification	Management of issues and errors
Phased out	Phased-out ontology ³⁶	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 Working Group data standards (e.g. minimum two implementations or proof-of-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 labelled 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 working group data standards has approved the promotion to ontology.
- A place (e.g. 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.

³⁵ Analog to the W3C Revising a Recommendation

³⁶ Analog to the W3C Obsoleted or Rescinded Recommendation

7 Working group on data standards

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 working group is a permanent entity 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 is based on international standards, guarantees sufficient support from stakeholders and provides 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 will 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 data standards working group 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. The chairperson of the data standards working group coordinates the designs of the ontologies into one proposal to the endorsement group respectively.

Reporting

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

Assignment description of the data standards working group

The working group is responsible for the central coordination and follow-up of the work with regard to the standardization of information. The activities include the standardization of: meaning of the information, the syntax of the information, the technical standards for the exchange of the information and the metadata. The working group ensures that the ontologies are supported, mutually consistent and, where possible, in line with international standards/ontologies.

8 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 current focus lies on defining processes and guidelines to achieve organizational interoperability in ontologies. Throughout this process, various challenges have been encountered. To address and overcome them, the forthcoming deliverable, D2.2, aims to provide comprehensive answers and solutions.

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 fulfil 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.

<p>Scalability</p>	<p>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.</p>
<p>Publication of the ontology and documentation</p>	<p>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 repository for publication. Avoiding scattered GitHub 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. a dedicated page on the OSLO Standards Registry), stakeholders can locate and access the different standards and ontologies and their documentation more efficiently.</p>
<p>Maintenance of recognized ontologies</p>	<p>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.</p>