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ONTO-DESIDE

DELIVERABLE

D4.7: Open Circularity Platform - v.4

Deliverable number	D4.7
Deliverable name	Open circularity platform - v.4
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Lead partner	IMEC
Contributing partners	LIU, CIRC, FAS
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Project information

Project summary
Circular economy aims at reducing value loss and avoiding waste, by circulating materials or product parts before they become waste. Today, lack of support for sharing data in a secure, quality assured, and automated way is one of the main obstacles that industry actors point to when creating new circular value networks. Together with using different terminologies and not having explicit definitions of the concepts that appear in data, this makes it very difficult to create new ecosystems of actors in Europe today. This project will address the core challenges of making decentralized data and information understandable and usable for humans as well as machines. The project will leverage open standards for semantic data interoperability in establishing a shared vocabulary (ontology network) for data documentation, as well as a decentralized digital platform that enables collaboration in a secure and privacy-preserving manner.

The project addresses a number of open research problems, including the development of ontologies that need to model a wide range of different materials and products, not only providing vertical interoperability but also horizontal interoperability, for cross-industry value networks, as well as transdisciplinary research on methods to find, analyze and assess new circular value chain configurations opened up by considering resource, information, value and energy flows as an integral part of the same complex system. Three industry use cases, from radically different industry domains, act as drivers for the research and development activities, as well as test beds and demonstrators for the cross-industry applicability of the results. The developed solutions will allow for automation of planning, management, and execution of circular value networks, at a European scale, and beyond. The project thereby supports acceleration of the digital and green transitions, automating the discovery and formation of new collaborations in the circular economy.

Project start date and duration
1st of June 2022, 36 months

Project consortium

No	Partner	Abbreviation	Country
1	Linköping University	LiU	Sweden
2	Interuniversitair Micro-Electronica Centrum	IMEC	Belgium
3	Concular Ug Haftungsbeschrankt	CON	Germany
4	+Impakt Luxembourg Sarl	POS	Luxembourg
5	Circularise Bv	CIRC	The Netherlands
6	Universitaet Hamburg	UHAM	Germany
7	Circular.Fashion Ug (Haftungsbeschrankt)	FAS	Germany
8	Lindner Group Kg	LIN	Germany
9	Ragn-Sells Recycling Ab	RS	Sweden
10	Texon Italia Srl	TEXON	Italy
11	Rare Earths Industry Association	REIA	Belgium
12	Prague University of Economics and Business	VSE	Czech Republic

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2.0	26/2/2025	Second version	Els de Vleeschauwer, Gertjan De Mulder, Ben De Meester, Maria Alejandra Leon Aguirre, Teresa Oberhauser	Caroline Braus

Document approval

Version	Date	Name	Role in the project	Beneficiary
2.0	26/2/2025	Caroline Braus	Partner	Concular

Table of Content

1 Summary

In this deliverable, we describe the final releases of following components, as contributed within the Onto-DESIDE project:

i) the Open Circularity Platform (OCP)'s implementation and documentation, available at https://github.com/KNowledgeOnWebScale/open-circularity-platform (specifically, the v1.0.0 release at https://github.com/KNowledgeOnWebScale/open-circularity-platform/releases/tag/v1.0.0; and
ii) the generic data viewer, available at https://github.com/SolidLabResearch/generic-data-viewer-react-admin (specifically, v1.5.0 release at https://github.com/SolidLabResearch/generic-data-viewer-react-admin/releases/tag/v1.5.0); and
iii) extensions of RDF mapping language (RML) to support permissioned data sharing, available at https://w3id.org/imec/rml/specs/access/httprequest and https://w3id.org/imec/rml/specs/target/dynamictarget (specifically, the January 13 2025 releases at https://w3id.org/imec/rml/specs/access/httprequest/20250113/ and https://w3id.org/imec/rml/specs/target/dynamictarget/20250113/, respectively); implemented in RMLMapper, available at https://github.com/RMLio/rmlmapper-java (specifically, the v7.2.0 release at https://github.com/RMLio/rmlmapper-java/releases/tag/v7.2.0)
iv) human-readable text-based representation for the RML extensions, available at https://w3id.org/imec/rml/yarrrml/spec/access/httprequest and https://w3id.org/imec/rml/yarrrml/spec/target/dynamictarget (specifically, the February 26 2025 releases at https://w3id.org/imec/rml/yarrrml/spec/access/httprequest/20250226/ and https://w3id.org/imec/rml/yarrrml/spec/target/dynamictarget/20250226/, respectively), implemented in YARRRML-Parser, available at https://github.com/RMLio/yarrrml-parser/ (specifically the v1.9.0 release at https://github.com/RMLio/yarrrml-parser/releases/tag/v1.9.0; and
v) the OCP-helper, available at https://github.com/KNowledgeOnWebScale/solid-ocp-helper (specifically the v0.2.0 release at https://github.com/KNowledgeOnWebScale/solid-ocp-helper/releases/tag/v0.2.0)
vi) a docker integrating the OCP-helper, YARRRML-Parser and RMLMapper to one service, available at https://hub.docker.com/r/rmlio/solid-ocp-transformer (specifically the tag v0.2.0, i.e. rmlio/solid-ocp-transformer:v0.2.0); and
vii) LOAMA (acronym for Linked Open Access Management Application), available at https://github.com/SolidLabResearch/loama (specifically, v0.1.0 release at https://github.com/SolidLabResearch/loama/releases/tag/v0.1.0).

Additionally, this deliverable contains a description of the complementary public Digital Product Passport (DPP) platform, developed by Circularise, showcasing how a DPP can be deployed in industry. The release of the source code of the public DPP is not part of this deliverable.

2 Introduction

Semantic interoperability of data is one of the biggest barriers towards data sharing in the Circular Economy. Onto-DESIDE aims to provide the technical foundations for information flows that will transform European Industry towards a Circular Economy, by means of digitalisation and data sharing. The project leverages a decentralized digital platform that enables collaboration in a secure manner. This allows for automation of discovery, planning, management, and execution of cross-industry circular value networks, at a European scale and beyond. Combined with access control policies for data privacy and confidentiality, automation is enabled whilst protecting company-internal data, and allows data sharing to happen at the right level of granularity.

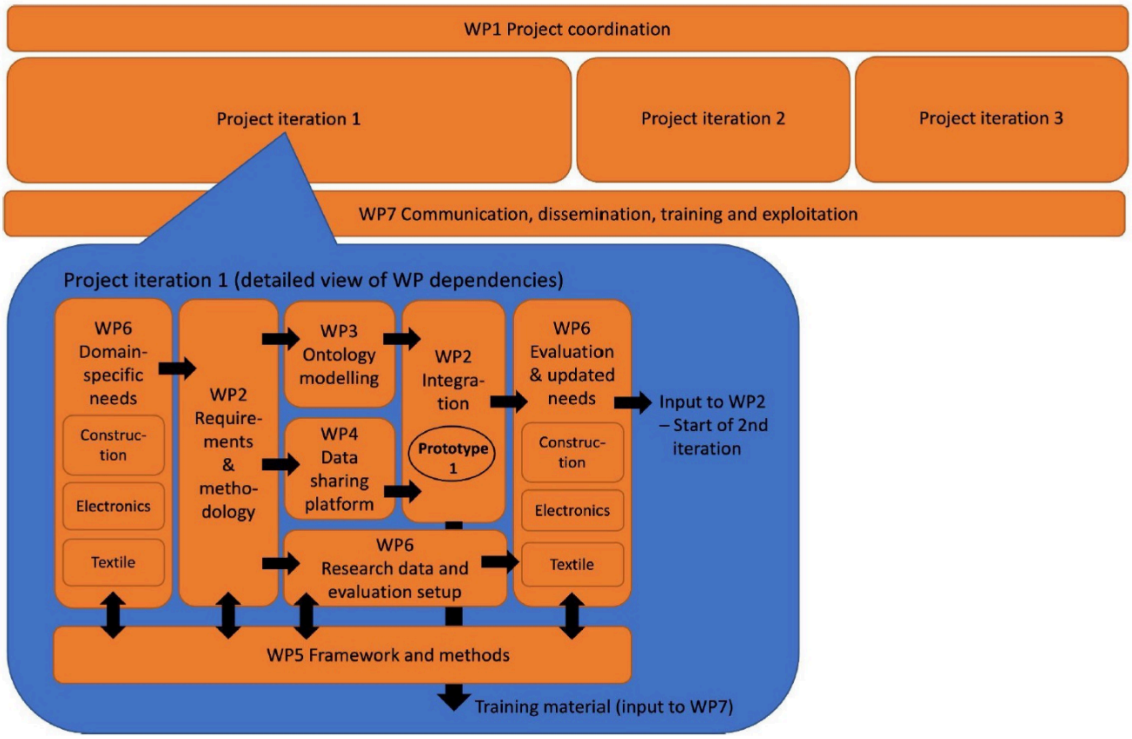
This project will develop at its basis a technology for allowing data sharing about materials and products at a global scale. Since access to verifiable information is central, the project will use well-established open standards for secure data and information sharing. As ownership and storage of data should remain with the actor that produces the data, a decentralized approach is necessary. Metadata and structures for transforming data into information (semantic descriptions and vocabularies) will be open, and comply with FAIR principles, to enable the highest possible degree of semantic interoperability and automation in data sharing. For sensitive data, methods allowing for proof of the existence of the data will be used, where these proofs can be shared while the actual data is kept private.

Further, this interdisciplinary project will also develop integrated tools and methods for further enhancing a Circular Economy. Although the importance of various ‘flows’ – resource flows (the various forms resources can take along their journey, e.g. material, component, product), information flows, energy flows, and value flows – has been widely acknowledged within the transformation to a Circular Economy, they have not been integrated or linked into a single framework or approach. Without such integration or linking it is not possible to make robust designs of circular value networks and to implement and operate value network coordination within industry.

The Onto-DESIDE project applies an iterative methodology, where research and innovation are driven by industry needs identified in a set of industry use cases, and solutions become more mature with each iteration. Three project use cases representing three distinct industry sectors – construction, electronics and appliances, and textile – will contribute to identify the needs and technical requirements of the Open Circularity Platform, but also act as test beds and evaluation scenarios for the novel solutions produced. This way, the project aims to show that the Open Circularity Platform is concrete enough to solve specific problems (i.e., the three specific use cases) but also has potential to be widely applied.

The project consists of three iterations, where each technical Work Package (WP) contributes to all the iterations. The WP dependencies are illustrated in Figure 1 where the details of the first project iteration are shown. The duration of the first project iteration is Month (M) 1-18, while the second and third iterations are shorter (M19-27 and M28-36 respectively). Each iteration ends with a collection of feedback from the industry use cases, analyzed and reported in a WP6 evaluation report.

FIGURE 1- PROJECT OUTLINE AND DETAILED DEPENDENCIES BETWEEN WORK PACKAGES EXEMPLIFIED BY THE FIRST ITERATION



2.1 Objectives and Research Methodology

2.1.1 Objectives

Today, lack of support for sharing data in a secure, quality-assured, and automated way is one of the main obstacles that industry actors point to when attempting to create new circular value chains.

Work package 4 (WP4) will contribute to an open decentralized digital platform that enables secure collaboration. This includes supporting the correct enforcement of access control policies, as well as using verifiable credentials to prove the existence of sensitive data instead of publishing or sharing this sensitive data. The outcome of the WP will be an Open Circularity Platform (OCP), i.e., an open framework for secure and privacy-preserving digital and automated data sharing, which enables verifiable, traceable, and decentralized sharing of data expressed and documented using the ontologies from WP3, within and across industry domains.

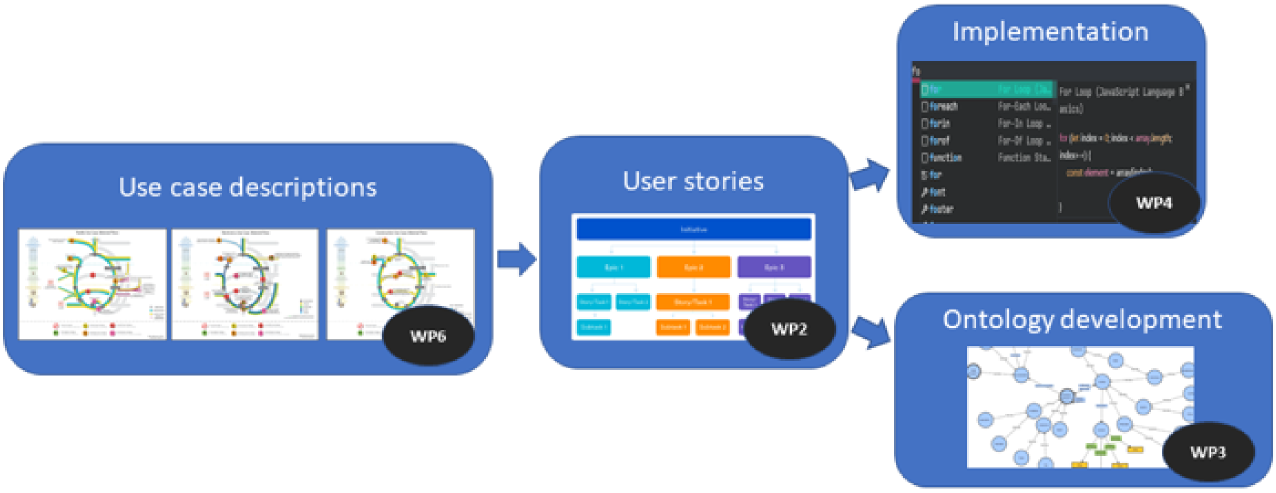
2.1.2 Research Methodology

The concrete research process of the Onto-DESIDE project has been divided into three iterations, each divided in 3 steps (cf. Figure 2):

- Step 1: analysis of needs and elicitation of requirements,
- Step 2: research and technical development, including solution integration into a coherent prototype, and
- Step 3: use case-based observation and evaluation, providing feedback as well as revised and extended needs and requirements to start off the next iteration.

Specifically, for WP4, the focus is the technical development of the Open Circularity Platform, adhering to the technical requirements as put forward in WP2. For this, a new method will be devised to set-up decentralized networks of data vaults and actors.

FIGURE 2 DIAGRAM VISUALISING THE WORKFLOW OF WP4 AND THE RELATED ARTEFACTS



2.2 Tasks and Deliverables

WP4 is led by IMEC and is divided into five tasks, each related to the objectives of the work package. These tasks are outlined below:

- T4.1 - Data transformation - lead: IMEC, participants: CIRC
- T4.2 - Retrieving public and private data - lead: IMEC, participants: LIU
- T4.3 - Verifiable statements and credentials - lead: IMEC, participants: LIU, CIRC
- T4.4 - Blockchain-based implementation - lead: CIRC, participants: IMEC
- T4.5 - Querying data - lead: IMEC, participants: LIU, FAS

Two deliverables are to be produced for WP4 during the project:

- D4.1, D4.2, D4.3 Digital twin concept design, including ontology-based data sharing platform architecture and methodology (v1 M9, v2 M24, v3 M33) - report
- D4.4, D4.5, D4.6, D4.7 Open circularity platform (v1 M10, v2 M22, v3 M31, v4 M33) - software

This document constitutes the report for deliverable D4.7 and aims to describe the Open Circularity Platform featuring the digital twin concept design, including ontology-based data sharing platform architecture and methodology as discussed in deliverable D4.3.

2.3 Introduction to deliverable

This deliverable reports on the associated code repositories, containing source code and instructions to set up and run the current version of the Open Circularity Platform and its demonstrator as part of the Onto-DESIDE Horizon Europe project.

3 Open Circularity Platform

The repositories at https://github.com/KNowledgeOnWebScale/open-circularity-platform and https://github.com/SolidLabResearch/generic-data-viewer-react-admin contain the implementation of an Open Circularity Platform and demonstration User Interface as part of the Onto-DESIDE Horizon Europe project. In this deliverable we demonstrate the Open Circularity Platform through a part of the electronics evaluation scenario, as described in D6.8, via the User Interface.

We set up a demonstrator network with:

- multiple data providers each publishing their data behind a secure access layer using Solid pods,
- a Web UI to execute and visualize queries on these Solid pods,
- a Web UI to manage the access to the resources on these Solid pods.

The online demonstrator is available at https://onto-deside.ilabt.imec.be/viewer/ and https://onto-deside.ilabt.imec.be/loama/.

During setup, an administrative user generates and loads all data structured using the Resource Description Framework (RDF) according to the Circular Economy Ontology Network (CEON)[1], into a Solid pod. For this purpose, he uses a YARRRML mapping, including RML extensions, that describes the end-to-end pipeline from heterogeneous data to CEON-annotated RFD data with access control on a Solid pod. This YARRRML mapping is converted to an RML mapping by the YARRRML-Parser. The RML mapping is executed by RMLMapper.

We directly configured how to organize the data in a Solid pod within the RML mapping rules. For this, we make use of RML's Logical Targets. In RML, Logical Targets[2] describe how RDF data – resulting from the execution of RML mapping rules – must be exported after generation. Such Logical Target includes a Target that describes how a target must be accessed when exporting the RDF data. To export the RDF data to a Solid Pod we have specified HTTP Request Targets[3]. Additionally we extended RML specifying Dynamic Logical Targets[4], enabling the creation of fine-grained resources needed for fine-grained access management. We implemented both RML extensions in RMLMapper, and included them in the RML mapping rules. As a result we can now configure the transformation of the company data and the storage of the resulting RDF data with WAC rules in one RML mapping document, executable with one command.

Next, a Verifiable Credential envelope is created over the CEON-annotated RFD data. This Verifiable Credential envelope allows verification using standard Verifiable Credential.

Finally, obsolete resources are removed from the Solid pod. Resources become obsolete when their source data is deleted between two mapping executions.

The addition of a Verifiable Credential envelope and the removal of obsolete resources is handled by the OCP-Helper, a dedicated JavaScript application.
The total setup process is triggered by a single Docker command including the location of the source data and the location the of the YARRRML mapping as input parameter, e.g.,

```
docker run --rm -v $(pwd)/data:/runtime/data \
rmlio/solid-ocp-transformer:v0.1.0 -m mapping.yml.
```

During usage, an end user browses to the user-friendly Web UI which provides access to the Solid-based decentralized data-sharing platform, i.e. the OCP-Viewer. The OCP-Viewer provides a set of predefined queries the user can execute over the Solid pods. The predefined queries can start from an index to transverse over an evolving set of query sources and can make use of variables to be filled in by the end user for more flexible querying. The OCP-Viewer also allows the end user to create, save and load custom queries.

It is possible to manage the access to the data resources on the Solid pods in a local file of any format (CSV, JSON, …). The mapping of this file can be included in the mapping rules. Alternatively, a Web UI, i.e., LOAMA, is available to manage the access to the data sources.

[1] CEON is developed in WP3 and described in detail in deliverable D3.3 and the upcoming deliverable D3.4.
[2] https://kg-construct.github.io/rml-io/spec/docs/#target-vocabulary
[3] https://w3id.org/imec/rml/specs/access/httprequest
[4] https://w3id.org/imec/rml/specs/target/dynamictarget

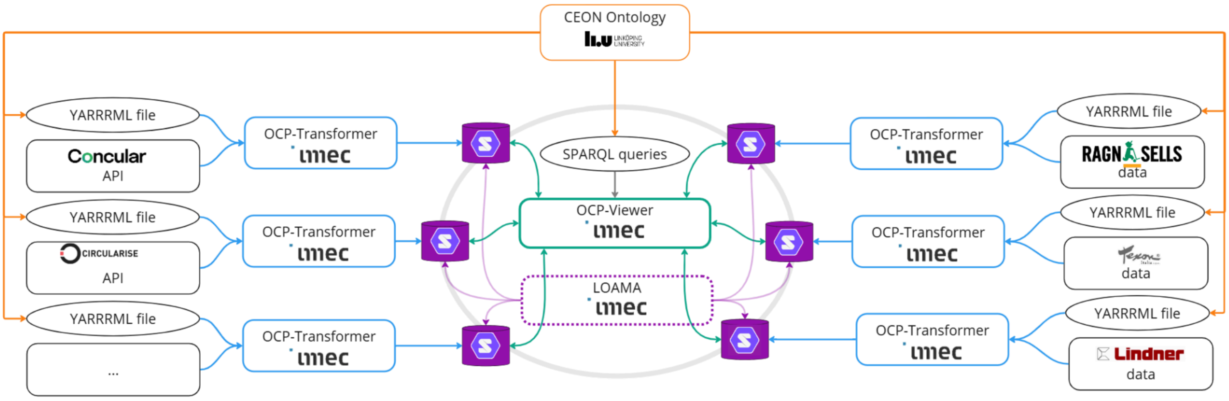
LOAMA also allows end users to initiate access requests to specific data resources, and to accept or decline those access requests.

We created one docker image[5] to complete all needed process steps:

- generate RDF data;
- split the RDF data into required subsets;
- add a Verifiable Credential (VC) to the RDF subsets;
- put the RDF subsets as resources on the Solid Pod;
- add access rules to resources on the Solid Pod; and
- delete any obsolete resources from previous process executions.

The setup of the Open Circularity Platform is made reproducible by relying on Docker containers[6] and Docker Compose[7]. All set-up instructions are available at https://github.com/KNowledgeOnWebScale/open-circularity-platform.

FIGURE 3 - THE SETUP AND USE OF THE OPEN CIRCULARIY PLATFORM.
THE OCP-TRANSFORMER TRANSFORMS HETEROGENEOUS SOURCE DATA TO CEON-ANNOTATED RDF RESOURCES ON A SOLID POD, INCLUDING ACCESS CONTROL.
END-USERS CAN VIEW THIS DATA USING THE OCP-VIEWER, INCLUDING SPARQL QUERIES USING THE CEON ONTOLOGY.
LOAMA ALLOWS FOR ACCESS MANAGEMENT THOUGH A WEB UI, AS AN ALTERNATIVE TO MANAGING ACCESS PERMISSIONS USING THE OCP-TRANSFORMER.



4 User stories

D6.8 describes the setup and results of one evaluation use case per domain (textile, construction and electronics). The user stories differ per domain, their setup and the supported features are identical. In D6.9 a cross-domain evaluation use case will be described, implemented and validated, following the same setup and supported features.

4.1 Setup

Each actor can share data while maintaining control over who can access their data. This data can be heterogeneous in format (CSV, JSON, XML, SQL …) and schema, mapped to RDF data and semantically annotated using the CEON ontology as Global Schema. Each actor stores their RDF data, split over different resources, in his Solid Pod, and adds a Verifiable Credential (VC) to each resource. The actor manages the access to these resources in a local file.

[5] https://docs.docker.com/get-started/docker-concepts/the-basics/what-is-an-image/
[6] https://www.docker.com/resources/what-container/
[7] https://docs.docker.com/compose/

Each actor has its own mapping file to describe which data is shared, how this data is translated to RDF, how the data is split over different resources and stored on the actor's Solid Pod, and how the access rules are translated to RDF and added to the actor's Solid Pod.

Each actor announces their resources to the administrator of the (sub)network. The administrator adds these resources to an index file (stored locally in any format). The administrator adds this index file as RDF data in a dedicated resource on his Solid pod. Every participant in the network gets read access to this index file. The administrator can use the same process as described above, with mapping file and docker image.

Each actor can log into the OCP-Viewer to retrieve data shared in the network. The data is retrieved by executing queries. The OCP-Viewer can store predefined queries and has an option to write additional custom queries. The index files of the administrator can be used as a source for the query. The list of consulted sources is displayed in the OCP-Viewer and includes a check on the VC. Per query a dropdown list with parameters can be predefined. The query results can be exported as a CSV file.

4.2 Features

4.2.1 Flexible support for heterogeneous systems

By using RML, we support heterogeneous data sources. We apply our proof-of-concept on top of tabular (CSV) data, however, we currently support:

- Local data sources:
    - Excel (.xlsx)
    - LibreOffice (.ods)
    - CSV files (including CSVW)
    - JSON files (JSONPath)
    - XML files (XPath)
- Remote data sources:
    - Relational databases (MySQL, PostgreSQL, Oracle, and SQLServer)
    - Web APIs with W3C Web of Things
    - SPARQL endpoints
    - Files resolved over HTTP (CSV files, JSON files (JSONPath), XML files (XPath))

Figure 4 shows an excerpt of a local data source, with data on products per room, that will be mapped to CEON-annotated RDF.

Figure 4 - Screenshot of the csv file containing data about products used in a building. The data is owned by the building owber and stored on his local infrastructure. Rmlmapper converts this data converted to CEON-annotated rdf data and adds it to the pod of the building owner.

	A	B	C	D	E	F	G	H
1	space_id	space_label	element_id	element_label	element_installation_date	element_area_M2	element_model	component_of
2	room_1	office room no. 325	building_1-storey_3-room_1-nortec	used Nortec	14/03/2005	9000	Nortec_1234	
3	room_1	office room no. 325	building_1-storey_3-room_1-nortec-tiles	used Nortec tiles	14/03/2005	9000	tile_1234	building_1-storey_3-room_1-nortec
4	room_1	office room no. 325	building_1-storey_3-room_1-nortec-pedestals	used Nortec pedestals	14/03/2005	9000	pedestal_1234	building_1-storey_3-room_1-nortec

Data from the Concular and Circularise platforms can be integrated as a remote data source, i.e. a Wep API.
By using RML, we can showcase that the Open Circularity Platform can cope with multiple existing systems.

4.2.2 Access Control

In Solid the access is managed on resource level.

We developed and specified RML extensions to enable the description of the end-to-end pipeline from heterogeneous data sources to RDF resources on a Solid pod (i.e., HTTP request target vocabulary, Figure 5) and to enable the creation of fine-grained resources needed for fine-grained access management (i.e., dynamic targets, Figure 6).

FIGURE 5 - HTTP REQUEST TARGET VOCABULARY ENABLES AN RML DESCRIPTION OF THE END-TO-END PIPELINE FROM HETEROGENEOUS DATA TO RESOURCES ON A SOLID POD. WHEN THE DATA OF ALL PRODUCTS IS SHARED AS ONE RESOURCE, ACCESS CAN BE GRANTED TO ALL PRODUCTS' DATA AT ONCE.

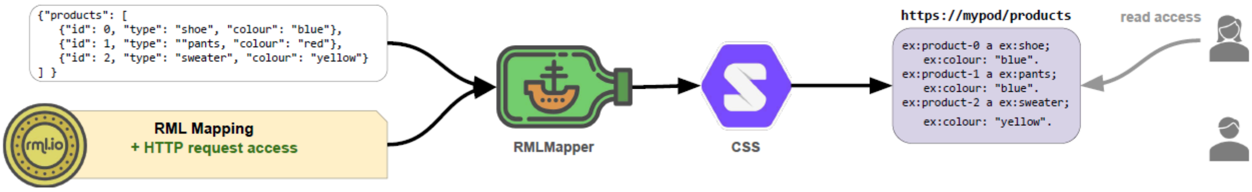
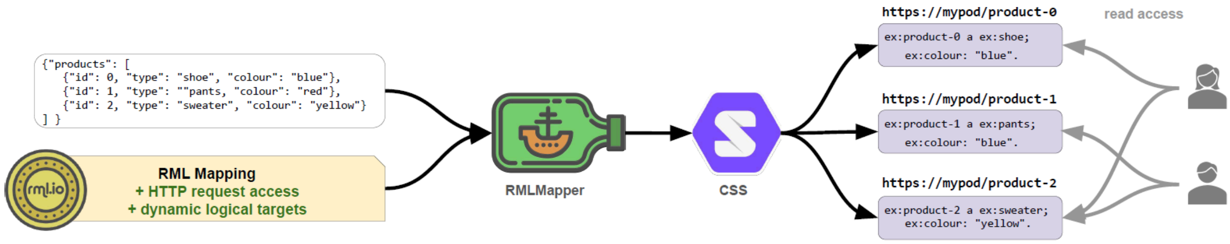


FIGURE 6 - DYNAMIC TARGETS ENABLE THE CREATION OF FINE-GRAINED RESOURCES NEEDED FOR FINE-GRAINED ACCESS CONTROL. THE DYNAMIC CREATION OF RESOURCES PER PRODUCT ALLOWS FOR ACCESS CONTROL ON PRODUCT LEVEL



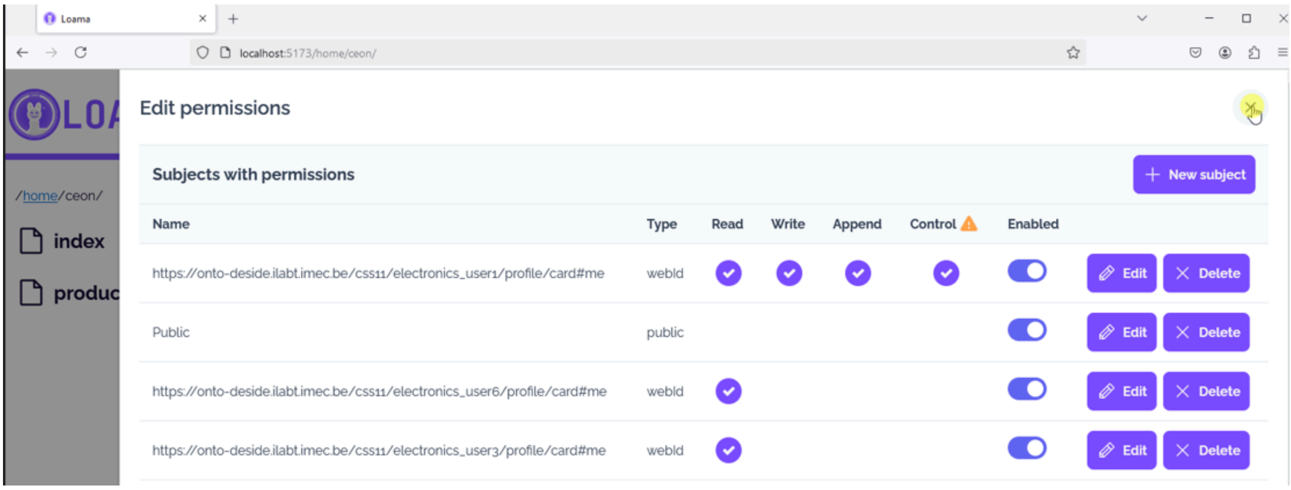
The extended RML cannot only describe the creation of RDF resources, but also the creation of auxiliary resources of the type Web Access Control, containing the access rules for the resource to which they are linked. This allows for access management via the infrastructure of the Actor. In Figure 7, you can find how access rules are described in a local csv file of an Actor.

FIGURE 7 - SCREENSHOT OF CSV FILE DESCRIBING THE ACCESS RULES TO 2 RESOURCES OF ONE ACTOR. THIS FILE IS MAPPED TO RDF DATA AND ADDED TO THE SOLID POD OF THE ACTOR AS AUXILIARY WEB ACCESS CONTROL RESOURCES.

	A	B	C	D	E
1	access_to	agent_webid	read_access	write_access	control_access
2	product-JUY9242	https://onto-deside.ilabt.imec.be/css11/electronics_user1/profile/card#me	Yes	Yes	Yes
3	product-JUY9242	https://onto-deside.ilabt.imec.be/css11/electronics_user6/profile/card#me	Yes	No	No
4	index	https://onto-deside.ilabt.imec.be/css11/electronics_user1/profile/card#me	Yes	Yes	Yes
5	index	https://onto-deside.ilabt.imec.be/css11/electronics_user6/profile/card#me	Yes	No	No

Alternatively, a Web UI (LOAMA) was developed to manage access directly on the Solid pod. Figure 8 shows a screenshot of the LOAMA window for editing access permissions of a single resource on a Solid pod.

FIGURE 8 - SCREENSHOT OF THE LOAMA WINDOW FOR EDITING ACCESS PERMISSIONS OF A SINGLE RESOURCE ON A SOLID POD.



The Web UI showcases an alternative, user-friendly approach to access management[8], integrating a process for access requests, where the access management via the infrastructure of the Actor scales better.

By using Solid and extended RML we can showcase that the Open Circularity Platform allows for fine-grained access management.

4.2.3 Verifiability

We created Verifiable Credentials for each published data set so that the user of the data can verify that the data is genuine and unaltered. This results in a Verifiable Credential envelope over the existing CEON-annotated data, automatically verifiably.

Attestation in the form of cryptographically verifiable claims allows data consumers to verify the integrity of the data (i.e., ensuring that the data has not been tampered with) as well as the authenticity of the data publisher.
Practically, this was implemented using Verifiable Credentials specification: a standardized data model that allows for describing the semantics of the claims and the cryptographic suites used to create and process the cryptographic material of a VC.

The OCP provides such verifiability through cryptographically verifiable claims (Figure 9): users can verify that the data (i.e., claims) shown on the platform are exactly the same as published by the data publisher. These verifiable claims are bound to the identity of the actor that published them, allowing users to verify the authenticity of the claims.

FIGURE 9 - SCREENSHOT OF THE VERIFICATION OF DATA SOURCES IN THE OCP.

[8] Currently, there is no reverse synchronisation from the data on the Solid pod to the source data used to generate this data. Editing access permission with LOAMA will not result in changes in local source files. Therefore, the proposed methods to manage access permissions should not be used simultaneously.

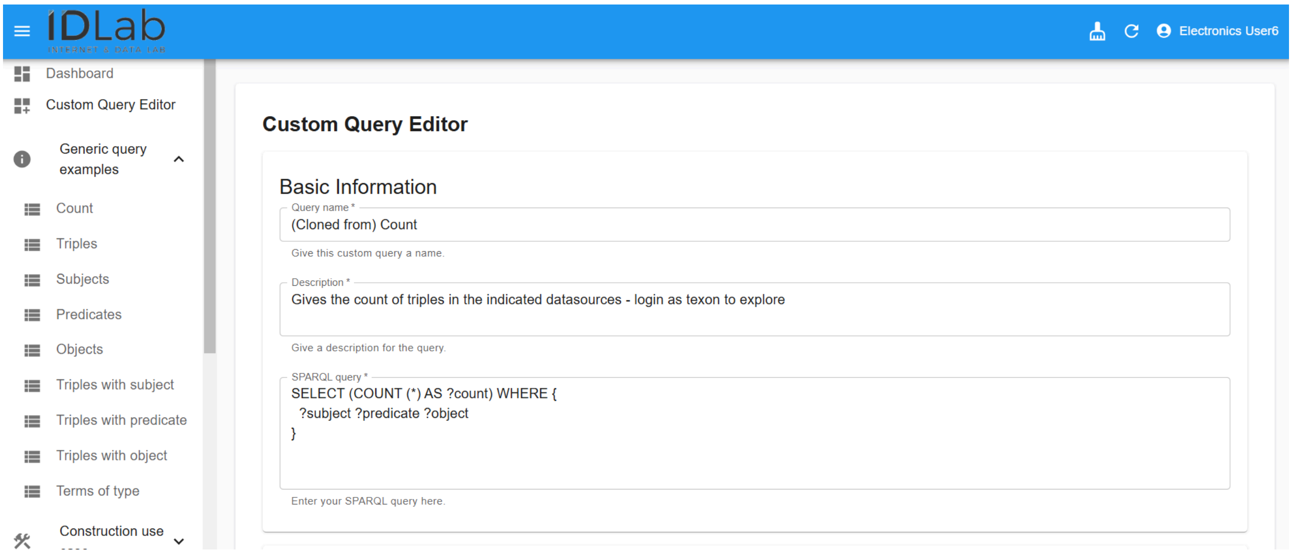
The first tree sources have already been verified.
To verify the last source the user needs to click on the question mark.

4.2.4 Scalable queries

Custom queries

It is possible to predefine SPARQL queries for the OCP, or to create custom queries in the Custom Query Editor (Figure 10) of the OCP. The custom queries can be optionally cloned from a predefined query, and the end user can save his custom queries to his Solid pod, and reload them to the OCP.

Figure 10 - Screenshot of the custom query editor.
This custom query is cloned from the predefined query with name 'count'.



Templated queries

As required by the use case partners, the queries can be templated: they can include variables, whose values are selected by the end user from lists of parameters. Such a list of parameters can be a hardcoded list or the result of another predefined query. Figure 11 shows a parameter list of a templated query: the predefined variables query first fetches all relevant products in a certain use case, and after selecting a specific product, the query template is filled in to query all properties of a specific product.

Figure 11 - Screenshot of the parameter list of a templated query.

Source index

The queries can be executed over a hardcoded list of sources or over indirect sources. In the latter case, the query sources are derived at execution time by a configurable link traversal query, starting from source, i.e. an index. Figure 12 shows the configuration of indirect query sources in the custom query editor.

FIGURE 12 - THE END USER CAN CONFIGURE A QUERY WITH INDIRECT QUERY SOURCES IN THE CUSTOM QUERY EDITOR

For the evaluation use cases, one index per domain was exposed by the Solid pod of the domain's administrative user, listing the indexes of actors participating in the Circular Value Network. These indexes of the participating actors contain a list of their data resources. This index mechanism secures a scalable configuration of queries over an evolving list of sources.

4.2.5 User-friendly view interface

End users can view the data in the OCP via a user-friendly interface, available at https://onto-deside.ilabt.imec.be/viewer, by selecting a predefined query or creating a custom query. The results are displayed in a tabular format, and can be exported to CSV. The user can also inspect and verify the query sources. The user will see the publicly available data and, after logging in, also the data to which he has been granted access.

4.3 Web UI for Access Management

The setup of the Open Circularity Platform allows for access management via the infrastructure of the Actor, mapping source data to Web Access Control resources on the Solid pod.

5 Demonstration

5.1 Open Circularity Platform

We demonstrate how this Open Circularity Platform copes with multiple existing data sources, mapped to the CEON ontology, using a user-friendly User Interface, with different actors that have different authorization levels, and being able to verify that data is genuine and unaltered, to export query results, and to create, save and load custom queries.

📽️ [OCP Demo]

The demo scenario is as follows:

- Browse to the preconfigured data viewer: https://onto-deside.ilabt.imec.be/viewer/
- Login as a speaker manufacturer:
    - Select identity provider (https://onto-deside.ilabt.imec.be/css11/)
    - Enter email (electronics_user6@example.com)
    - Enter password (electronics_user6)
    - Read CSS dialogue and Authorize
- Select a query group (“Evaluation June 2024 - Electronics”)
    - Select a query ("Overview")
- View results
    - Focus on the number of results in the list and the number of sources
- Click the “i” next to “Sources”
    - Have a look at the list of the sources: a combination of index files and sources per product
    - Highlight that the results come from a combination of sources, with different levels of authorization
    - Click the “?” in the column “Verified” to verify the data in your own browser
- Click on "EXPORT"
    - Save the query results as a CSV file
- Select another query ("Resilience of the supply chain of a product")
    - Highlight that this is a query template that the end-user can fill in
    - Select product label "Speaker"
    - Highlight that information is missing
- Navigate to local system, representing the infrastructure of the supplier of the electrical structure
    - Add the missing data to the file electronics_user1_data.csv
    - Highlight the file electronics_user1_acl.csv for managing access to Solid resources
    - Highlight the file electronics_user1_mapping.csv for the configuration of the publication pipeline
    - Execute the mapping pipeline
    - Return to the data viewer
- Select another query ("Resilience of the supply chain of a product")
    - Highlight that this is a query template that the end-user can fill in
    - Select product label "Speaker"
    - Highlight that all needed information is now available
- Click on "CLONE AS CUSTOM QUERY"
    - Adapt the query name, description and SPARQL query
    - Click on "CREATE QUERY"
- Select a query group (“Custom queries”)
    - Select a query (("Resilience and rare earth content of the supply chain a product")

- Select product label "Speaker"
  - Highlight the details added to the view due to the adapted SPARQL query
- Select "Dashboard"
  - Click on "SAVE ALL"
  - HIghlight that saved custom queries can be reloaded at later use of the data viewer
- Logout
- Login as the supplier of the electrical structure
  - Select identity provider (https://onto-deside.ilabt.imec.be/css11/)
  - Enter email (electronics_user1@example.com)
  - Enter password (electronics_user1)
  - Read CSS dialogue and Authorize
- Select a query group (“Evaluation June 2024 - Electronics”)
  - Select a query ("Overview")
- View results
  - Notice that you see a different set of results

5.2 LOAMA

We demonstrate how access to resources on a Solid pod can be managed using a user-friendly User Interface, allowing end users to edit access rights to resources on their own pod, to request access to resources on a pod of another user and to handle access requests from other users to resources on their own pod. It is demonstrated in the video

📽️ LOAMA Demo.

The demo scenario is as follows:

- Browse to the preconfigured LOAMA application: https://onto-deside.ilabt.imec.be/loama/
- Log in as electronics_user1, a supplier of a component of a speaker:
  - Select identity provider (https://onto-deside.ilabt.imec.be/css11/)
  - Enter email (electronics_user1@example.com)
  - Enter password (electronics_user1)
  - Read CSS dialogue and Authorize
- Select a folder on the pod (“CEON”)
  - Select a resource ("product-JUY9242")
- Edit the access right of the selected resource
  - Inspect who has the access rights for this resource
  - Click on "Edit”
  - Inspect the type of access per subject
  - Click on "New subject"
  - Select a subject type ("webid")
  - Type the Web ID
  - Click on "Create": the added subject has now read access.
  - Optionally, it is possible to modify the access rights per subject by clicking on "Edit" next to the subject, or to delete all access rights of a subject.
  - Click on "x" to return to the overview
- Make the resource available for access requests by switching the toggle on
- Log out
- Log in as electronics_user4, another supplier of a component of a speaker:
  - Select identity provider (https://onto-deside.ilabt.imec.be/css11/)
  - Enter email (electronics_user4@example.com)

- Enter password (electronics_user4)
- Read CSS dialogue and Authorize

- Select the tab 'Request access'
  - Type the Web ID of the owner of the desired resource (electronics_user1)
  - Select the desired pod of this owner
  - Navigated through the structure of resources available for access requests
  - Select the desired resource
  - Select the desired access right(s)
  - Click on "Request Access"
- Log out
- Log in as electronics_user1, the owner of the resource to which access was request
  - Select identity provider (https://onto-deside.ilabt.imec.be/css11/)
  - Enter email (electronics_user1@example.com)
  - Enter password (electronics_user1)
  - Read CSS dialogue and Authorize
- Select the tab 'Access Requests'
  - Inspect all incoming access requests
  - Accept the request (or decline)
- Log out
- Log in as electronics_user4, another supplier of a component of a speaker:
  - Select identity provider (https://onto-deside.ilabt.imec.be/css11/)
  - Enter email (electronics_user4@example.com)
  - Enter password (electronics_user4)
  - Read CSS dialogue and Authorize
- Select the tab 'Access Requests'
  - Inspect all incoming request responses
  - Mark the request response as read
- Log out
- Log in as electronics_user1, the owner of the resource to which access was request
  - Select identity provider (https://onto-deside.ilabt.imec.be/css11/)
  - Enter email (electronics_user1@example.com)
  - Enter password (electronics_user1)
  - Read CSS dialogue and Authorize
- Select a folder on the pod (“CEON”)
  - Select a resource ("product-JUY9242")
- Restore the initial access permissions to the selected resource
  - Click on "Edit”
  - Delete the access permission of electronics_user3 and electronics_user4
  - Click on "x" to return to the overview
- Make the resource unavailable for access requests by switching the toggle off
- Log out

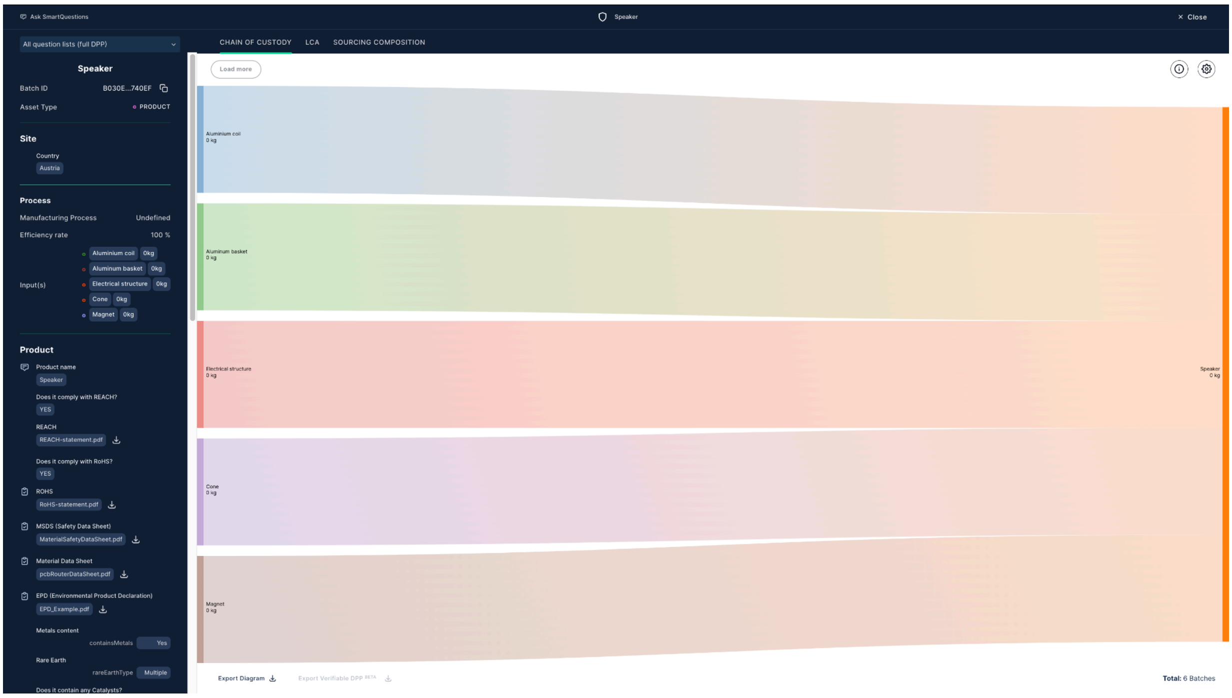
6 Blockchain-based data communication system

6.1 Blockchain-based system characteristics

In the Onto-Deside project, Circularise has worked on the development of a tool for data traceability for the electronics sector. This tool enables secure data sharing among stakeholders in the value chain, who communicate component information through the system. Having such a platform is of vital importance, given the high confidentiality and sensitivity of data within this industry.

Companies need to share data to comply with regulations, however, not all data is required and the granularity up to which this data needs to be shared varies. The Circularise system provides a solution to this by securing data sharing, as well as enabling access control to each data point. Now actors can determine what is shared, up to what level, and with whom, at all times. This is done through a Digital Product Passport (DPP), created for each component, with the relevant data for the different actors, which are then shared throughout the network.

Figure 13 - Screenshot of the Circularise platform, supporting the traceability of a speaker.



6.2 Required criteria of software for the Onto-DESIDE project.

The supply chain traceability system underlying Circularise's activities in the Onto-DESIDE project is a B2B platform focused on the communication between stakeholders along a specific supply chain. The data is specific to the data needs of Original Equipment Manufacturers (OEM) and consists of highly sensitive data types due to their key role in companies' IP and competitive advantage, e.g., material recipes and supplier selection. This has the advantage that the platform is fully focused on usability, e.g., the possibility to analyse different supply chain steps and allows concrete fine-tuning of access rights to different types of supply chain partners. Analytics tools and very extensive DPPs entail additional optional chapters facilitating the production and analysis of materials, e.g., technical data sheets on mechanic properties, Life Cycle Assessments (LCA), material composition, etc. With this expanded DPP that goes beyond the requirements stated in the Ecodesign for Sustainable Products Regulation (ESPR) legislation[9], the Software as a Service system caters to companies' needs and wants. With this focus, within Onto-DESIDE we are able to test this new software on the newest legislative developments on the European level.

The Circular Economy Action Plan[10] – and its detailed successor, the ESPR legislation – specify the requirement for material and product information to be partially publicly available to strengthen consumer rights and support increased sustainability and accountability of producers. Access to

9 https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/ecodesign-sustainable-products-regulation_en

10 https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en

data is only possible after several verification steps, e.g., after the creation of a user account and after the supply chain stakeholder specifically unlocks access to the supply chain data. This access is granted by every data-communicating partner based on identifying individual actors they trust, with the future possible expansion to unlock identified providers of a category of value chain partners, e.g., anyone who can officially identify as a recycler or refurbisher.

The Onto-DESIDE project, by contrast, focuses on

a) making data and systems interoperable;
b) incorporated the data needs of not just companies but any humans, including consumers, public institutions, academia, and smaller circular economy providers enabling to close the loop (e.g. repair cafes, refurbishers); and
c) an encouraging mechanism for companies to share their sustainability efforts (with the hope to counterbalance recent downsizing of sustainability efforts of companies).

6.3 The software developed

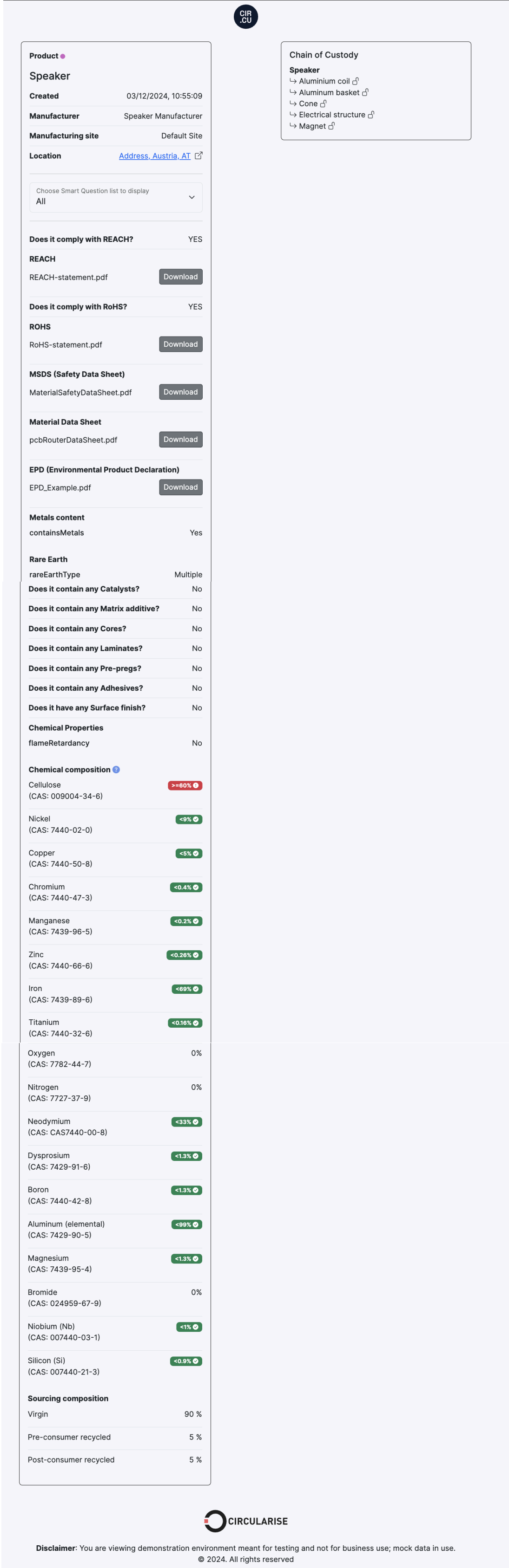
Based on the abovementioned requirements, Circularise has developed a public DPP platform. It can be accessed here: https://demo.cir.cu/fb4c1ed5b4f57f5aa61c6ea61802b3729fa34f049960d2e3b6e26c83941e5b5a
PW: OntoDESIDESpeaker
The public DPP is a separate new software platform that combines the need for detailed data communication between supply chain stakeholders to provide a full picture while also focusing on a maximum level of data accessibility. This combination of maximum accountability and maximum data availability is reflected by the software architecture, which builds on the blockchain-based system for reliable data with a user-friendly open overview of end user-targeted data points.

Onto-DESIDE is thus providing a publicly available version of the blockchain-verified DPPs, so that stakeholders who are not on the supply chain internal system can be provided with data. Just as before, actors responsible for the data can assess what will be shared in these public versions, to avoid confidential data being released. The datasheets provided are called public DPPs and are easily accessible via this website or linked via QR Code, protected by a basic password set by the OEM of the product at display.

To help value chain actors satisfy compliance requirements and facilitate communication with their customers, Circularise developed this platform that can translate DPPs into a visually appealing mobile-first webpage. This platform is able to display any published DPP via browser and also provides multiple additional features, such as Google Analytics integration and an API.

On this website, Circularise's users can determine what data to share publicly. For example, share the sustainability metrics, dimensions, instruction guidelines, compliance with regulations, and other relevant details. This public version is not only for individuals, but also for, for example, recyclers and other End-of-Life (EoL) stakeholders, who are not necessarily in contact with OEMs, and thus are not part of their DPP network. Through this digital information, EoL operators can better dismantle products, recover resources and manage them for further uses (improve their decision-making on the best alternative for a second life, repair, refurbishment, or others). Additionally, recyclers can also determine the best recycling route based on the chemical composition, status and market demand shared via the page

FIGURE 14 -SCREENSHOT OF THE PUBLIC DPP OF A SPEAKER WITH THE DETAILS TRACED IN THE CIRCULARISE'S SYSTEM.



The system does not only provide a public DPP of the full product, but also smaller public DPPs for the different components and subcomponents linked to the overall public DPP of the product. In a cascading overview, users can click on specific components, subcomponents, and materials to see their specific public DPP. The separate components and subcomponents unfold when clicking on the specific section on the data tree. This nested data model enables stakeholders to not only use a joint public DPP with data of all supply chain stages and components in a mixed version but also a stakeholder and component-specific view that differentiates not only between components but also between different tiers of the supply chain, enabling a clear overview in which subcomponent materials listed in the composition table are allocated. The public DPP entails the data from the Circularise platform that has been categorized as public, but it also enables stakeholders to add further supporting documents, e.g., a sustainability report or other marketing material, as well as data for end users and smaller circularity providers e.g. information on a possible takeback process of the product or repair manuals.

Additionally, Circularise provides QR codes that encode direct links for every such passport. To support compliance with regulations, there is a need to include data carriers on the product, so any stakeholder receiving the product can use such data carriers to get all the details disclosed by the manufacturer. For example, electronics components themselves will have a QR code on their surface (or on their package), which when scanned, will take the user directly to the website with all the details. This will facilitate the automation of processes and handling and classification of components and products during manufacturing or at the EoL.

Figure 15 -Screenshot of the QR codes generated to access the speaker data. These lead to the (password-protected) DPP. In case of any issues with the access, please contact maria@circularise.com or teresa@circularise.com.

In the case of the Onto-DESIDE project, through these public DPPs stakeholders from the electronics sector who use Circularise's system to provide component information, do not need to worry about their data only being accessible by Circularise's users. The details can reach any actor who has the link to the website, or who can scan the QR code in the component or product. This will ensure compliance with the regulatory requirements of DPPs and overall value chain traceability. Additionally, it will support circularity practices, as EoL actors can access data on the composition, and the status of the component, and make more informed decisions.

By default, the passports are available to anyone without any access control. However, to cater to the different stakeholders' needs, a passphrase can be added on a per-DPP level to provide a basic authentication layer. This is to enable companies to easily share DPPs with certain actors, without the need to publish them for anyone to get free access.

For the Onto-DESIDE project, the public DPP platform has been connected via API with the Open Circularity Platform. The API enables the use of data on the Circularise public DPP in the OCP. This has been facilitated by building technology on the side of the OCP that allows for calls to the Circularise API and a joint data mapping exercise that ensures the ontology of both data sets is harmonized. After said harmonization, the data can now also be successfully displayed on the OCP. The availability of data from the Circularise public DPP system on the OCP enables cross-sectoral collaboration and the use of data in harmonization with data from other data sources. WP6 piloted a small example of an integrated use case where the construction, textile, and electronics sectors collaborate in a possible scenario of dismantling a building and using all three product passports in conjunction via the OCP. The electronics sector is enabled by Circularise.

6.4 Public Blockchain Verifiability

Onto-DESIDE further improved traceability solutions concerning the public verifiability of data transactions. Supply chain stakeholders are dependent on receiving reliable data via the traceability platform. Business decisions are made trusting the integrity of the data and underlying audits and compliance are being assessed. To ensure the immutability of data claims (in the scope of Onto-DESIDE and beyond), Circularise developed software to improve the verifiability of data claims with the help of a public blockchain. This software enables users to verify that a data claim has been made by a specific person on a specific date with a specified content. The public verifiability technology enables transparency on the integrity of such data claims and proof that data claims have not been altered since their initial creation.

7 Changes with respect to D4.6

Since the last deliverable, we updated the software in the following ways:

- We released specifications for YARRRML extensions supporting these RML extensions.
- We introduced an OCP-Helper handling the addition of Verifiable Credential envelopes to the RDF data on the Solid pods and the deletion of obsolete resources after source data updates.
- We updated the docker image to execute the mapping pipeline from heterogeneous to CEON-annotated RDF data with access control and verifiable credential on a Solid pod, including the versions of YARRRML-Parser and RMLMapper implementing the developed extensions, and the OCP-Helper.
- We released LOAMA, a Web UI supporting access management on Solid pods.

8 Conclusion

The components presented in this deliverable, enable the deployment of the Open Circularity platform, presented in deliverable 4.3.

The components, developed for the Open Circularity Platform, are reusable outside the context of the Onto-DESIDE project. The developed RML extensions increase the expressiveness of RML: HTTP Request Access allows for the publication from and to any web target (not only to Solid pods), and Dynamic Logical Targets for the specification of any fine-grained publication strategy, independent of the access control requirement. The Web-based dashboard application can be configured to showcase federated querying and data verification over any network of Solid pods, also outside the context of Circular Economy. The visual access editor demonstrates access management to any Solid pod.

Additionally, public DPPs enable actors who are not part of traceability systems to access data about components, without compromising sensitive data. This is possible through the customised access given by stakeholders who are responsible for the components's information, as they can fine-tune what can be seen by whom. Moreover, by having such information also available in the OCP, it is now possible to have cross-sectoral collaboration, as the OCP includes data from multiple industries, stakeholders and data providers, keeping everything in one place and under harmonised and standardised templates.

Future work, beyond the Onto-DESIDE project, can include the improvement of the data updating process (e.g. with integration of incRML[11]), the exploration of on-the-fly generation of the RDF data sources and synchronization of write operations in the Solid pods with the source data.

[11] Van Assche, D., Andres Rojas Melendez, J., De Meester, B., & Colpaert, P. (2024). Resources of IncRML: Incremental Knowledge Graph Construction from Heterogeneous Data Sources [Data set]. In Semantic Web Journal (1.1.0, Number Special Issue on Knowledge Graph Construction). Zenodo. https://doi.org/10.5281/zenodo.14038823