EOSC Architecture and Interoperability

Technical and Semantic Interoperability Task Force

EOSC Beyond and EOSC United

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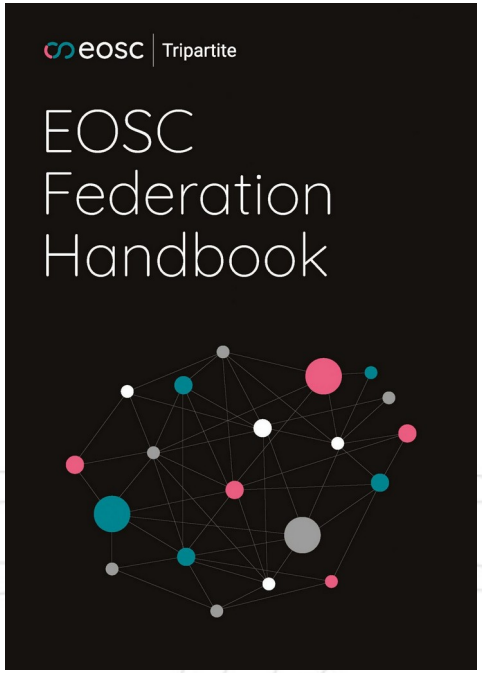
Jiri Marek (Masaryk University)

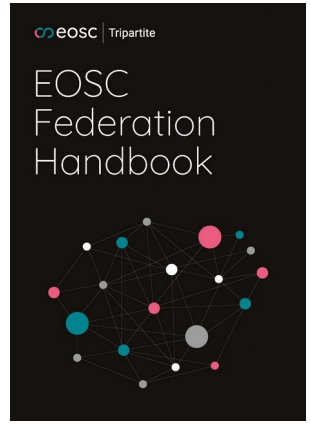
28 January 2026

Agenda

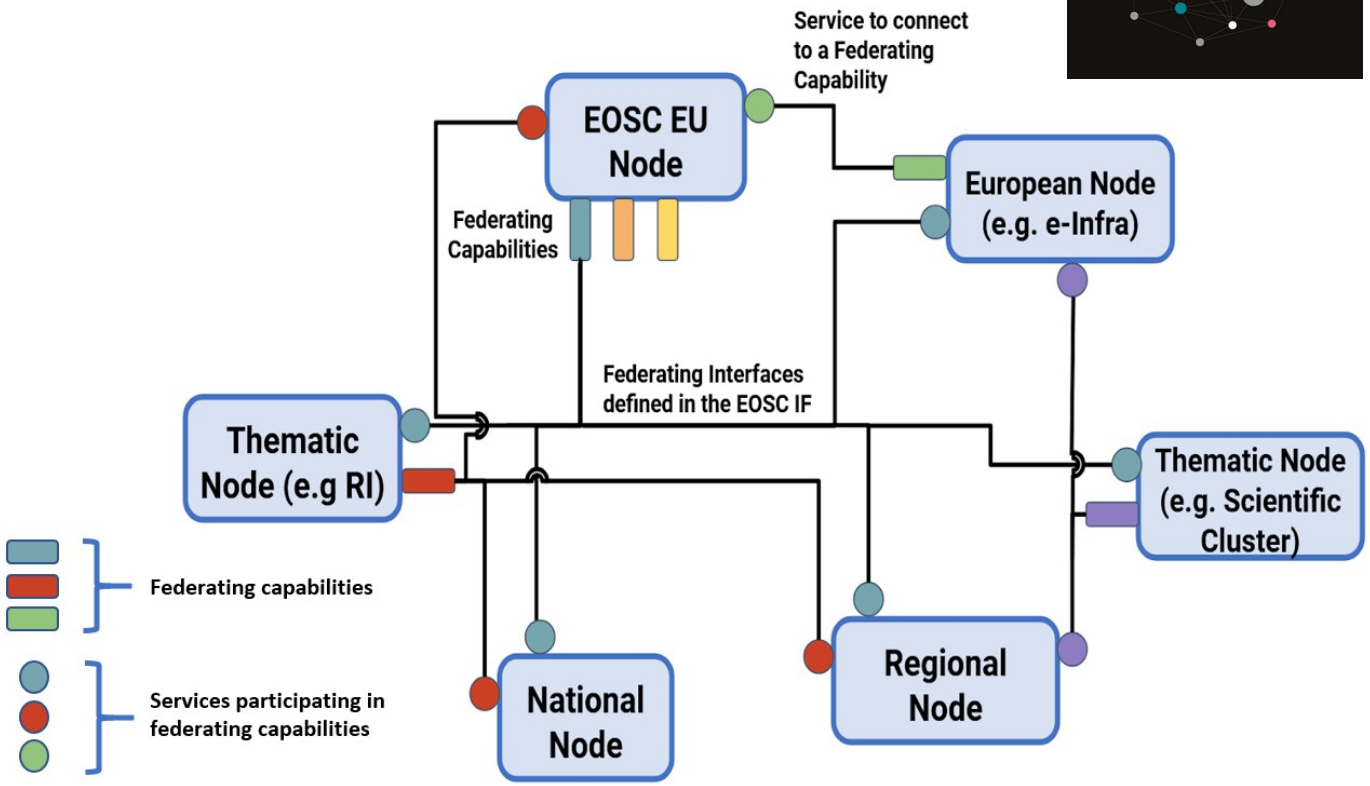
1. EOSC Federation Architecture (15’)
   - Overall view
   - EOSC Node Architecture
   - Federating Capabilities
2. EOSC Interoperability Framework (10’)
   - Governance
   - Registry
   - Interoperability Guidelines



EOSC Federation Architecture



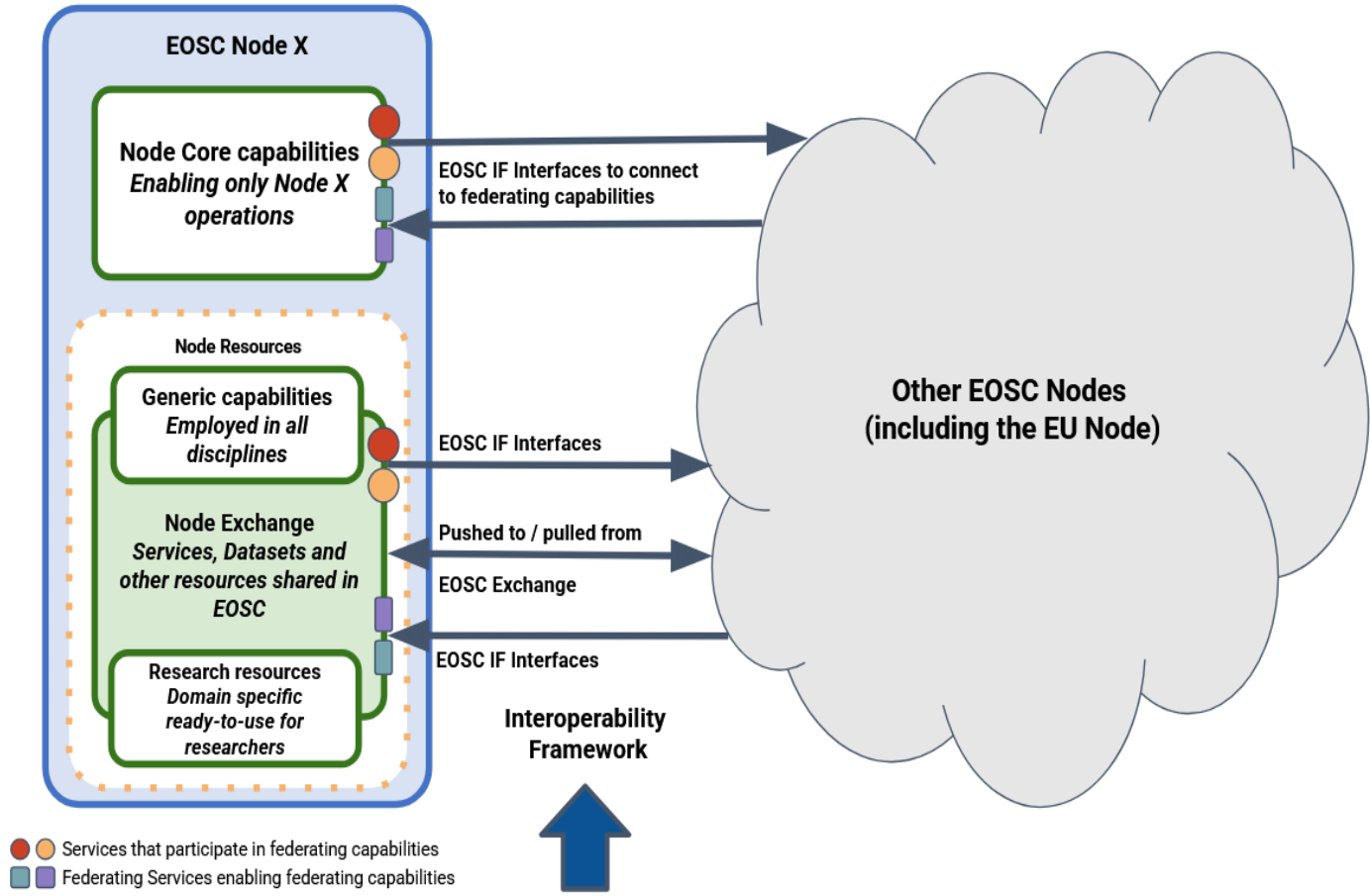
- **EOSC Nodes:** national, regional, thematic, European nodes (i.e. e-infras) and the EOSC EU Node;
- **EOSC Federating Capabilities:** functions enabled collaboratively by the EOSC Nodes offered (or required) at the Federation level (enabled by **Federating Services**).
- **EOSC Interoperability Framework:** standards (protocols, APIs, metadata schemas) and guidelines (including legal/organisational aspects) for communication between Node services



Network of autonomous nodes that interact with each other to deliver added-value capabilities to their users

EOSC Node Architecture

- A **reference architecture** that defines a system-agnostic integrated digital platform for organisations willing to establish an EOSC Node
- Set of recommended interconnected **Core and Horizontal functions**
  - Ensure adequate service delivery in terms of user experience, quality, support, etc.
- Reference architecture can be implemented with technologies of choice
- EOSC Nodes of the Build-up phase are first implementation of the EOSC Node Architecture



Node Core and Generic Capabilities

Node Core Capabilities	Description
Resource Catalogue and Registry services	Catalogue of resources that can be accessed through the EOSC Node with a search engine to discover, access and order them
AAI	AAI (AARC Blueprint compliant) enabling access to Node resources (Core and Exchange) via federated credentials (i.e. community AAI and Infrastructure Proxy)
Helpdesk	Support incident response and service requests for services and other integrated resources
Service Monitoring	Monitor the availability and quality of the Node services
Service and Research Product Accounting	Track and record usage of resources
Order Management	A framework for providers to define o end-users to request access to resour
Configuration Management System	Shared space to store information or services are provided through the no delivery (only for internal use)
User space	Dynamic customisable dashboard, offering easy access to the Node resc
Application Deployment Management	Automated deployment and executio Node provisioned infrastructure
Resource provisioning	Support users in identifying all available resources for a project and then assigning a subset of them to the project

Table 4.1: EOSC Node Core Capabilities

Node Capabilities	Description
Data Management and Transfer	Management of data between storage locations
Interactive Notebooks	Support for data analysis
Compute and storage resources (including middleware)	Support for data analysis with relevant middleware (e.g. support for containers)
File Sync & Share	Syncing automatically data across devices (e.g. PCs, tablets, or smartphones) and securely sharing them within research teams

Table 4.2: EOSC Node Generic capabilities

EOSC Federating Capabilities

- **EOSC Federating Capabilities**: added-value functionalities that allow EOSC users and providers to exploit EOSC services, data and other resources
  - provided by two or more Nodes collaboratively
- Federating Capabilities are enabled by **EOSC Federating Services** and **Interfaces** defined in the EOSC IF
  - **EOSC Federating Services** are special services, offered by one or more Nodes, capable of federating functionalities and/or data offered by services of other Nodes
  - The Federating Services expose **EOSC Interfaces** (e.g. APIs and metadata schemas) to allow EOSC Nodes to connect
- EOSC Federating Capabilities can be:
  - **Mandatory**: all EOSC Nodes must participate to enrol in the EOSC Federation;
  - **Recommended/Optional**: EOSC Nodes should consider to federate with (i.e. connect to) (not a requirement to enrol in the Federation)

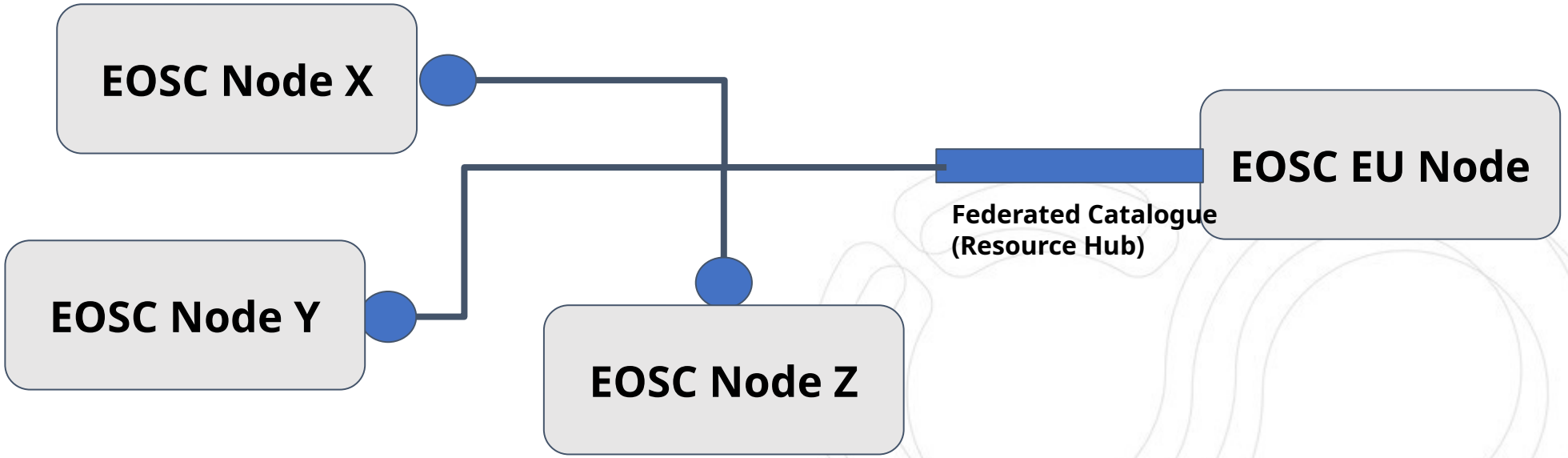
Examples of Federating Capabilities

- ***Federated catalogue*** that provides access to (all) EOSC resources
- ***Search service*** across catalogues from different Nodes
- ***Federated cloud*** Cloud compute and storage available in multiple Nodes

EOSC Federating Capabilities

EOSC Nodes can contribute to the delivery of a Federating Capability by either:

A. **enabling a Federating Capability** that can be used by other EOSC Nodes (e.g. act as a federator, a Node enabling a federation of cloud resources)
B. **participating in the delivery of a Federating Capability** by integrating one or more services provided by the Node in a Federating Capability enabled by another Node
   - *e.g. a Node participating in the federated AAI by integrating its AAI proxy with the AAI Federation enabled by the EOSC EU Node*



Federating Capabilities in the EOSC Federation interim phase

ID	Federating Capability	Description	Classification
FC-1	**AAI**	Ensures the AAI interoperability across the EOSC Nodes	**Mandatory**[29]
FC-2	**Resource Catalogues and Registry services**	Enables the discovery and access of resources (e.g. Services and Research Products) provided through EOSC Nodes within the EOSC Federation.	**Mandatory**[30,31]
FC-3	**Helpdesk**	Integrates the helpdesks of EOSC Nodes within the EOSC Federation to provide a federated support channel between users and providers from nodes.	Recommended (Will become **Mandatory in 2026**)
FC-4	**Service Monitoring**	Provide information about the quality and availability of services and resources made available through EOSC Nodes into the EOSC Federation.	Recommended (Will become **Mandatory in 2026**)
FC-5	**Service Management System**	EOSC Federation FitSM-based Service Management System. defining the essential processes between EOSC Nodes to enable efficient IT service management within the EOSC Federation. It also includes Security Coordination between Nodes.	Recommended (Will become **Mandatory in 2026**)
FC-6	**Service Accounting**	Provide information about the usage of services offered by EOSC Nodes within the EOSC Federation.	Recommended
FC-7	**Research Product Accounting**	Provide information about the usage of research products made available through EOSC Nodes in the EOSC Federation.	Recommended
FC-8	**Order Management**	Provides a framework that allows providers and users to manage the full lifecycle of service and resources requests and access granting across federated Nodes.	Recommended
FC-9	**Application Deployment Management**	Automated deployment and execution of services across multiple federated nodes.	Recommended

Extending the initial set of Federating Capabilities

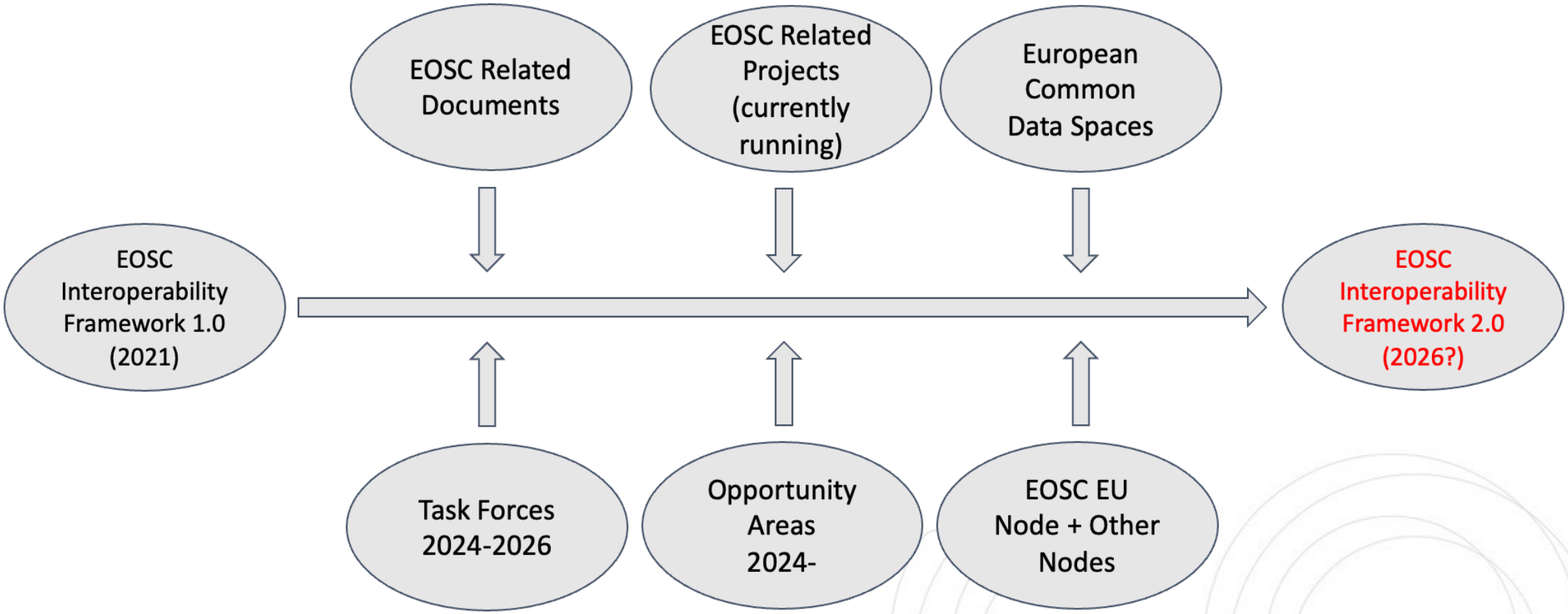
- **EOSC Federating Capabilities** are expected to evolve and be extended during the Federation's interim phase
  - support more complex use cases
- New Federating Capabilities under development by various initiatives and EOSC related projects:
  - A comprehensive overview of these efforts has been published by the EOSC-A Technical and Semantic Interoperability Task Force
- Decision to adopt a new Federating Capability is on the EOSC Federation Governance body
  - Determining whether a capability is mandatory, recommended, or optional.
  - Tasking suitable providers with the design and implementation of the required Federating Services and Interfaces.
  - Finalising Service Level Agreements (SLAs) with the EOSC Nodes selected for operation.
- During the interim phase (2026-2027), the Interim EOSC Node Coordinator Committee, supported by the Interim EOSC Node Operations Committee, governs the portfolio of Federating Capabilities.

EOSC Interoperability Framework

- **Interoperability Governance**
  - **Under review by EOSC United project to enable discussion of the future development of Federating capabilities (all aspects of the interoperability - technical, semantic, organizational, legal)**
- **Interoperability Registry**
  - Current version (1.0 from EOSC Future) is operated by EU Node:
    - Currently contains obsolete material : 27 Interoperability guidelines, that need revision based on current Federating capabilities of EOSC Federation.
  - New enhanced version (2.0) under development within the EOSC Beyond project and will be ready for production, when settled by the EOSC Federation Governance
- **Interoperability Guidelines**
  - Define the mechanisms for inter-operation at various levels of integration, from which a Node joining the EOSC Federation can select the best option that fits its needs. The new version of the guidelines will be published in Interoperability Registry (3 are already ready: 1 for AAI and 2 for Federated Catalogue)

Towards EOSC Interoperability Governance

EOSC United T3.2: Towards EOSC Interoperability Framework Governance/Convergence



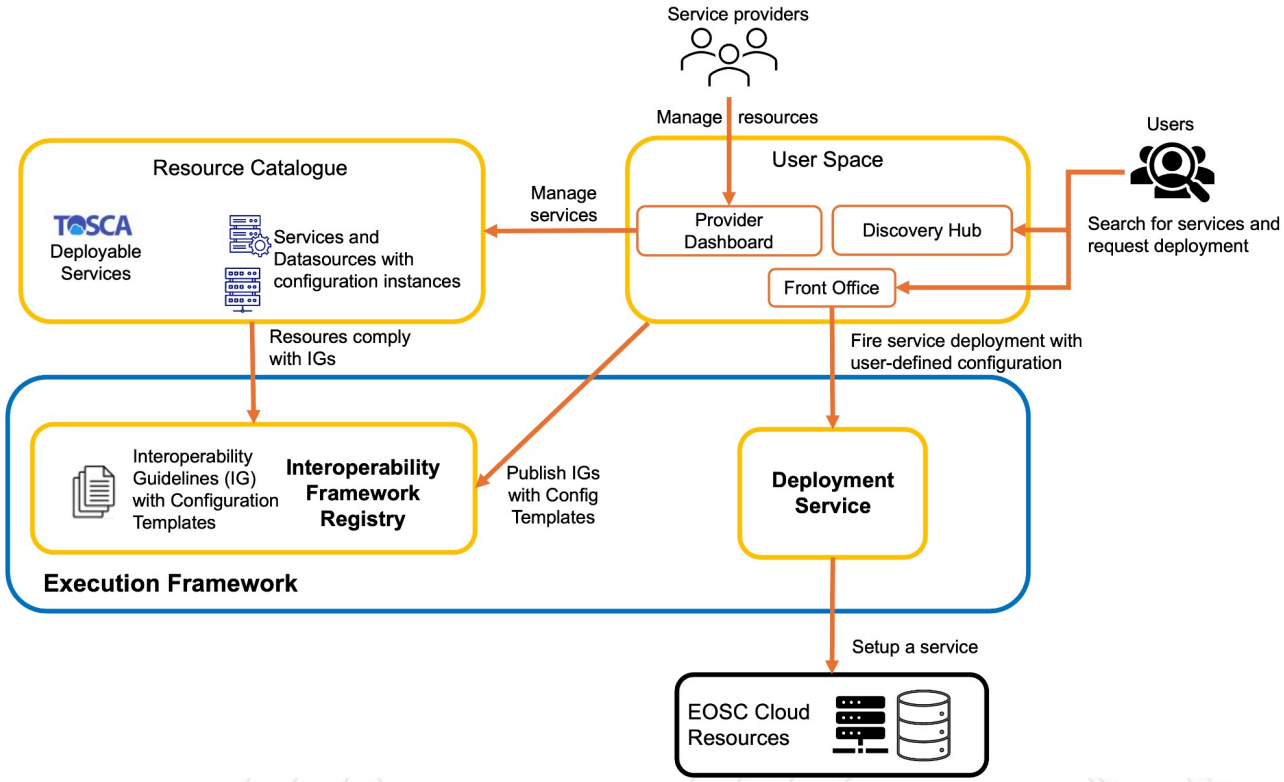
EOSC Interoperability Assessment 2026

Organizational Interoperability **- United T3.1, T3.5, T3.6**	**Legal Interoperability** **- United T3.3**
Technical Interoperability - TF Technical interoperability recommendations - AAI EOSC Architecture 2025 - EOSC Beyond	Semantic Interoperability - TF Semantic interoperability recommendations

- **Interoperability Assessment Interviews with the current EOSC nodes happening** from mid-April till mid May and the results will be discussed with Nodes governance at F2F meeting in June. Based on the assessment, creation of refined Interoperability Framework in 2026.

EOSC IF Registry 2.0

- **EOSC IF Registry 2.0:**
  - from a simple collection of human-readable guidelines to a collection of guidelines that support machine-composability of resources
- **Configuration Templates:** structured metadata profiles that detail the actual access parameters of services (linked to guidelines)
- EOSC Service Catalogue stores **Service Configurations**
- Example: OAI-PMH guidelines with a configuration template to specify the repo URL



Call for action: Semantic Interoperability Subgroup of the Task Force

Call for action: experts/contributors needed for February drafting of the recommendation:

- Mappings and Crosswalks
- Validation and quality of Semantic Artefacts
- Governance of Semantic Interoperability

Email: marek@ics.muni.cz or to speak to me directly:)

Photo by Leeloo The First on Pexels

Q&A

The FAIR Implementation Profile (FIP)

The FAIR Implementation Profile (FIP)

The FIP is a **collection** of **FAIR implementation choices** made **by a community of practice** for **each of the FAIR Principles**

Why FIPs?

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Bridge FAIR principles to practice

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Explicit community decisions

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Explicit community decisions

Accelerate convergence & reuse

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Shared language & technology stack

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Machine-readable and scalable

Why FIPs?

Bridge FAIR principles to practice

Explicit community decisions

Accelerate convergence & reuse

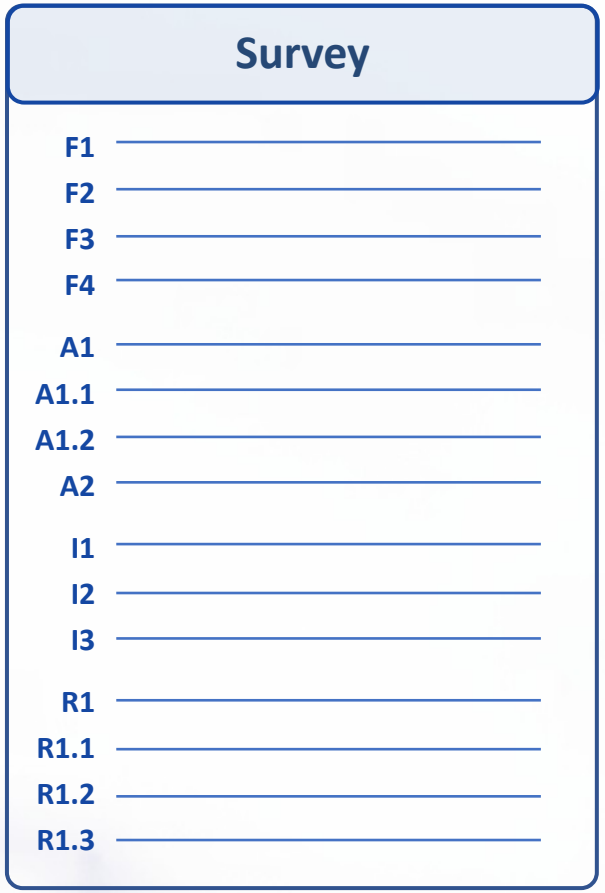
Shared language & technology stack

Machine-readable and scalable

Enable automation

What is a FIP?

Survey on each of the FAIR Principles



What is a FIP?

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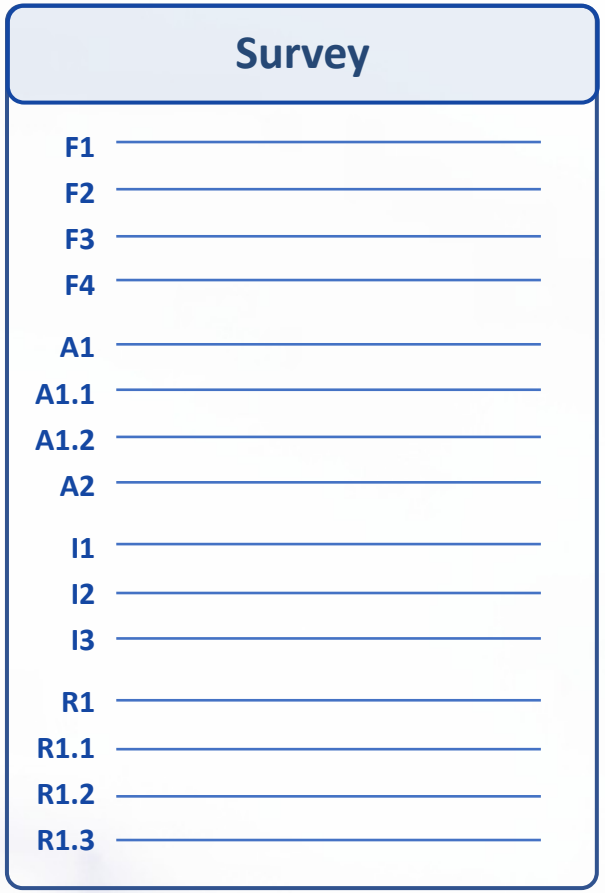
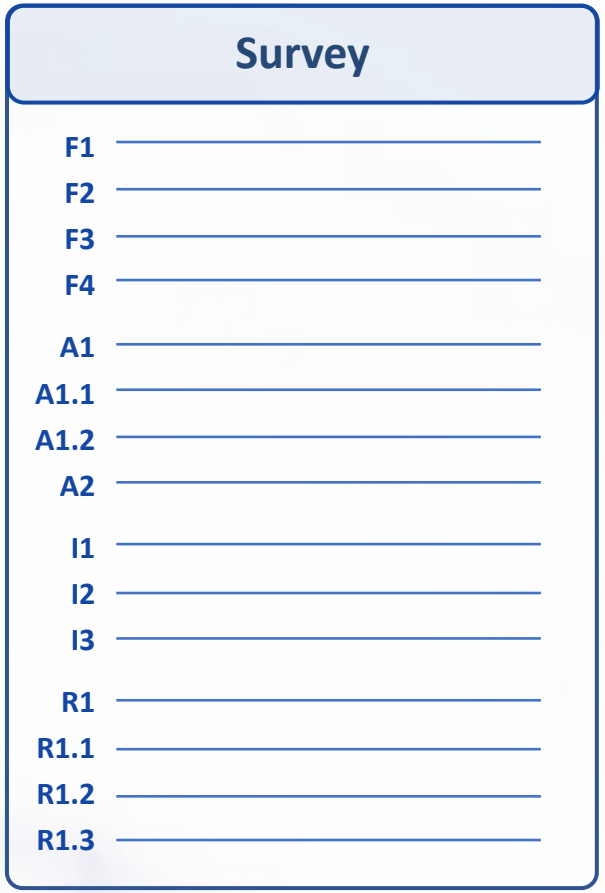


Technical implementation choices for each FAIR Principle

What is a FIP?

Survey on each of the FAIR Principles



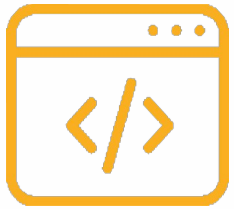
Technical implementation choices for each FAIR Principle

Result: a list of **FAIR Supporting Resources**

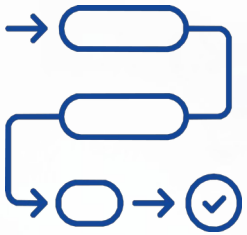
GO FAIR foundation

Applicable to many different digital object types

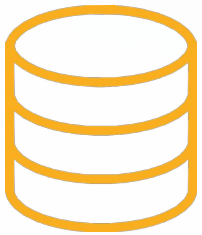
Case study



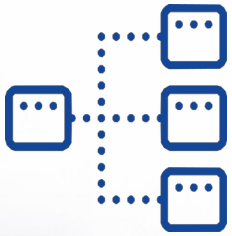
Code



Project



Data



Data registry

Data Management plan

Result: a list of **FAIR Supporting Resources**

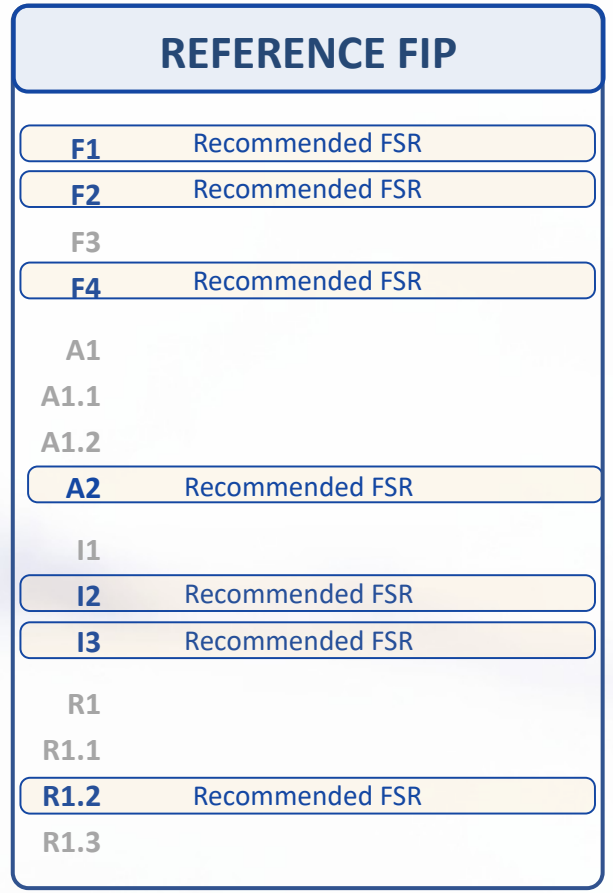
FIP	
F1	FAIR Supporting Resource (FSR)
F2	FAIR Supporting Resource (FSR)
F3	FAIR Supporting Resource (FSR)
F4	FAIR Supporting Resource (FSR)
A1	FAIR Supporting Resource (FSR)
A1.1	FAIR Supporting Resource (FSR)
A1.2	FAIR Supporting Resource (FSR)
A2	FAIR Supporting Resource (FSR)
I1	FAIR Supporting Resource (FSR)
I2	FAIR Supporting Resource (FSR)
I3	FAIR Supporting Resource (FSR)
R1	FAIR Supporting Resource (FSR)
R1.1	FAIR Supporting Resource (FSR)
R1.2	FAIR Supporting Resource (FSR)
R1.3	FAIR Supporting Resource (FSR)

FIP: Usage declaration

Enables community to declare what they use

Reference FIPs

Enables community to recommend must haves!

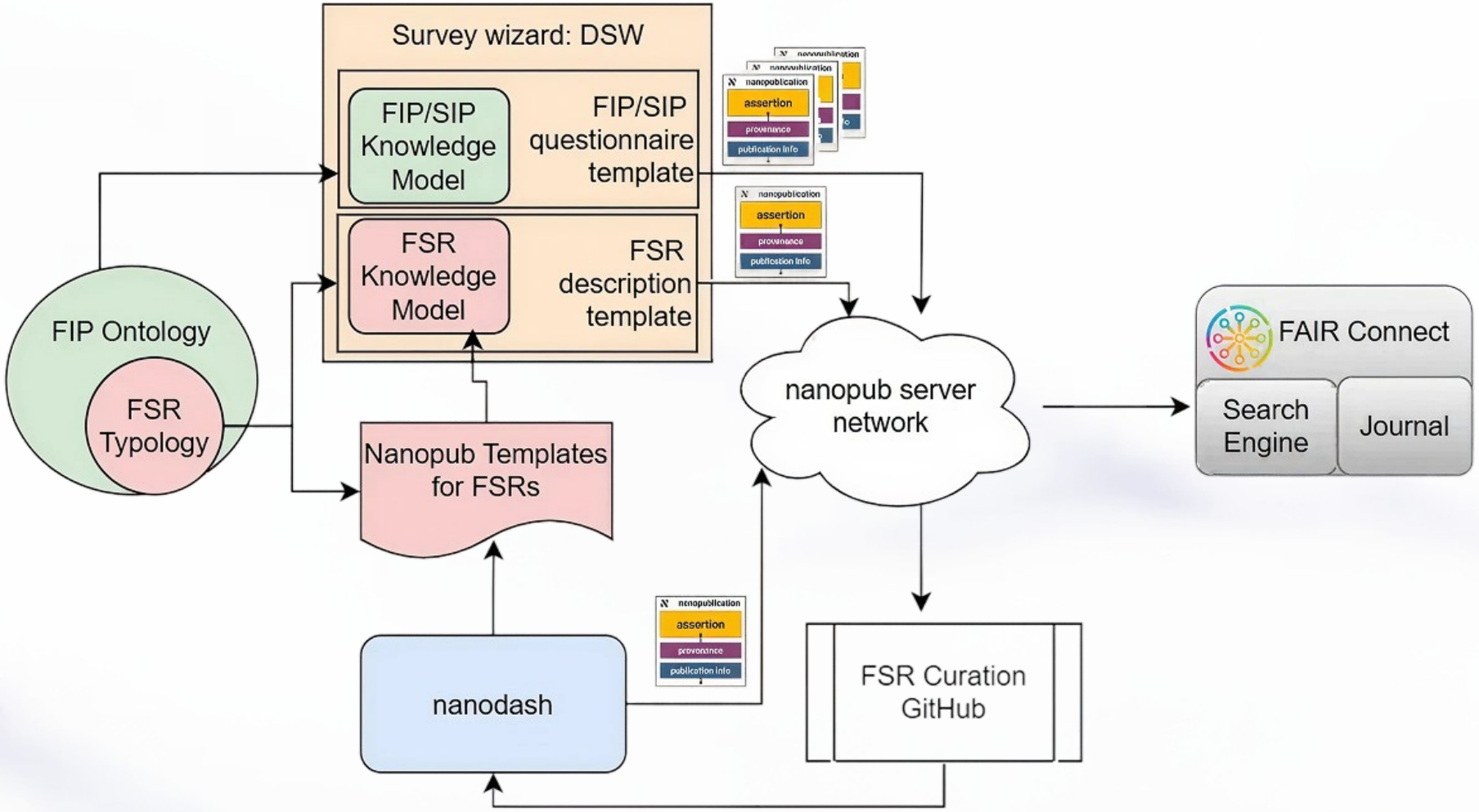


Enabler needed for creating FIPs

- **User friendly creation** of version controlled FIPs
- **Selection and creation** of resource metadata reusing FAIRsharing descriptions
- Based on a **Resource topology**, fully aligned with FAIR principles
- **Fully machine-readable** output of FIPs

FIP ecosystem

Ensures that FIPs and FSRs can be easily created, curated, discovered, and queried



The FIP Wizard – enables creation of FAIR compliant FIPs

Selection of resource descriptions

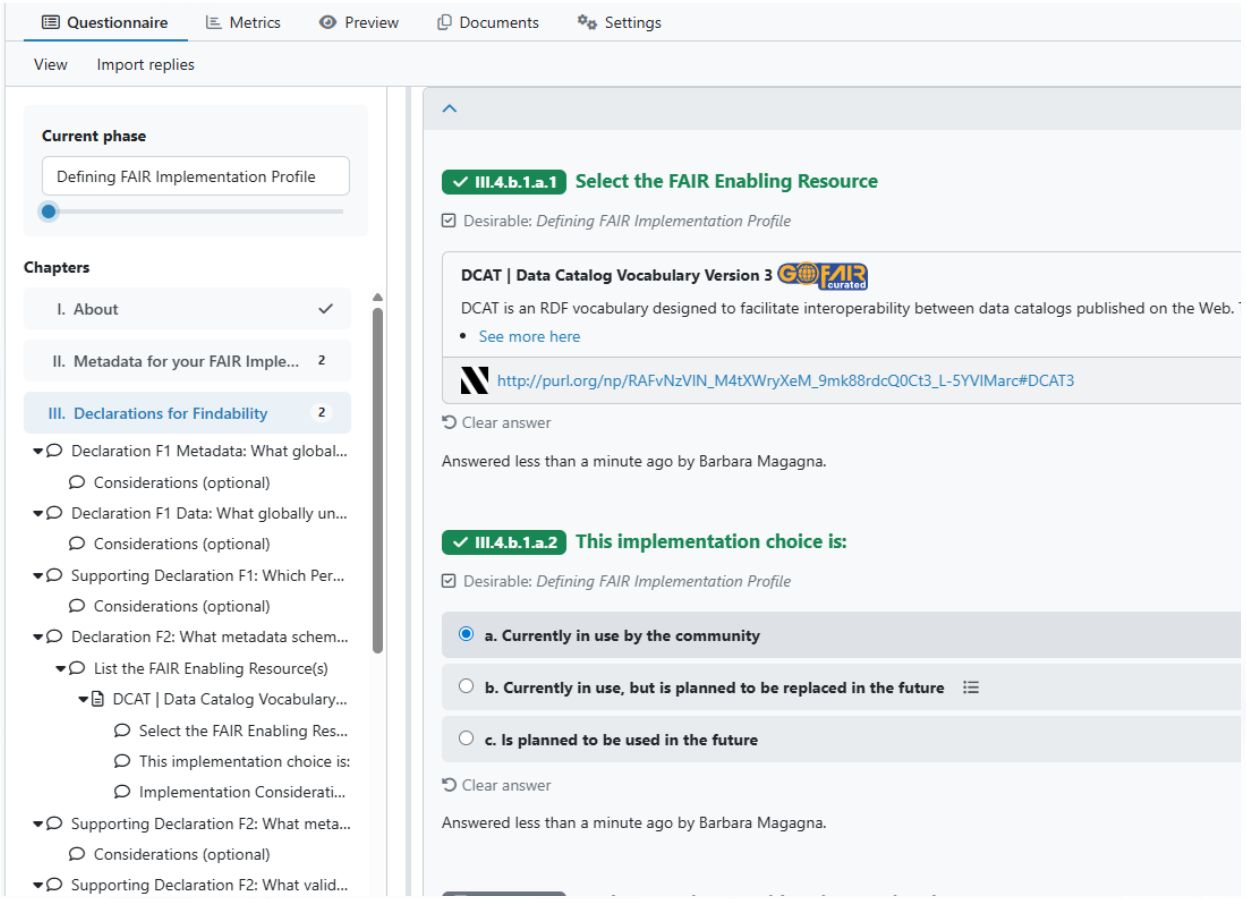
Survey

F1
F2
F3
F4

A1
A1.1
A1.2
A2

I1
I2
I3

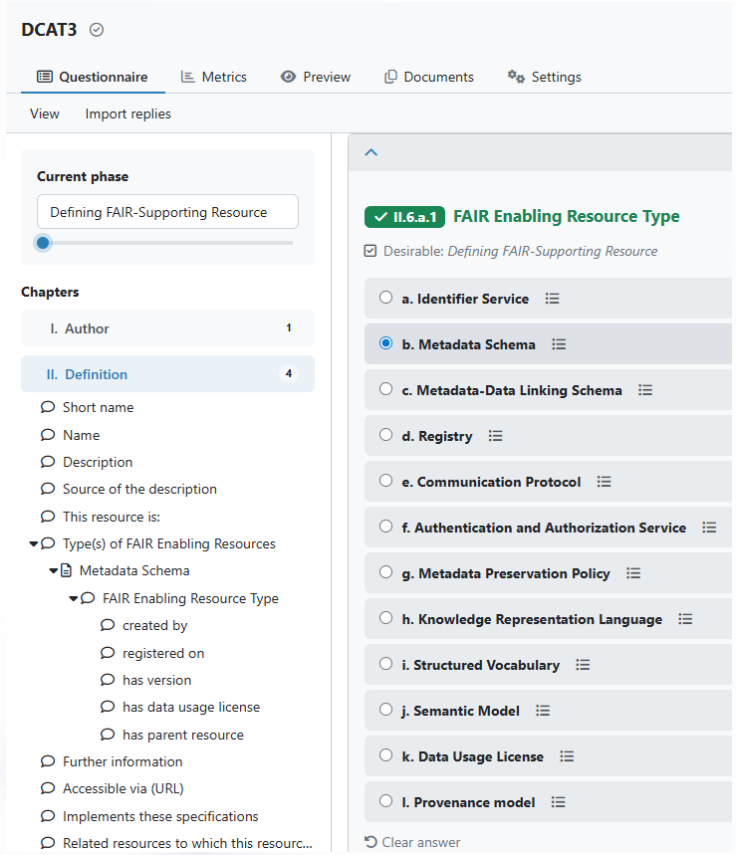
R1
R1.1
R1.2
R1.3

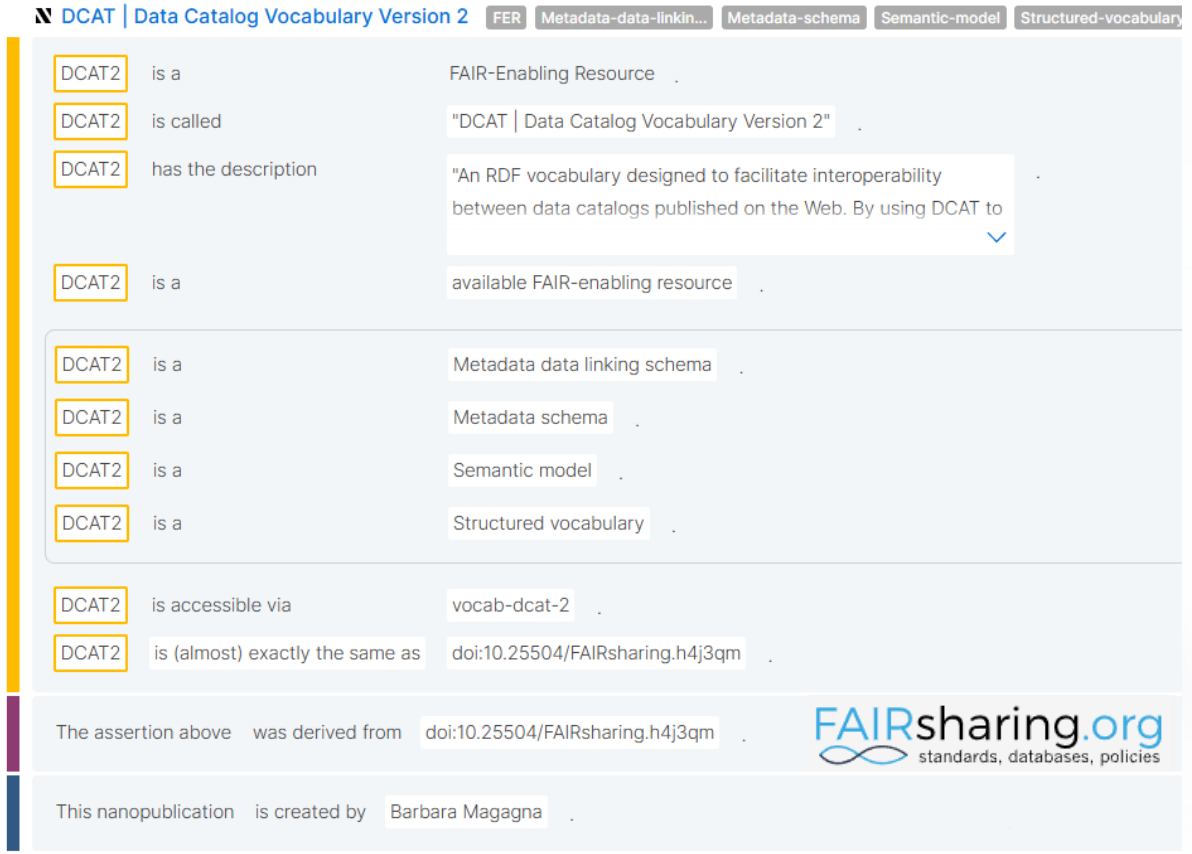


https://fip.fair-wizard.com/

The FIP Wizard – enables machine readability

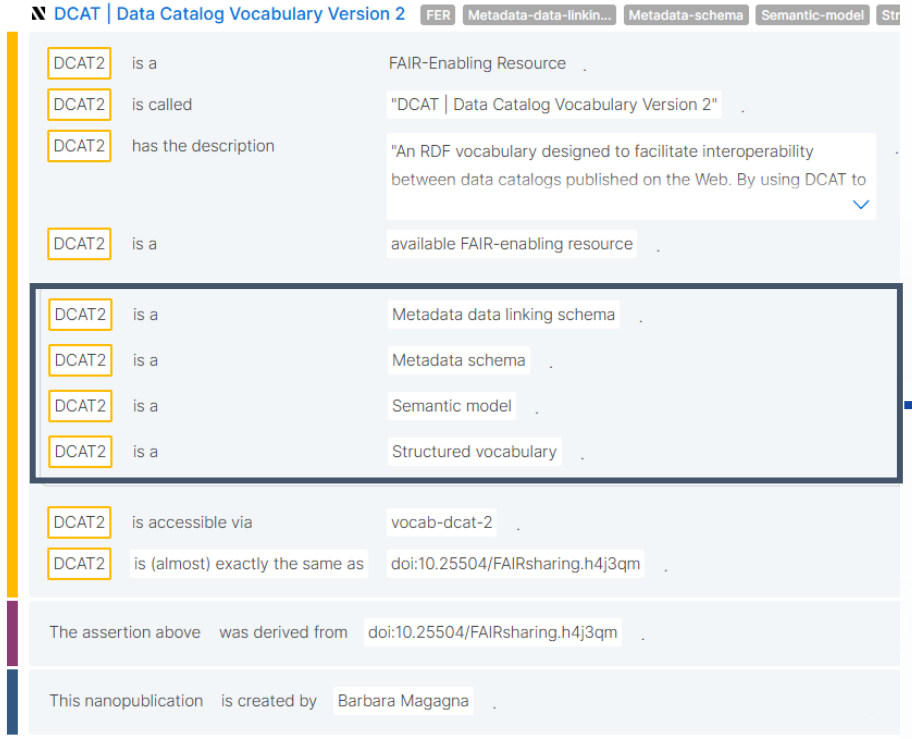
Publication of FDOs as RDF nanopublications

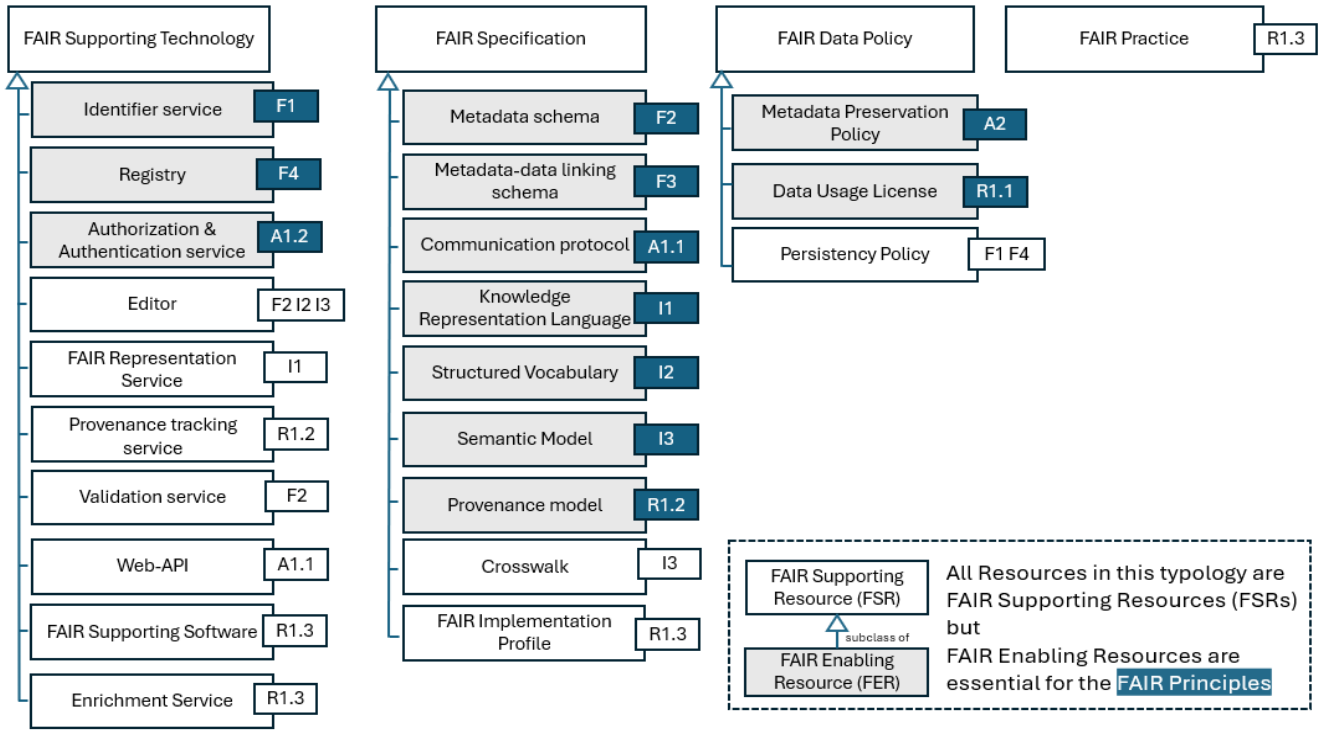




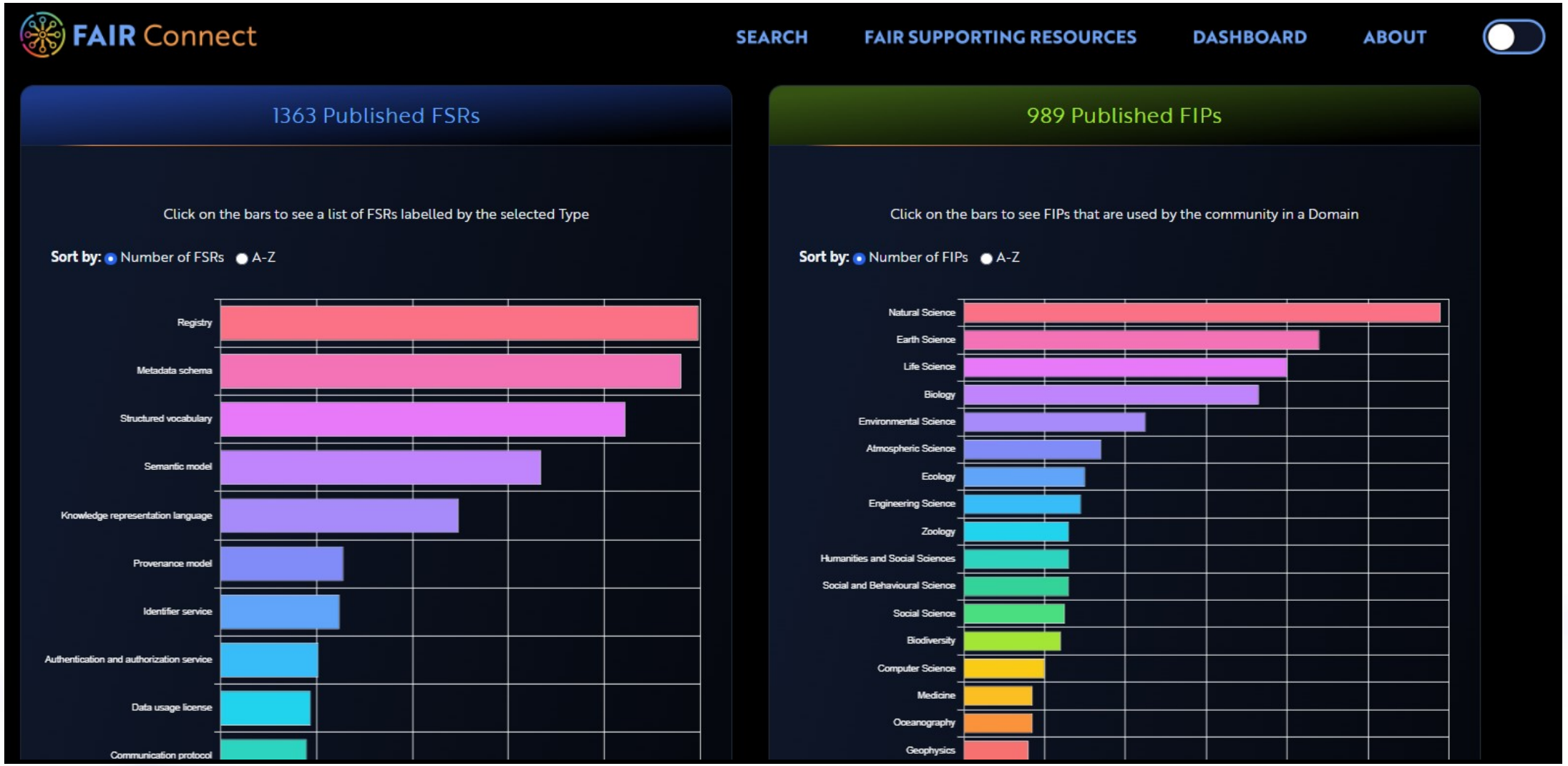
FAIR Supporting Resource Typology

Tools, services, standards and policies that support aspects of FAIR Implementation





A growing ecosystem



FIPs for EOSC

- Profiles per EOSC nodes
- A shared catalog of resources
- Interoperability Solutions represented as recommended FSRs by EOSC

How to continue?

- Round Table - Adoption of FIPs in projects, EOSC
- Opportunity Area Expert Group on Metadata, Ontologies and Interoperability
- RDA P26 BoF session

Contact us

Barbara Magagna

barbara@gofair.foundation

Learn more

The FIP Wizard:	https://fip.fair-wizard.com/
The FIP Ontology:	https://w3id.org/fair/fip
FAIR Connect:	https://fairconnect.pro/

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Open Science Plan-Track-Assess Pathways

DMP-IF

Data Management Planning – Interoperability Framework

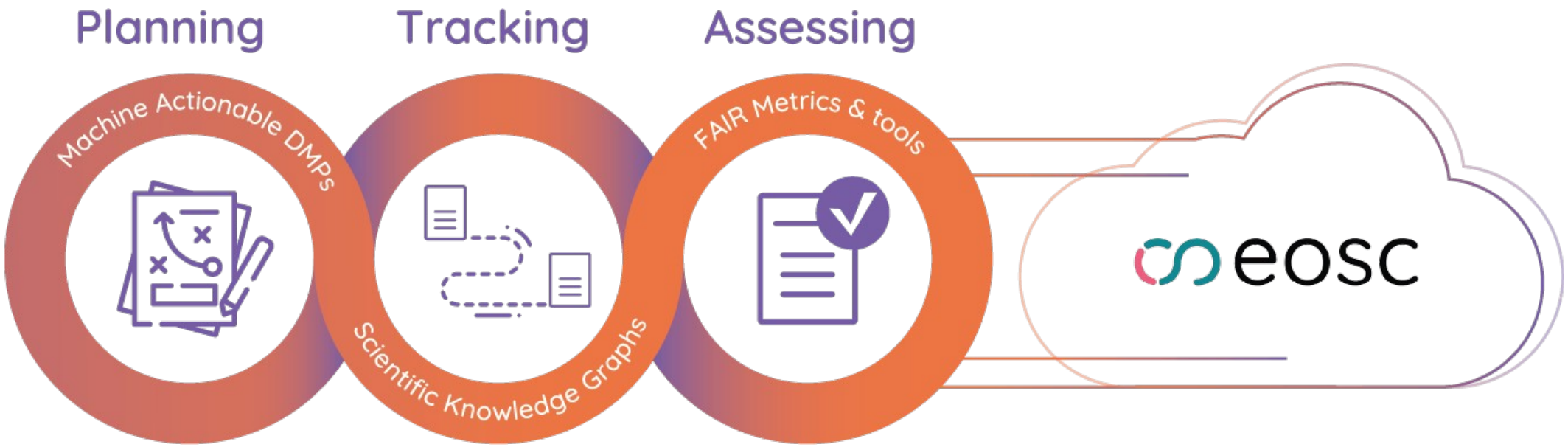
Tomasz Miksa

OSTrails Technical coordinator

Funded by the European Union

Supporting eosc

OSTrails



2024 – 2027
40 Partners

M24/M36

Coordinator: OpenAIRE

8M EUR

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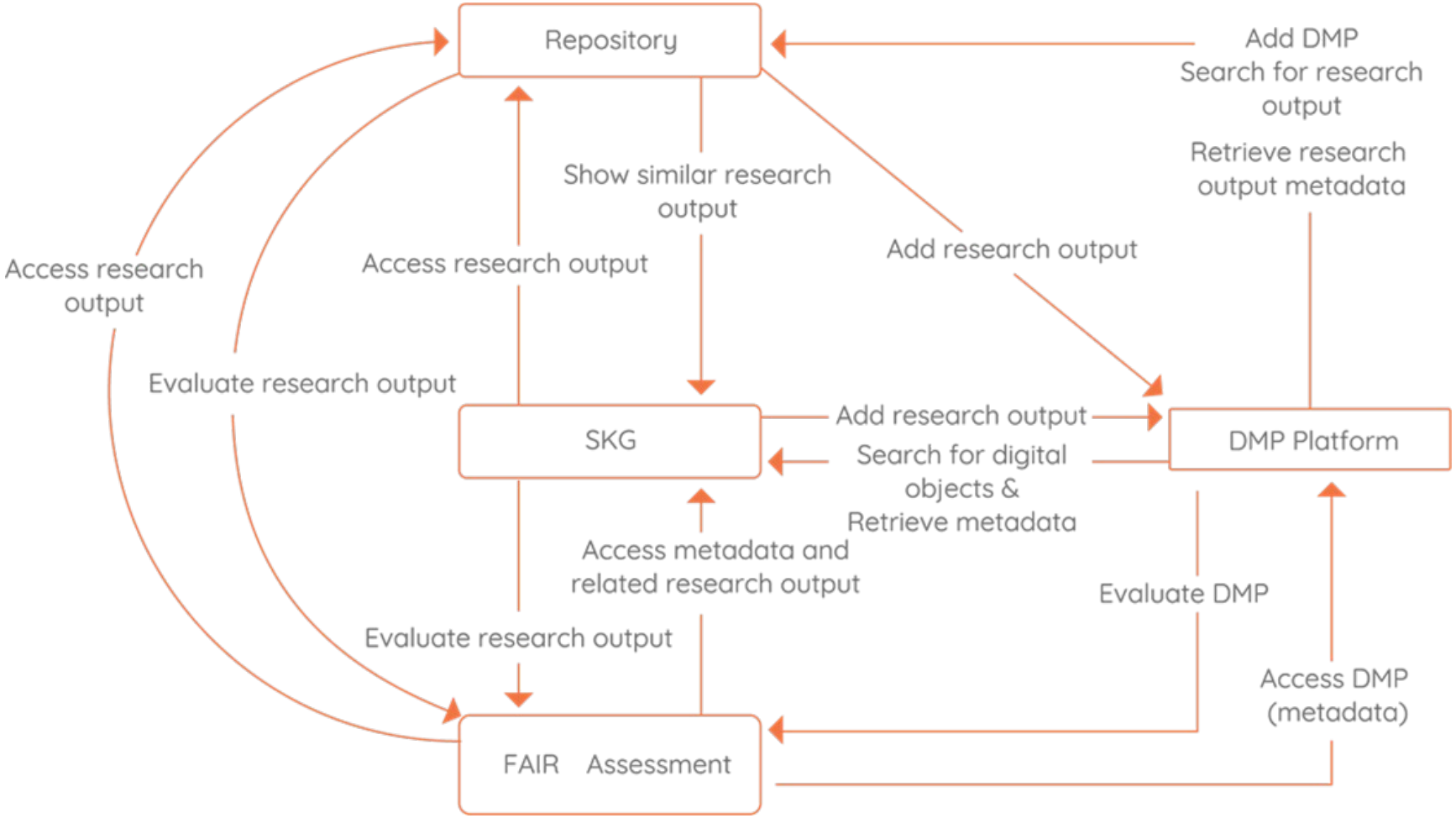
OSTrails pathways



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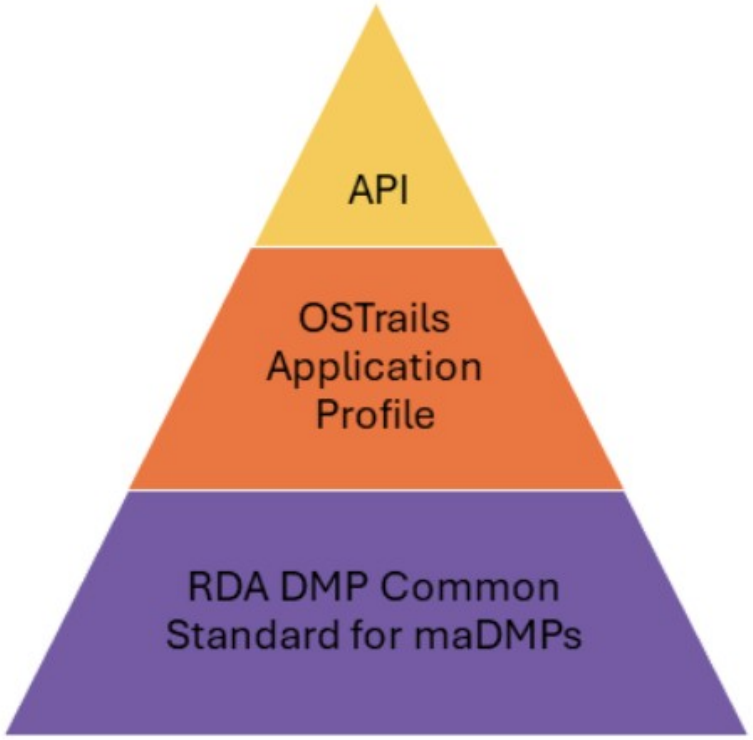
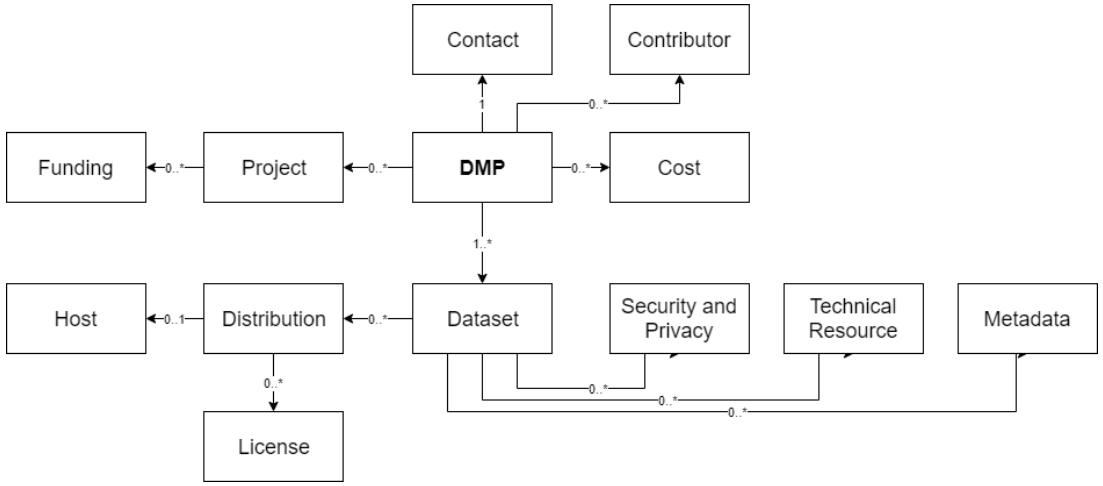
https://zenodo.org/doi/10.5281/zenodo.13145787

DMP-IF: Common standard for machine-actionable Data Management Plans (maDMPs)





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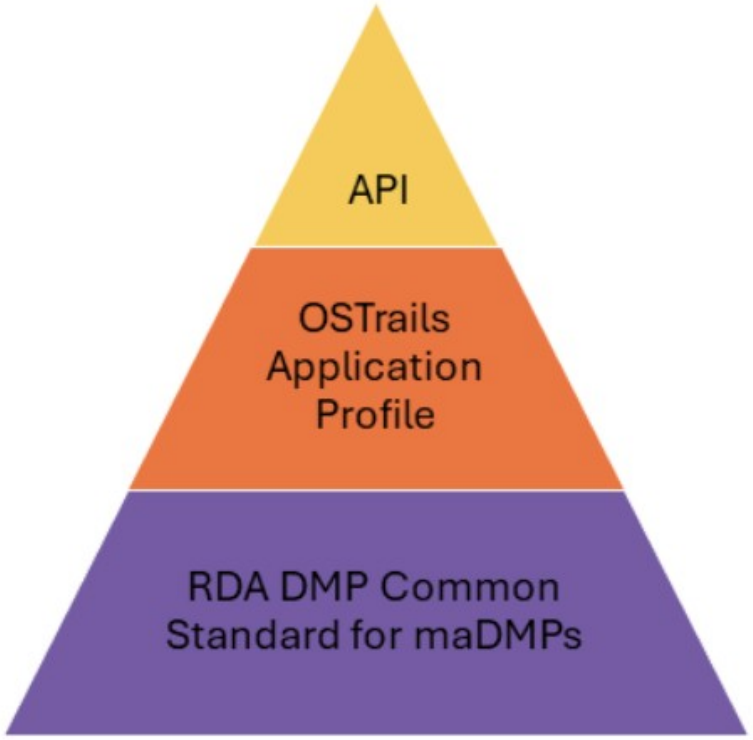
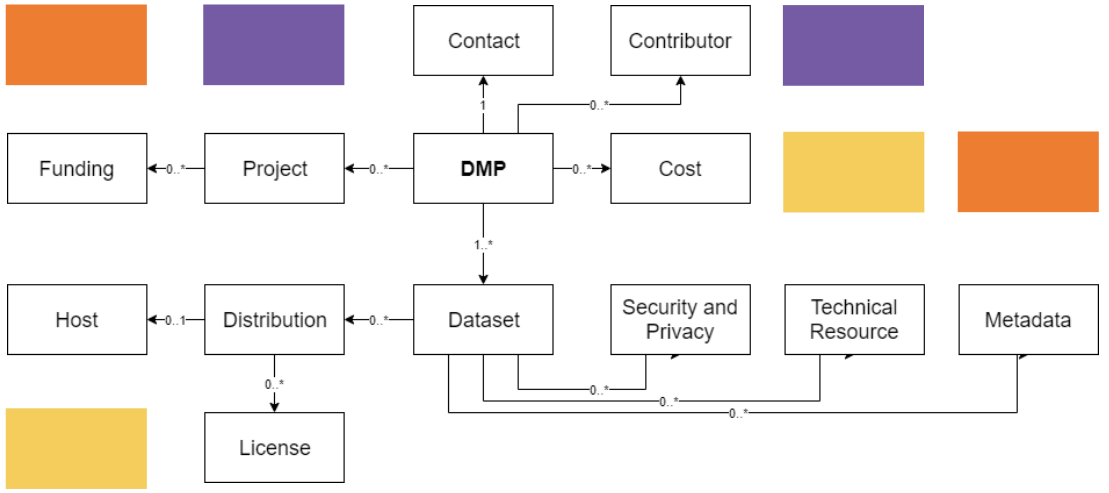
RESEARCH DATA ALLIANCE

DMP-IF: OSTrails Application Profile





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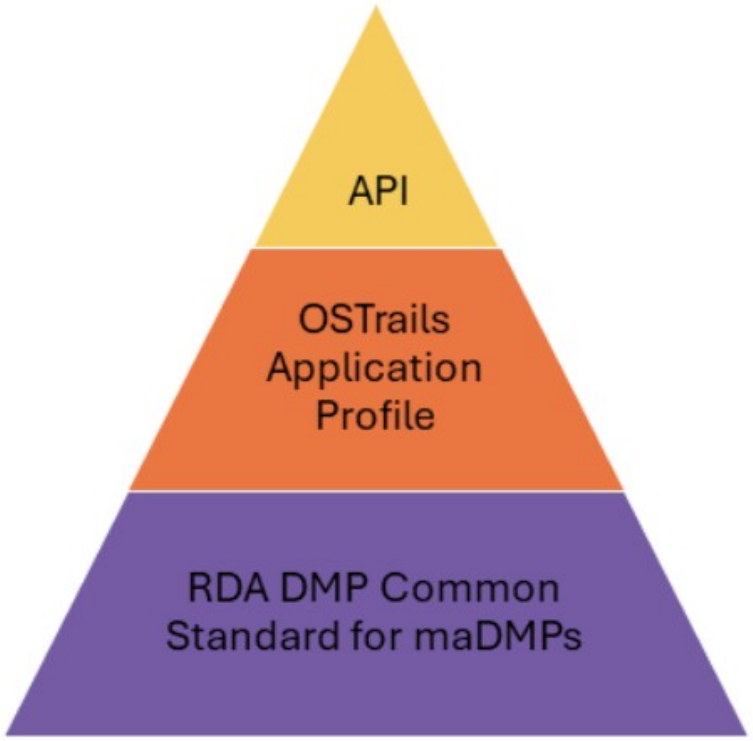
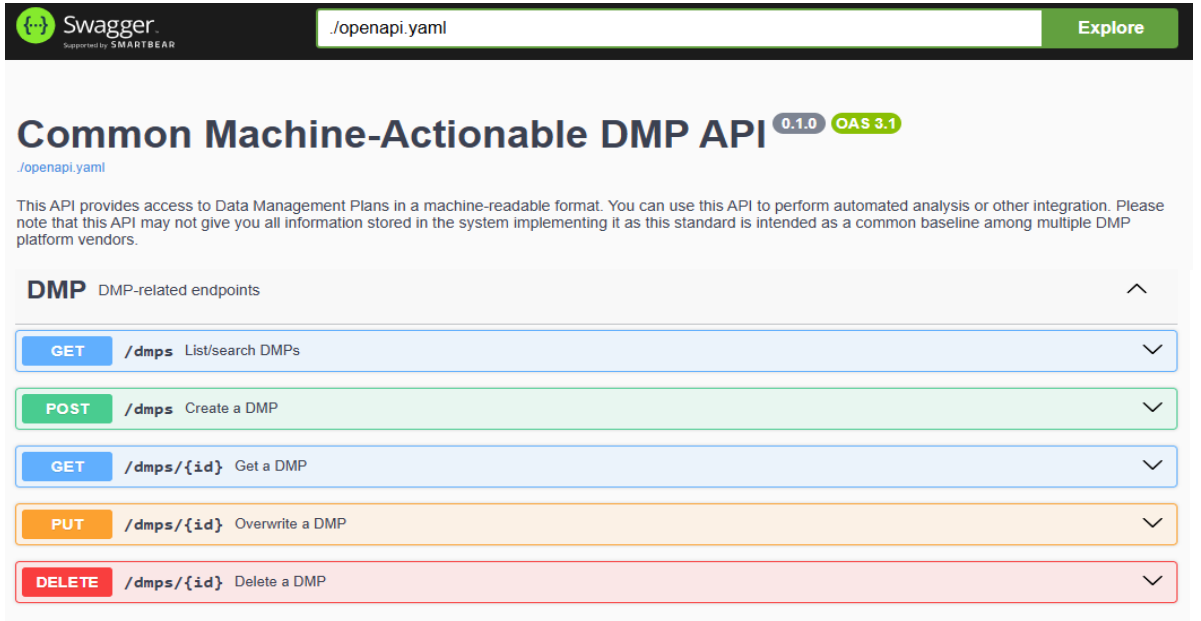
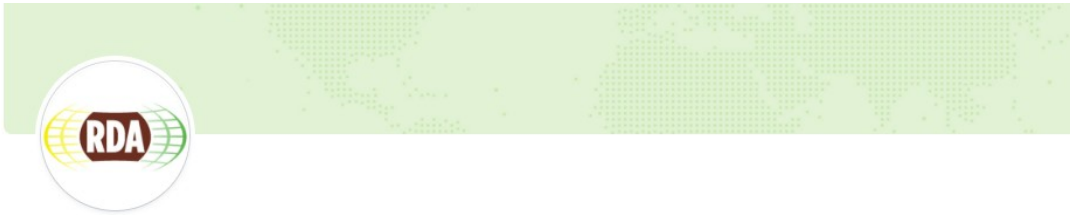
DMP-IF: Application Programming Interface (API)







WORKING GROUP

Common Application Programming Interface (API) for machine-actionable Data Management Plans (maDMPs)

Group Stage: WG Getting Started

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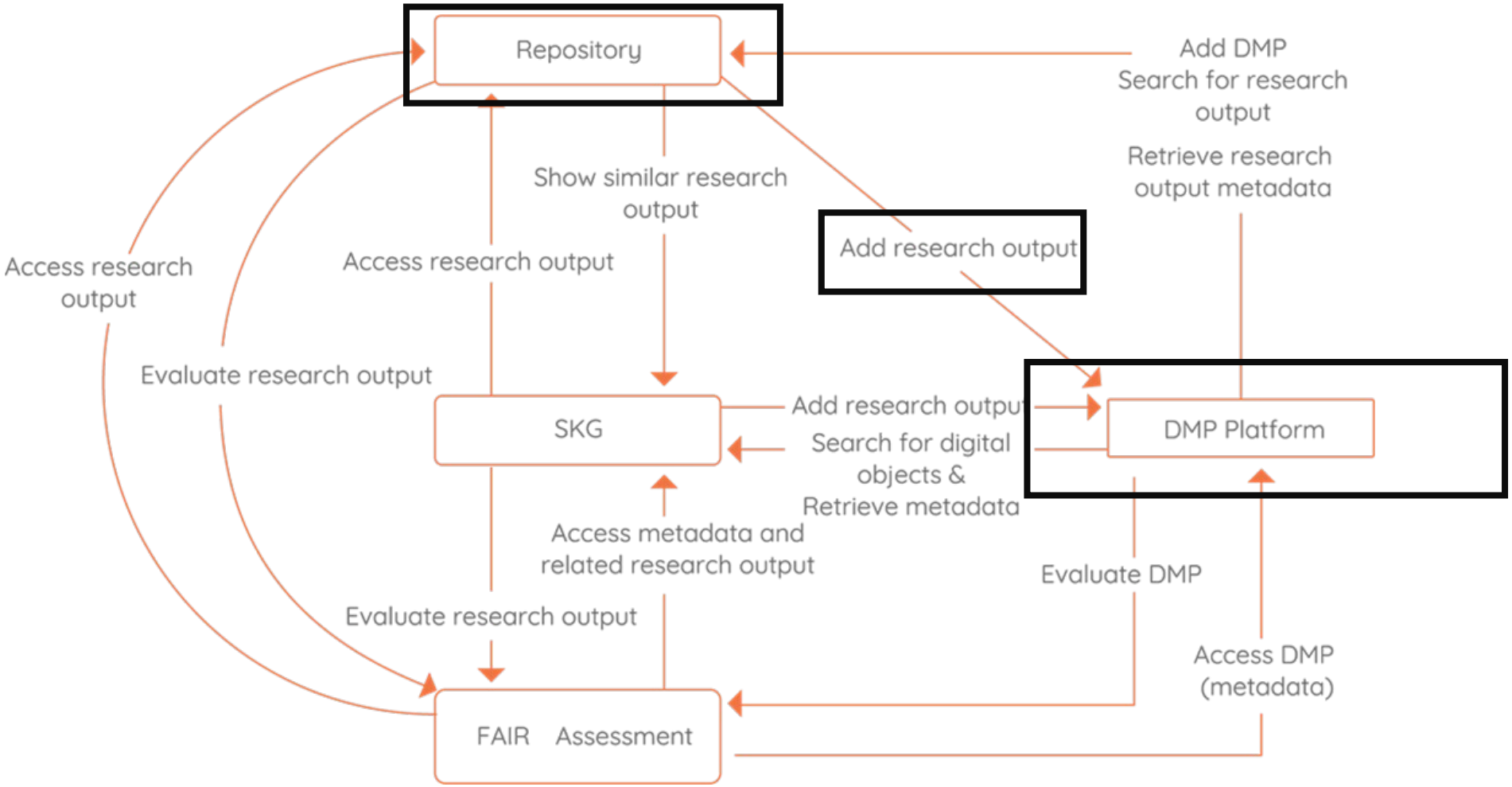
Example



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Details

DOI

DOI 10.70124/0psw7-aps54

Resource type

Image

Publisher

TU Wien

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Citation

Moser, M. (2021). test tomek. TU Wien.
https://doi.org/10.70124/0psw7-aps54

Style APA

Export

JSON Export

Technical metadata

CreatedApril 14, 2021

ModifiedMarch 20, 2025

Additional actions

Add to DMP

Link record to DMP

Does the dataset contain personal data? * Yes No

Does the dataset contain sensitive data? * Yes No

- **Skills4EOSC**
- **Setup and management of the EOSC Secretariat supporting the EOSC Governance**
- **EOSC Focus**
- **gAia**
  Ziel des Projekts gAia ist die Entwicklung einer Methodik (i) zur Vervollständigung historischer Ereignisdaten für Hangrutschungen aus Fernerkundungsdaten und (ii) zur Erstellung darauf aufbauender robuster Gefahrenhinweiskarten. Durch intelligente Datenf

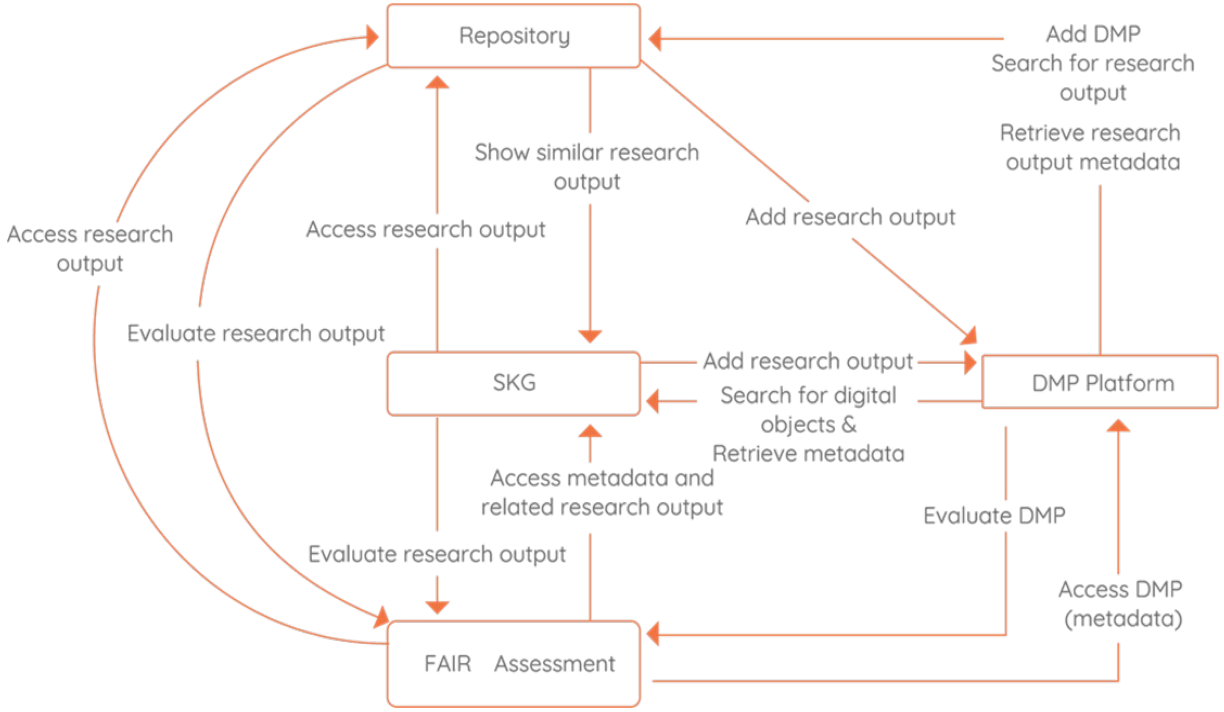
DMP-IF

- DMP-IF is there to replace or at least reduce the need for PDFs
- DMP-IF provides the glue between Research Data Management services
- DMP-IF prevents vendor lock-in

ostrails
Funded by the European Union

Question to you

- Which other services
  - can update maDMPs?
  - need information from maDMPs?



ostrails
Funded by the European Union

Demonstrating cross-domain Essential Climate Variable data access using harmonisation at the data level (ENVRI-HUB-Next's)

Tjerk Krijger (MARIS)

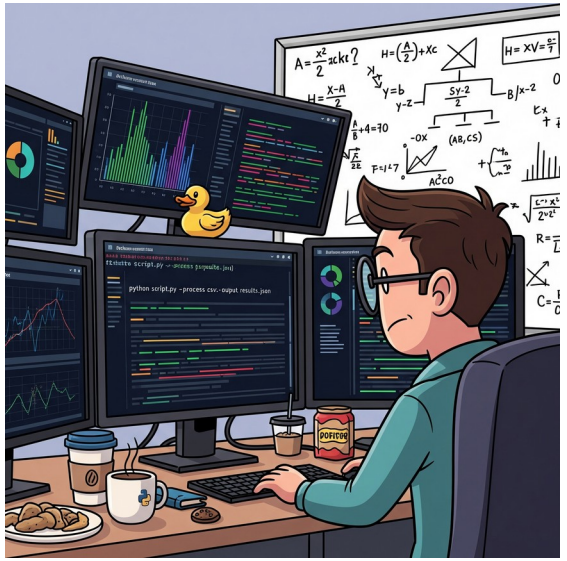
Data interoperability

How to compare and access Essential Climate Variable (ECV) data (e.g. ocean temperature) from different Research Infrastructures (RI) at the same time?

Common challenge for **EOSC related services,** RI's offer:

- Different types of services for accessing data;
- Different metadata models;
- Multiple observed parameters linked to an ECV;
- Different vocabularies (e.g. to describe the observed parameters and units).

This makes it difficult to access and use data in a harmonised manner, in for example a Virtual Research Environment (VRE).



Data interoperability

Solution via vocabulary and mapping

Starting point:

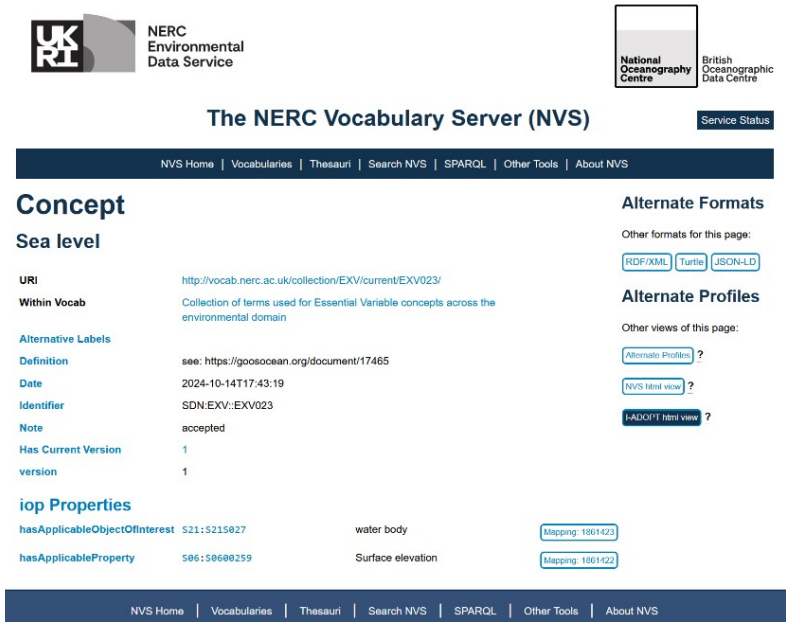
- Each RI has their own data access service, with own API, metadata, data format, vocabularies

Approach:

- Use the I-ADOPT ontology as a semantic broker between ECV and variables contained in data files;
- Decompose targeted variables using I-ADOPT in their respective repositories;
- Set up a SKOS vocabulary on the NVS containing the ECV concepts https://vocab.nerc.ac.uk/collection/EXV/current/ and decomposed them according to I-ADOPT;
- A dedicated hackathon (Amsterdam) was organised to build the foundations:
  - Where each RI offers a notebook/python script to access the data from their service.

Outcome:

- Set-up of notebook to access data from several RI's
  - Making use of I-ADOPT to retrieve the right observed parameters for an ECV per RI
- This experience lead to better understanding of the RI services, and recommendations to improve RI services, metadata and dataformats (where possible).



Behind the scene:
Notebook for access to ECV related data at RIs

Example in practice: Sea-surface temperature (https://vocab.nerc.ac.uk/collection/EXV/current/EXV017/)

Generic request:

- Pick ECV from Vocabulary;
- Choose bounding box;
- Time range;
- Height range (depth below sea level or height above ground).

```
exv = "EXV017"
region = (-10, 40, 30, 45)
time = ("2020-01-01", "2021-01-01")
height = (-10, 0)
cache = True
```

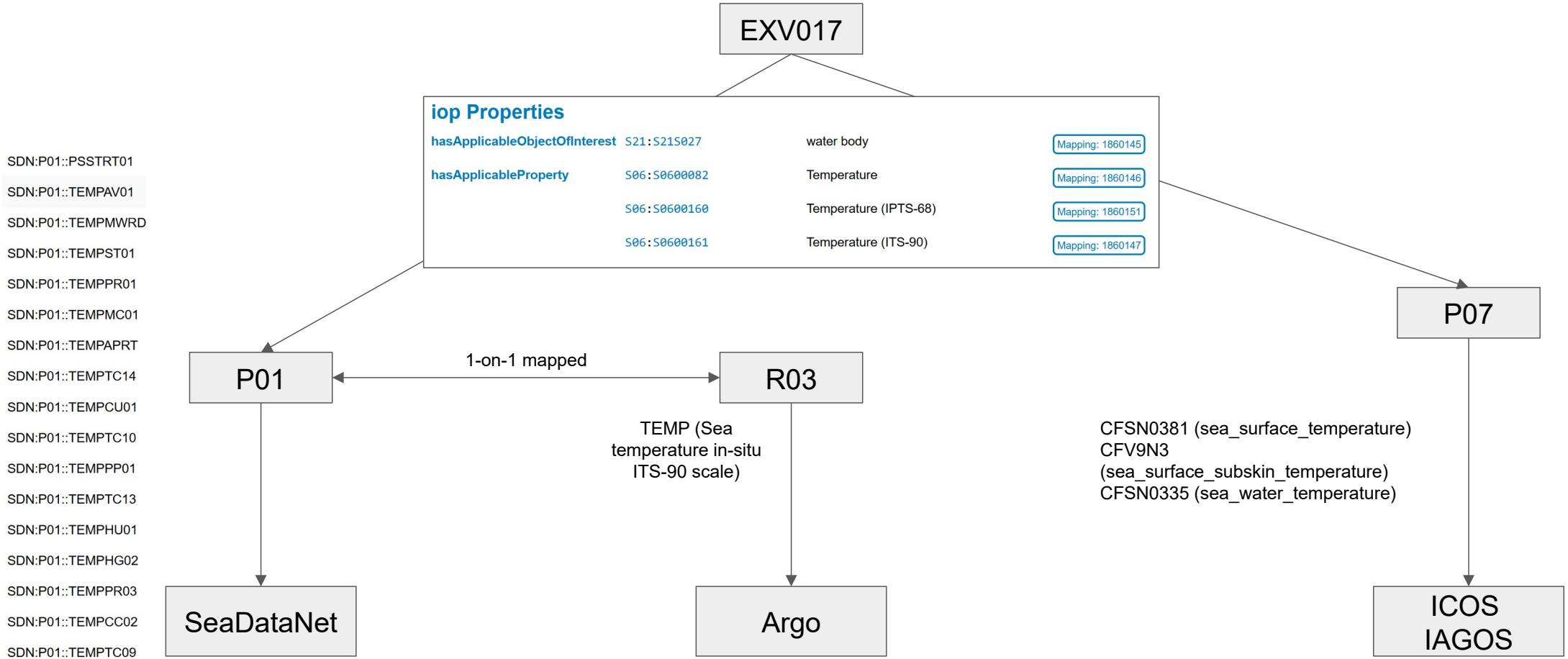
✓ 0.0s

```
## Argo & SDN
#EXV017 Sea-surface temperature (SDN / Euro-Argo)
#EXV018 Subsurface temperature (SDN / Euro-Argo)
#EXV019 Sea Surface Salinity (SDN / Euro-Argo)
#EXV020 Subsurface Salinity (SDN / Euro-Argo)
#EXV028 Oxygen (SDN / Euro-Argo)
#EXV029 Nutrients (SDN / Euro-Argo)
#EXV033 Ocean color (SDN / Euro-Argo)

## ACTRIS & SDN
#EXV011 Cloud properties (ACTRIS / SDN)
#EXV016 Aerosol properties (ACTRIS / SDN)

## ICOS & SDN
#EXV013 Carbon dioxide, methane and other greenhouse gases (ICOS / SDN)

## EPOS & SDN
#EXV023 Sea level (SDN / EPOS)

## Individual RIs
#EXV014 Ozone
#EXV015 Precursors (supporting the aerosol and ozone ECVs) (IAGOS)
#EXV022 Subsurface Currents (Euro-Argo)
#EXV030 Ocean Inorganic Carbon (SDN)
#EXV039 Soil moisture (ICOS)
```

Next step: mapping chosen ECVs to relevant parameters in use by R

Behind the scene:
Supporting and enhancing Catalogues: vocabularies - I-ADOPT

Example in practice: Sea-surface temperature (https://vocab.nerc.ac.uk/collection/EXV/current/EXV017/)



Behind the scene:
Notebook for access to ECV related data at RIs

Example in practice: Sea-surface temperature (https://vocab.nerc.ac.uk/collection/EXV/current/EXV017/)

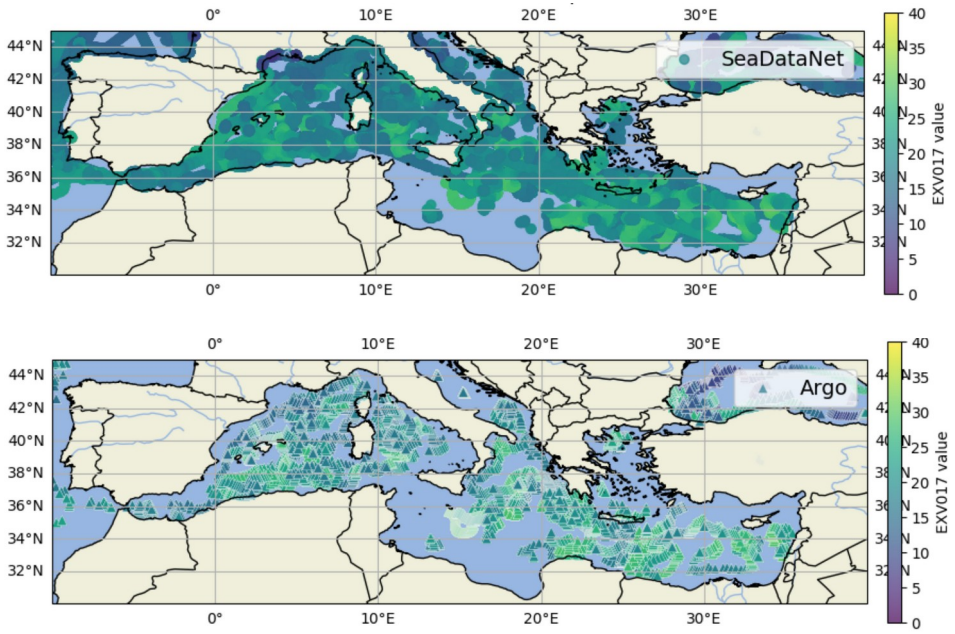
Calling RI specific data access service with:

- Set of mapped parameter;
- Spatial, temporal and height filters.

Different results from the services (no merging of output):

- Providing files based on input filters;
- Providing subsets exactly matching the query:
  - SeaDataNet via **Beacon** data lake;
  - Argo via **Argopy** library.

Sea-surface temperature gives results for SeaDataNet & Argo.



Behind the scene:
Notebook for access to ECV related data at RIs

Next step: Harmonization at data level

- Workflow for discovery and access to data established;
- However, current setup uses RI specific data access services;
  - With file-based services giving:
    - Datasets that only partly match the query;
    - Multiple files.
- Improving cross-domain access to data by setting-up data lake **(Beacon)**:
  - Proven to work in marine domain, i.e. european/national projects, Blue-Cloud 2026;
  - Giving fast access to the exact subset the user is querying;
    - Returning **one harmonized file** as output;
  - Allowing internal mapping of parameters, units.

For more information: reach out to tjerk@maris.nl

FDOs: Semantic Interoperability in the EOSC Federation

The EOSC Data Commons Approach

28 | 01 | 2025 by Lukasz Opiola (Cyfronet) / Enol Fernández (EGI Foundation)

Funded by the European Union

This project has received support from the EOSC EU Node

Project overview

Call topic: HORIZON-INFRA-2024-EOSC-01-05

Innovative and customizable services for EOSC Exchange

Budget: 7.000.000€

Start: 01/04/2025

Duration: 36 months

Consortium: 22 partners including
- National/international/thematic repositories owners
- Technology providers, and
- Research communities

Coordinator: EGI Foundation

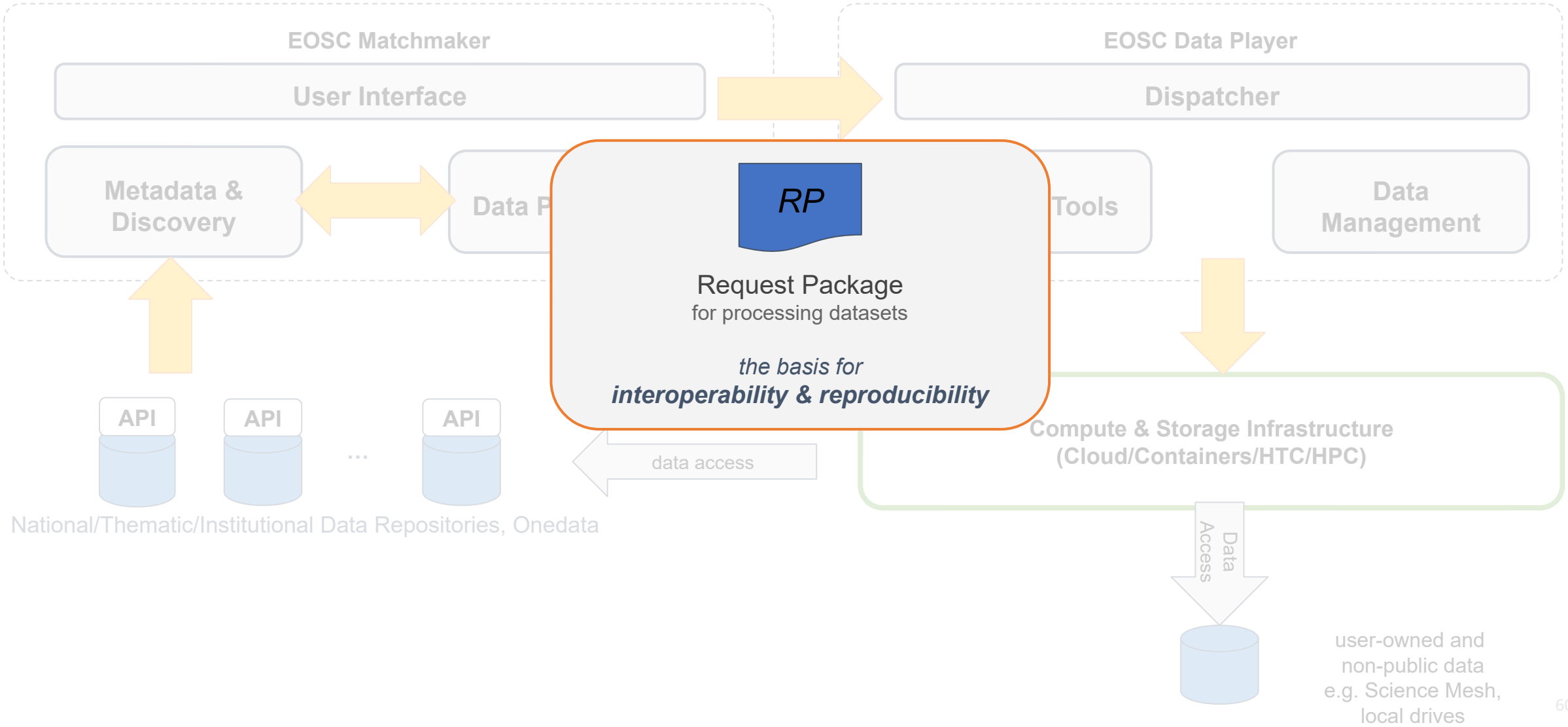
Objective

Contribute to establishing EOSC as the **European Research Commons by federating repositories** from national, institutional and thematic initiatives with a **metadata warehouse** of paired data and software for **use and reuse of datasets** across the compute continuum.

The overall goal

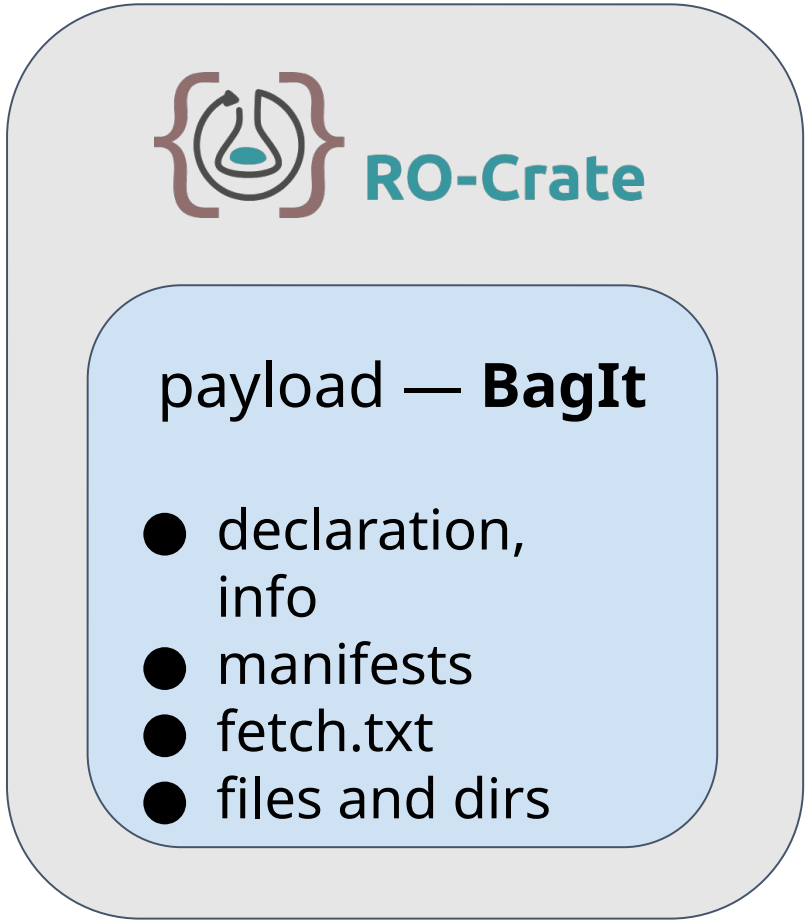
Bridge data sources & repositories with execution environments, facilitating **FAIR and reproducible** research.

High-level architecture



RP - our approach to interoperability

Request Package



Hybrid approach

as described in the RO-Crate official documentation

Outer layer: **RO-Crate**
Inner layer: **BagIt**

Combines advantages of both:

- Semantic linking (RO-Crate)
- Machine-actionable metadata (RO-Crate)
- Fixity (BagIt)
- Reliable transfers (BagIt)

RP - our approach to interoperability

Request Package — RO-Crate

```
<RO-Crate root>/
  |   ro-crate-metadata.json  # metadata file
  |   bag1/                   # "wrapped" bag
  |      bagit.txt            # required
  |      bag-info.txt         # required
  |      manifest-<alg>.txt   # required
  |      fetch.txt            # optional
  |      data/                # payload
  |         README.md
  |         nested-directory/
  |             data.dat
```

must sit in the root (outside of the bag)

BagIt bag

RP - our approach to interoperability

Request Package — RO-Crate

```
<RO-Crate root>/
  |   ro-crate-metadata.json  # metadata file
  |   bag1/                   # "wrapped" bag
  |      bagit.txt            # required
  |      bag-info.txt         # required
  |      manifest-<alg>.txt   # required
  |      fetch.txt            # optional
  |      data/                # payload
  |         README.md
  |         nested-directory/
  |             data.dat
```

} BagIt info and declaration

RP - our approach to interoperability

Request Package — RO-Crate

```
<RO-Crate root>/
  |   ro-crate-metadata.json  # metadata file
  |   bag1/                   # "wrapped" bag
  |      bagit.txt            # required
  |      bag-info.txt         # required
  |      manifest-<alg>.txt   # required
  |      fetch.txt            # optional
  |      data/                # payload
  |         README.md
  |         nested-directory/
  |             data.dat
```

} checksums of the payload for fixity

RP - our approach to interoperability

Request Package — RO-Crate

```
<RO-Crate root>/
  |   ro-crate-metadata.json  # metadata file
  |   bag1/                   # "wrapped" bag
  |      bagit.txt            # required
  |      bag-info.txt         # required
  |      manifest-<alg>.txt   # required
  |      fetch.txt            # optional
  |      data/                # payload
  |         README.md
  |         nested-directory/
  |             data.dat
```

} remote file URLs to be fetched — large datasets should not sit directly in the payload

RP - our approach to interoperability

Request Package — RO-Crate

```
<RO-Crate root>/
  |   ro-crate-metadata.json  # metadata file
  |   bag1/                   # "wrapped" bag
  |      bagit.txt            # required
  |      bag-info.txt         # required
  |      manifest-<alg>.txt   # required
  |      fetch.txt            # optional
  |      data/                # payload
  |         README.md
  |         nested-directory/
  |             data.dat
```

all packaged files & directories

RP - our approach to interoperability

Request Package — RO-Crate

```
<RO-Crate root>/
  |   ro-crate-metadata.json  # metadata file
  |   bag1/                   # "wrapped" bag
  |      bagit.txt            # required
  |      bag-info.txt         # required
  |      manifest-<alg>.txt   # required
  |      fetch.txt            # optional
  |      data/                # payload
  |         README.md
  |         nested-directory/
  |            data.dat
```

} the crucial part;
let's look inside

PoC Request Package

ro-crate-metadata.json

```
{
    "@context": [
        "https://w3id.org/ro/crate/1.1/context",
        {
            "onedata": "https://onedata.org/ro-crate-profile/1.0"
        }
    ],
    "@graph": [...]
}
```

RO-Crate profiles for extensibility

PoC Request Package

ro-crate-metadata.json

```
{
    "@context": [...],
    "@graph": [
        {
            "@id": "ro-crate-metadata.json",
            "@type": "CreativeWork",
            "conformsTo": {"@id": "https://w3id.org/ro/crate/1.1"},
            "about": {"@id": "./"}
        },
        {
            "@id": "./",
            "@type": "Dataset",
            "datePublished": "2025-05-06T14:35:47+00:00",
            "mainEntity" : { "@id": "#workflow" },
            "runsOn" : { "@id": "#destination" },
            "hasPart": [
                { "@id": "#workflow" },
                { "@id": "#destination" },
                { "@id": "bag1/data/stopwords-from-bag.txt" },
                { "@id": "#image-from-onedata.tiff" },
                ...
            ]
        },
        ...
}
```

RO-Crate Root

content declaration

PoC Request Package

ro-crate-metadata.json

```
{
    "@context": [...],
    "@graph": [
        {...},
        {
            "@id": "#workflow",
            "@type": ["File", "SoftwareSourceCode", "ComputationalWorkflow"],
            "name": "OCR for a journal from DaSCH - PoC workflow",
            "programmingLanguage": {
                "@id": "https://w3id.org/workflowhub/workflow-ro-crate#galaxy"
            },
            "url": "https://dockstore.org/api/ga4gh/.../galaxy-workflow-ocr-test-DaSCH.ga",
            "description": "A workflow processing material from DaSCH in Galaxy...",
            "license": { "@id": "https://creativecommons.org/licenses/by/4.0/legalcode" },
            "author": [
                { "@id": "#author-schneider" },
                { "@id": "#author-nussbaum" }
            ]
        },
        {...}
}
```

Tool specification (Galaxy workflow)

PoC Request Package

ro-crate-metadata.json

```
{
    "@context": [...],
    "@graph": [
        {...},
        {...},
        {
            "@id": "https://w3id.org/workflowhub/workflow-ro-crate#galaxy",
            "@type": "ComputerLanguage",
            "identifier": {"@id": "https://galaxyproject.org/"},
            "name": "Galaxy",
            "url": {"@id": "https://galaxyproject.org/"}
        },
        {
            "@id": "#destination",
            "@type" : "Service",
            "url": "https://usegalaxy.eu/"
        },
        {...}
}
```

Programming language specification (Galaxy project)

Service specification (Galaxy EU)

PoC Request Package

ro-crate-metadata.json

```
{
    "@context": [...],
    "@graph": [
        {...},
        {...},
        {...},
        {
            "@id": "bag1/data/stopwords-from-bag.txt",
            "@type": "File",
            "name": "simpletext_input",
            "encodingFormat": "text/txt"
        },
        {
            "@id": "#image-from-onedata.tiff",
            "@type": "File",
            "name": "Input Image",
            "encodingFormat": "image/tiff",
            "onedata:onezoneDomain": "datahub.egi.eu",
            "onedata:spaceId": "6e6b22d6f32b63db34fcfac53e52e233chd8ba",
            "onedata:fileId": "3130393062356433623965356632623531386368364233 6...",
            "onedata:publicAccess": true
        },
        {...}
}
```

References to directly included files

References to remote files using specific protocols

(Onedata profile)

Towards EOSC Interoperability

PoC release (Nov 2025) - working PoC of RP available

EOSC Data Commons First release (June 2026) - Evolve the RP using of RO-Crate profiles to:

- extend support for repositories and data sources
- extend support for execution environments
- generalize or create profiles for:
  - tools
  - parameters
  - services / platforms / on-demand VREs
- track provenance incrementally with every analysis

EOSC Data Commons Interoperability guidelines (Dec 2027) - RP adopted as part of the EOSC

IF

- **FDO** based on **RO-Crate** that can be **shared, published**, or used for **reproducing analyses**
- become a standard for defining data processing jobs in EOSC
- every repository or exec. environment that implements it **becomes interoperable** with the existing ones — **snowball effect**

EOSC Data Commons Second release (Feb 2028) - Complete implementation of the RP for all repositories/execution environments of the project

eosc | DATA COMMONS

Get in touch with us

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Funded by
the European Union

EOSC Beyond

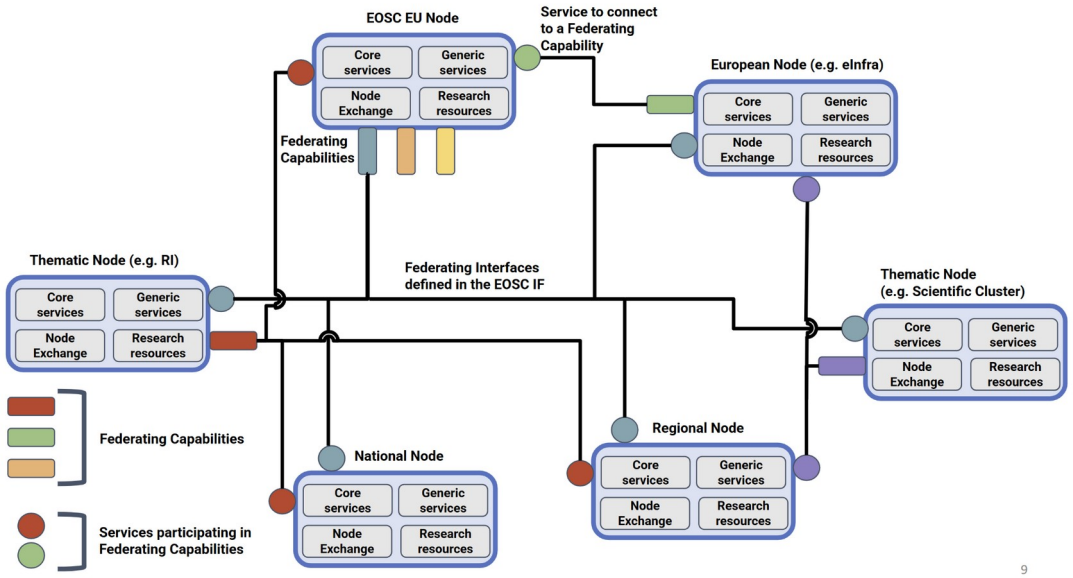
Metadata Heterogeneity and Interoperability: Impact on Data Discovery

28 | 01 | 2026 by Nicola Fiore (EGI Foundation)

Funded by the European Union

This project has received support from the EOSC EU Node.

Metadata Heterogeneity



EOSC Federation Architecture

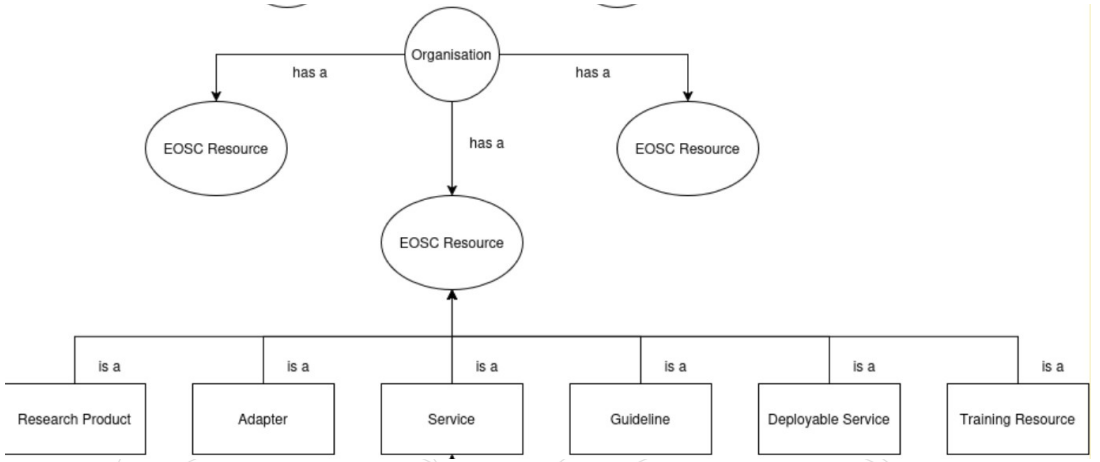
- **Structural heterogeneity** (different schemas)
- **Semantic heterogeneity** (same concept, different meanings)
- **Syntactic heterogeneity** (different formats)

When metadata is not interoperable, data discovery becomes fragmented and unreliable.

Managing Metadata Heterogeneity

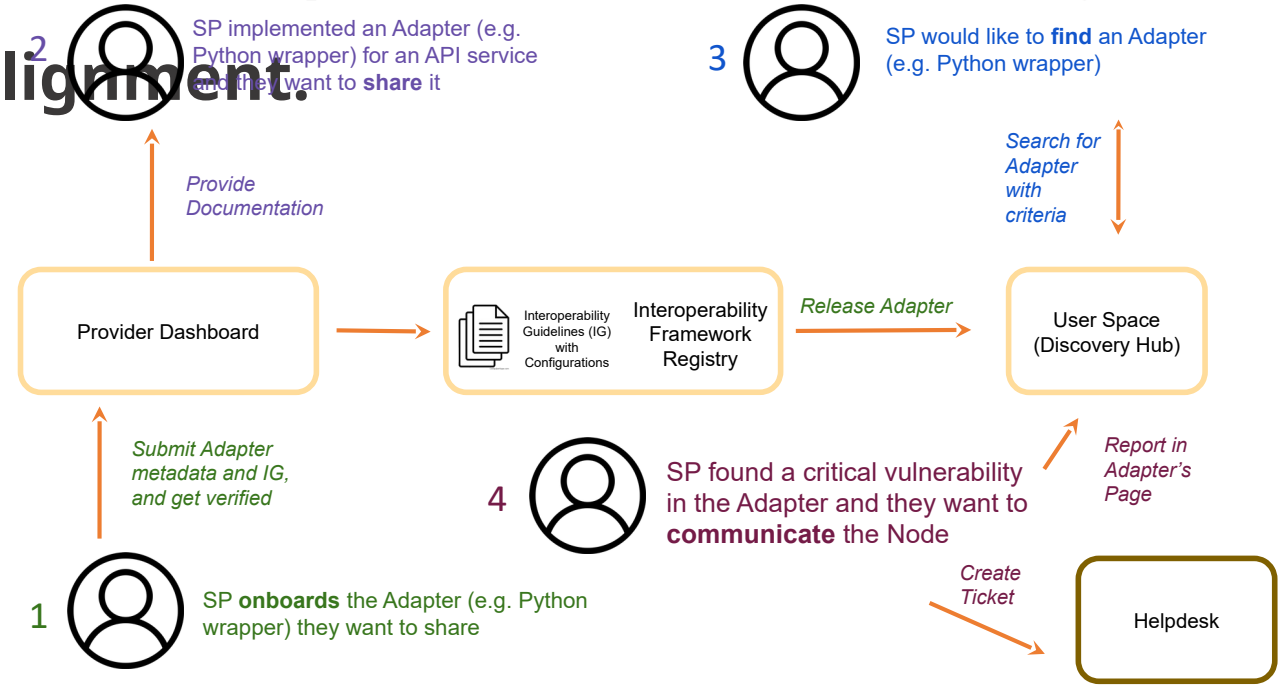
Not a SINGLE STANDARD but a SEMANTIC FRAMEWORK

- **Top-level ontology** for semantic alignment
- **Shared vocabulary management** (VocBench)
- **Ontology publication and reuse**
- **Integration Suite with adapters**



EOSC Integration Suite (EOSC IS)

A framework that turns heterogeneous metadata and services into interoperable resources through Adapters and semantic alignment.



THE ADAPTERS

- the EOSC IS had been populated with **10 Core and 15 Horizontal adapters**
- **8 Pilot Nodes** had integrated at least one adapter into their workflows

www.eosc-beyond.eu/service/eosc-integration-suite

Thank you!

Get in touch with us

Website www.eosc-beyond.eu
LinkedIn /company/eosc-beyond/
Bluesky /eosc-beyond.bsky.social
YouTube /@EOSCBeyond
Email eosc-beyond-po@mailman.egi.eu

Funded by the European Union

eosc | GRAVITY

Thematic Track 1

Harmonizing and integrating (meta)data from various sources

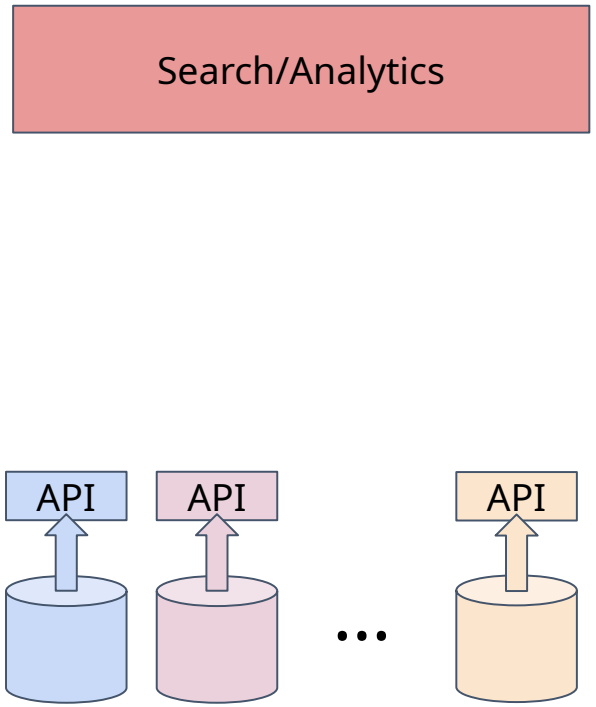
Daniel Garijo, Paolo Manghi

2026 EOSC Winter School, Nice, 27-29 Jan 2026

Funded by the European Union

Grant agreement ID: 101188045

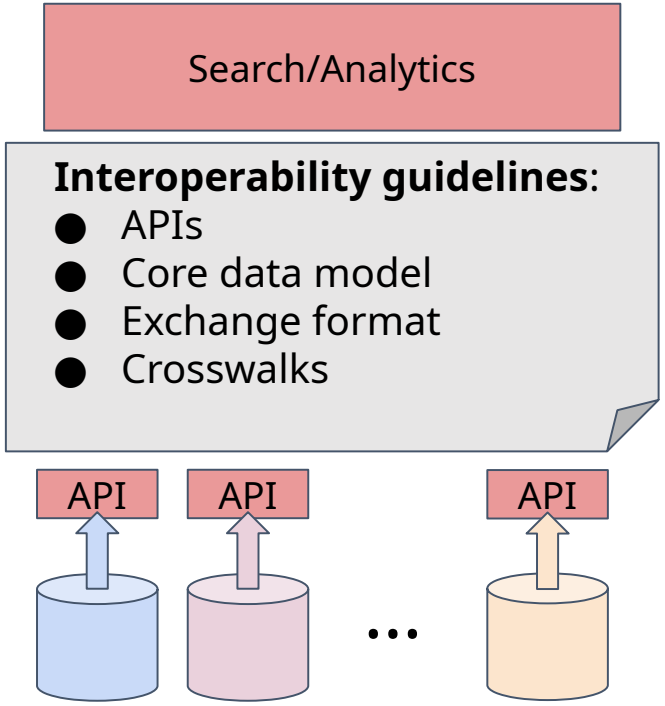
Metadata aggregation



- Heterogeneous data sources (APIs, exchange format, data model)
- Crosswalking into a common data model

Funded by the European Union
Grant agreement ID: 101188045

Metadata aggregation: Interoperability Guidelines



- Heterogeneous data sources (APIs, exchange format, data model)
- Crosswalking into a common data model

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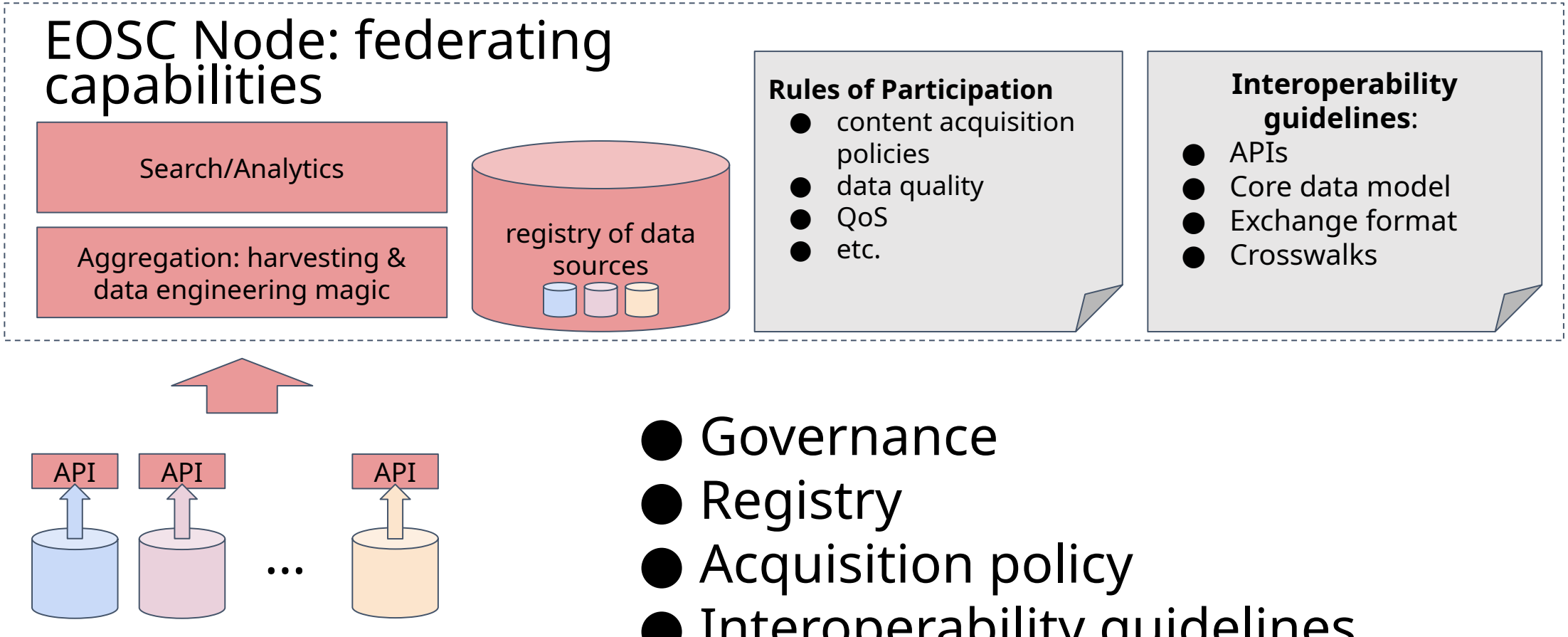
Grant agreement ID: 101188045

Metadata aggregation: Federating capabilities



- Governance
- Registry
- Acquisition policy
- Interoperability guidelines

Funded by the European Union
Grant agreement ID: 101188045

EOSC EU Node federating capabilities for the EOSC Resource Catalogue

EOSC EU Node

EOSC Resource Hub

EOSC Resource Catalogue: harvesting & data engineering magic

Data Source Catalogue

Rules of Participation for Research Product Catalogues and Service Catalogues

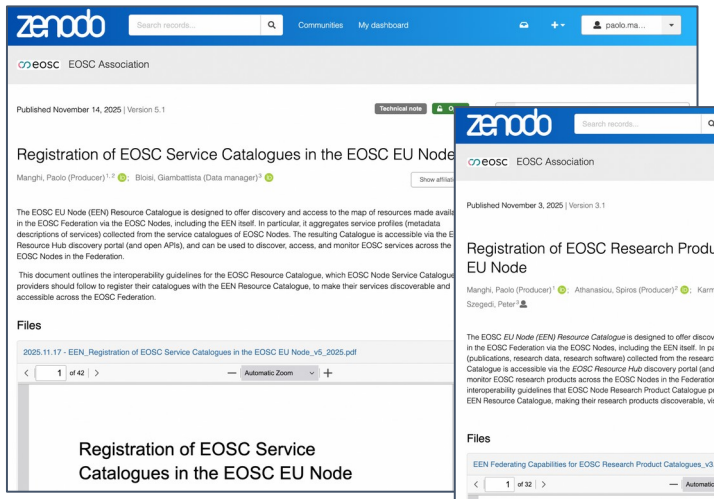
Interoperability guidelines for Research Product Catalogues and Service Catalogues

EOSC Node

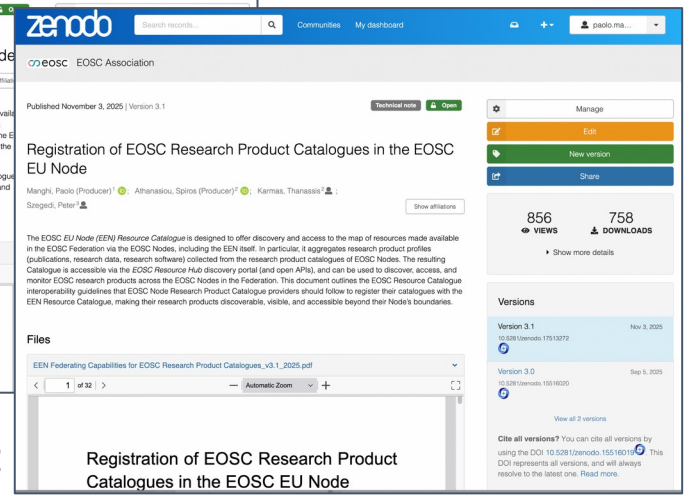
service catalogue

EOSC Node

research product catalogue



https://zenodo.org/records/17641396



https://zenodo.org/records/17513272

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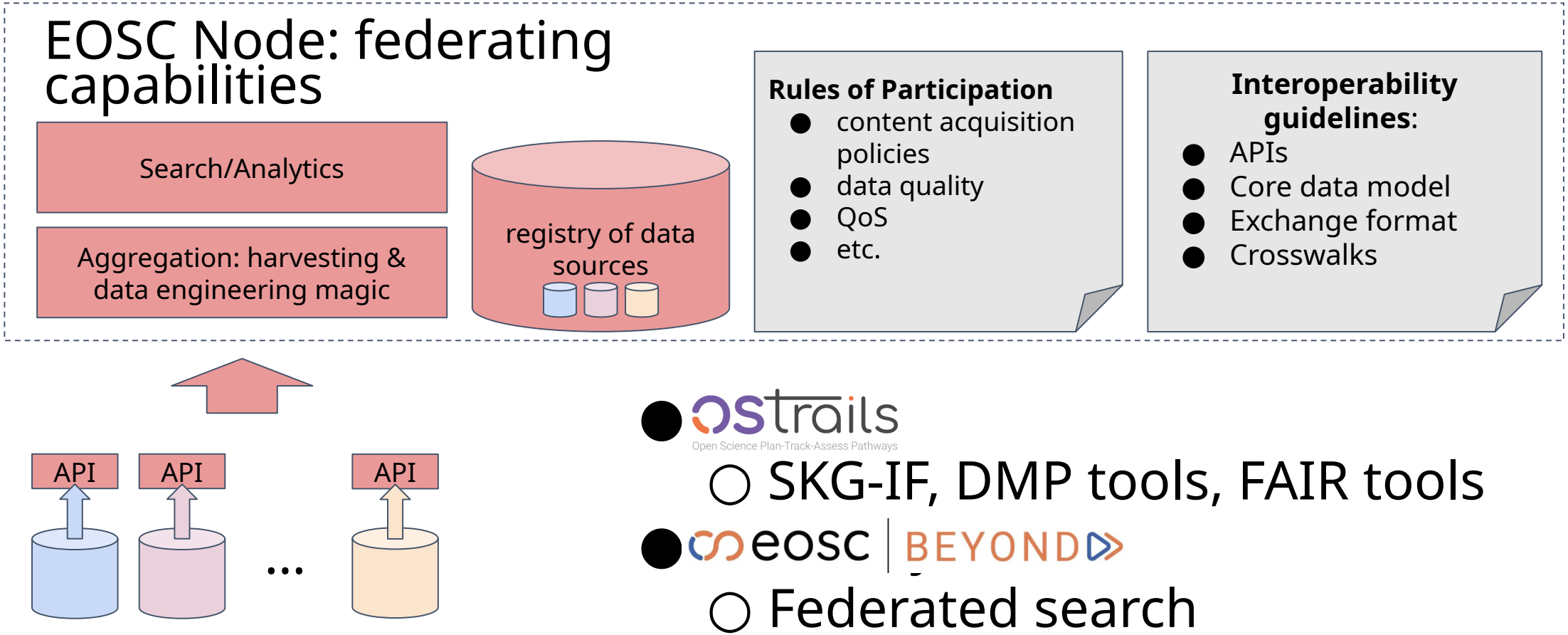
Grant agreement ID: 101188045

Metadata aggregation: Interoperability Guidelines

Some examples



- OSTrails (Open Science Plan-Track-Assess Pathways)
  - SKG-IF, DMP tools, FAIR tools
- EOSC BEYOND
  - Federated search
- Software Heritage
  - CodeMeta guidelines for

Funded by the European Union
Grant agreement ID: 101188045

eosc | GRAVITY

Federating Capabilities and Interoperability

Esteban González on behalf of the EOSC Technical Interoperability TF

2026 EOSC Winter School, Nice, 27-29 Jan 2026

Funded by the European Union

Grant agreement ID: 101188045

Use cases

- 82 use cases & 70 user stories collected

- Input from:
  - Life Sciences
  - Photon & Neutron facilities
  - Astronomy & Astrophysics (incl. SKA)
- Technical needs identified:
  - **Metadata Management**: The need for standardized metadata practices to improve data interoperability and ensure that datasets are well documented is a recurring theme.
  - **Data Sharing Practices**: Users are concerned with sharing their datasets in compliance with FAIR principles, ensuring that their data is findable, accessible, interoperable, and reusable.
  - **Service Integration:** Many use cases revolve around the integration of services across the EOSC Federation, emphasizing the importance of federated access to resources and tools.

Funded by the European Union
Grant agreement ID: 101188045

Gaps

Metadata and Data Discovery	Inconsistent metadata and limited multilingual support limit effective data discovery and access.
Data Harmonization and Integration	Data integration is limited by incompatible formats, ontologies, and vocabularies.
Service Discovery and Interoperability	Service discovery and integration are limited by fragmented catalogues and inconsistent APIs.
Authentication and Authorization (AAI)	Access to resources is limited by fragmented authentication and authorization mechanisms.
Data Management and Preservation	Inconsistent data management practices affect preservation, versioning, and PID usage.
Resource Management and Allocation	Inefficient mechanisms hinder fair allocation of compute, storage, and network resources.
Support and Training	Insufficient training and user support limit effective use of EOSC services.
Governance and Policy	Unclear governance and policies complicate data sharing, access control, and compliance.

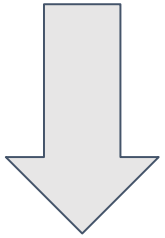
Funded by the European Union
Grant agreement ID: 101188045

New federating capabilities: Recommendations

Data and Metadata Interoperability through Radical Transparency	Define minimal, shared rules to describe digital assets and declare their technical interoperability.
Federated Resource Discovery	Enable discovery across EOSC Nodes through federated catalogues, a common data model, and an EOSC Registry.
Federated Access and Reuse of Services	Standardise access policies and enable machine-composable, reusable services across the federation.
Federated Compute and Storage for Data Analysis	Provide scalable, secure compute and storage that bring computation close to the data across Nodes.
File/Data Sync & Share Services	Support cross node data sharing through federated file sync and share services.
Large-Scale Data Transfers	Enable scalable, automated, and federated transfer of large datasets using PIDs and catalogue integration.
AI tools to support interoperability	Evaluate emerging AI tools to improve interoperability in EOSC and use metadata schemes such as CroissantML and FAIR4ML

Funded by the European Union
Grant agreement ID: 101188045

If you want to know more



Scardaci, D. O., Dimper, R., Wilk, R., Gonzalez Guardia, E., Portier, M., & Van de Sanden, M. (2025). Technical interoperability in the EOSC Federation and initial gap analysis. Zenodo. https://doi.org/10.5281/zenodo.17507570

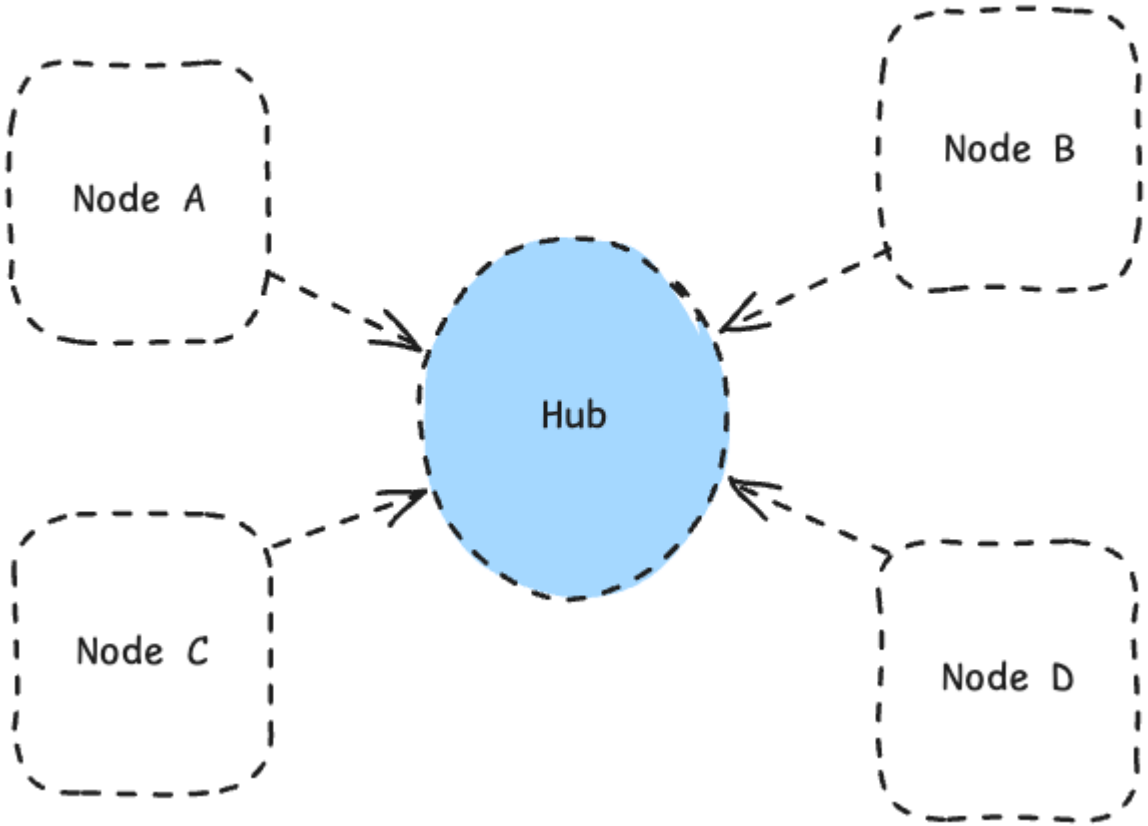
Funded by the European Union
Grant agreement ID: 101188045

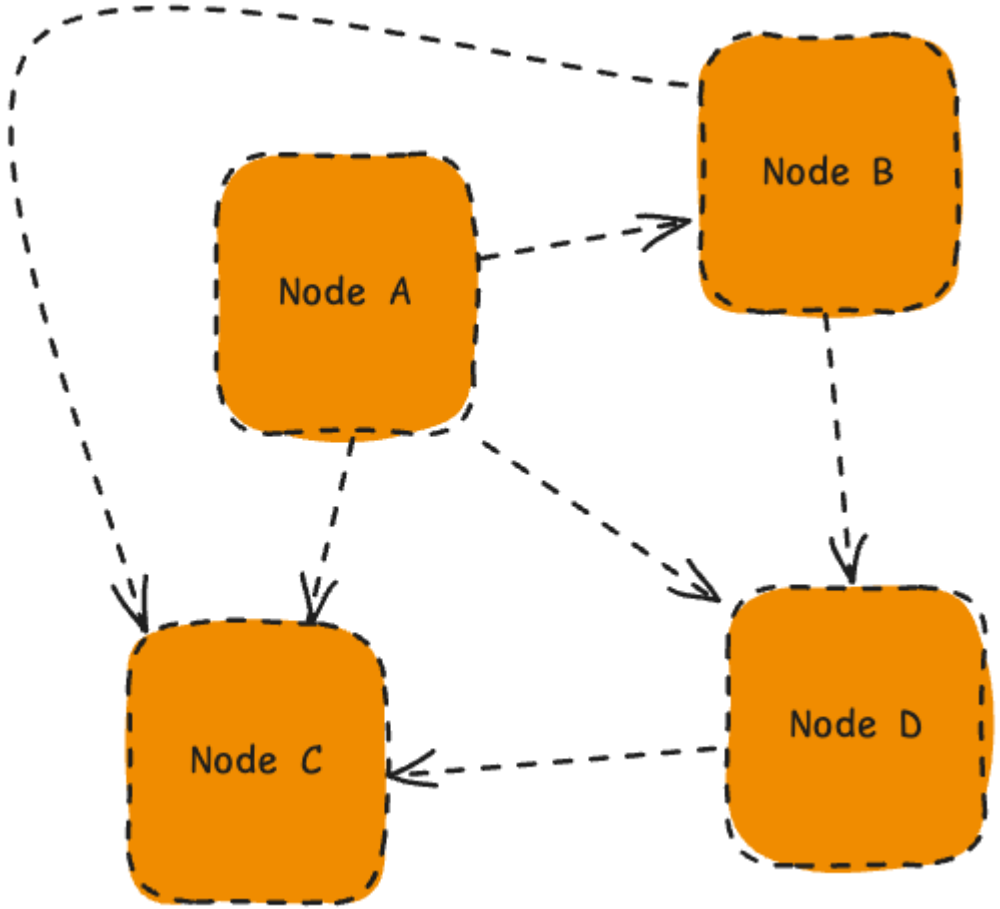
Challenges to service discovery and interoperability

Kostas Koumantaros, GRNET

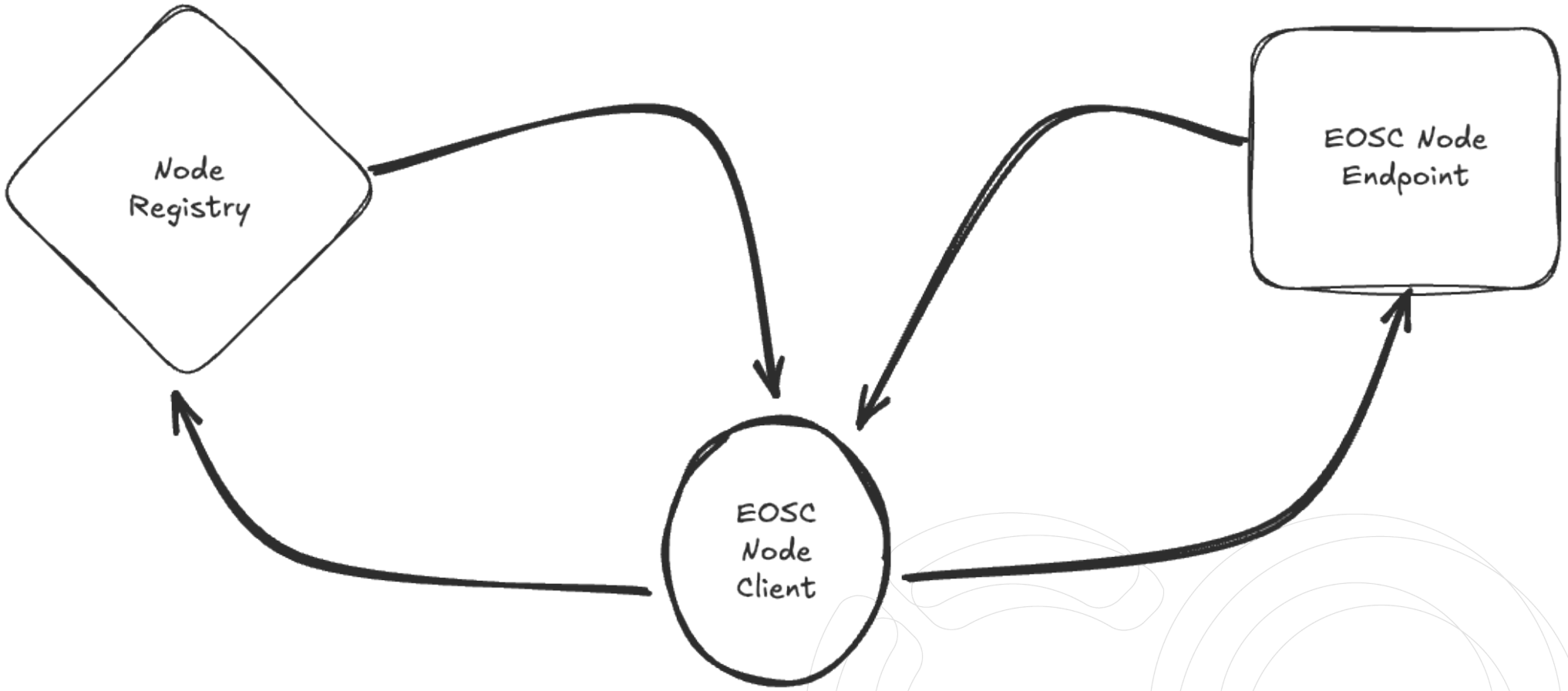
Funded by the European Union

The EOSC Core Architectural Shift

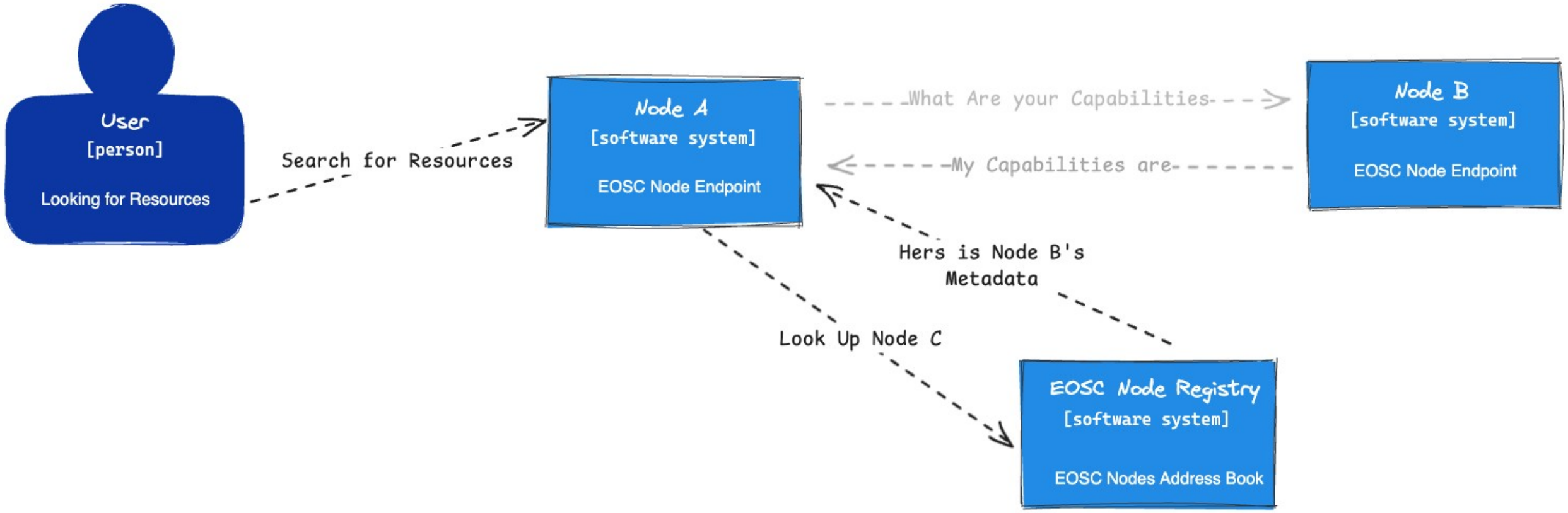




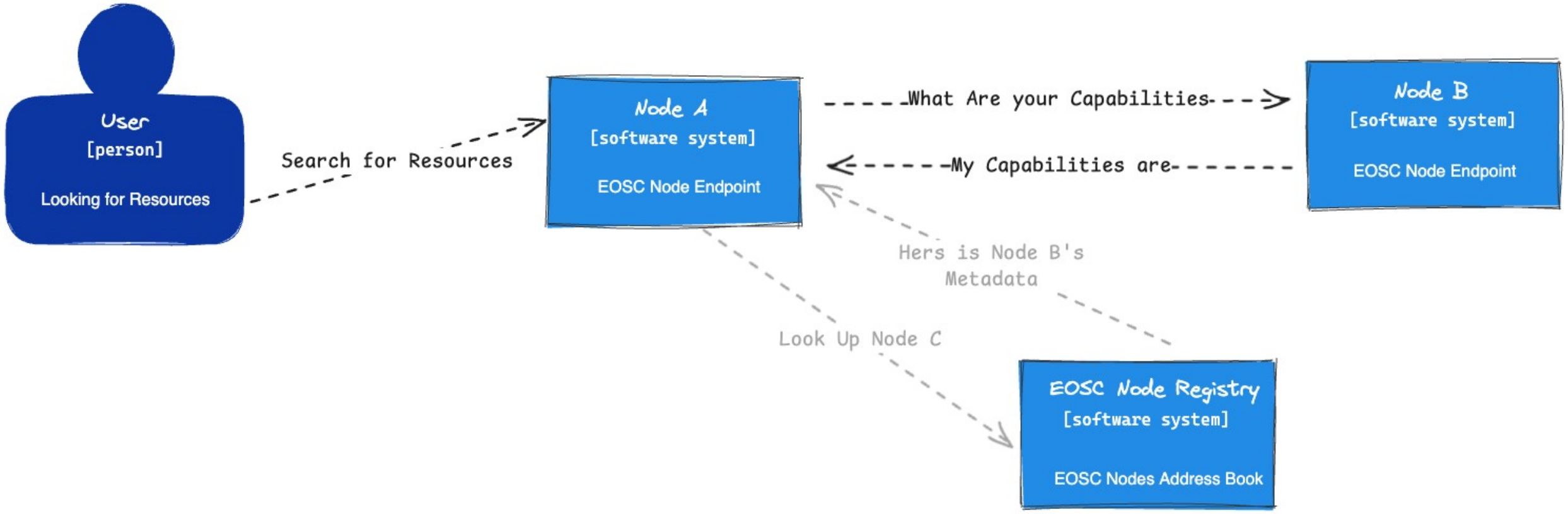
EOSC Node Registry Components



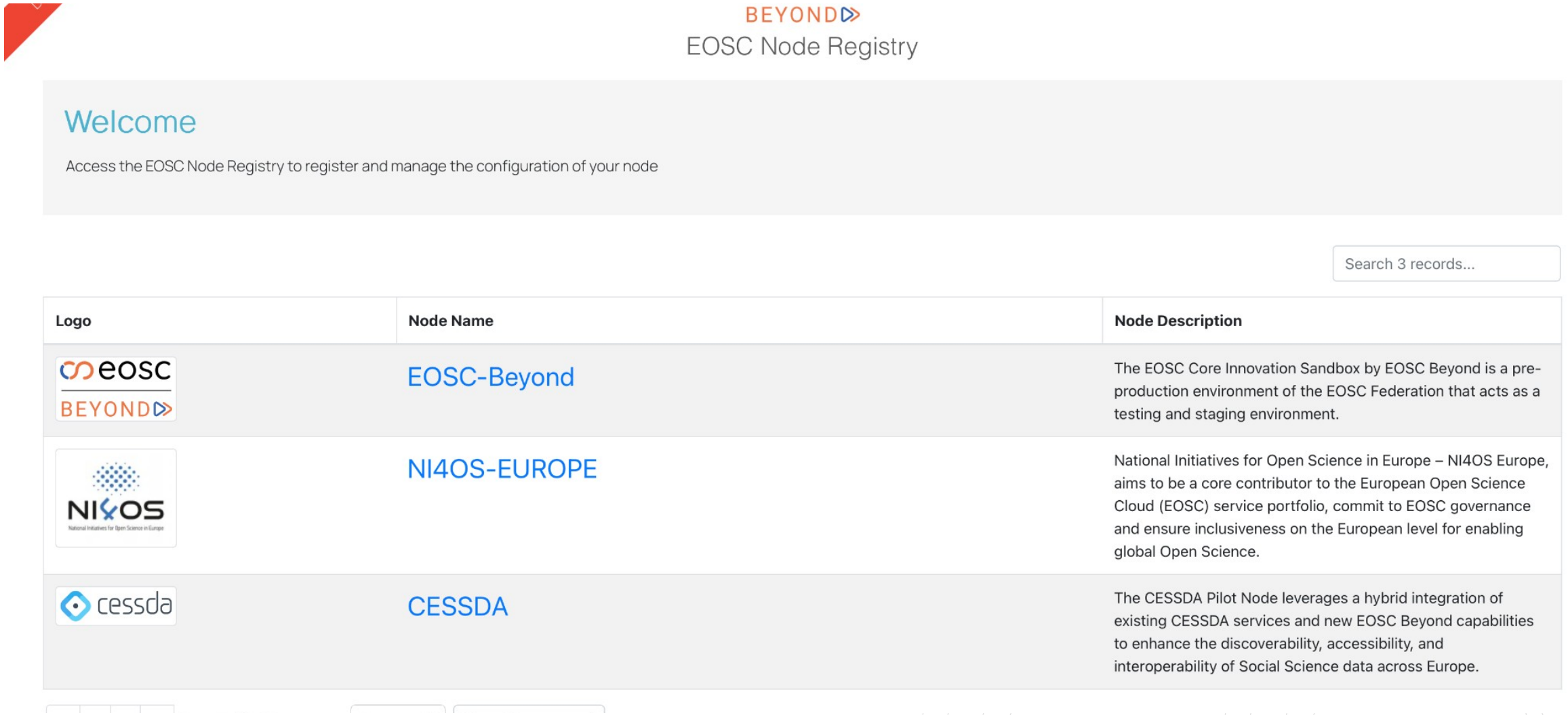
The EOSC Core Architectural Shift



The EOSC Core Architectural Shift



Node Registry Front Page



EOSC Node Registry

MAIN
Manage Nodes

PERSONAL
User Information

NODE CATALOG
All Nodes

Home / Manage Nodes / View Node

Tags

Tags can be used to filter node search results

No active tags for this node

Node name * NI4OS-EUROPE
Human-readable name that identifies the Node.

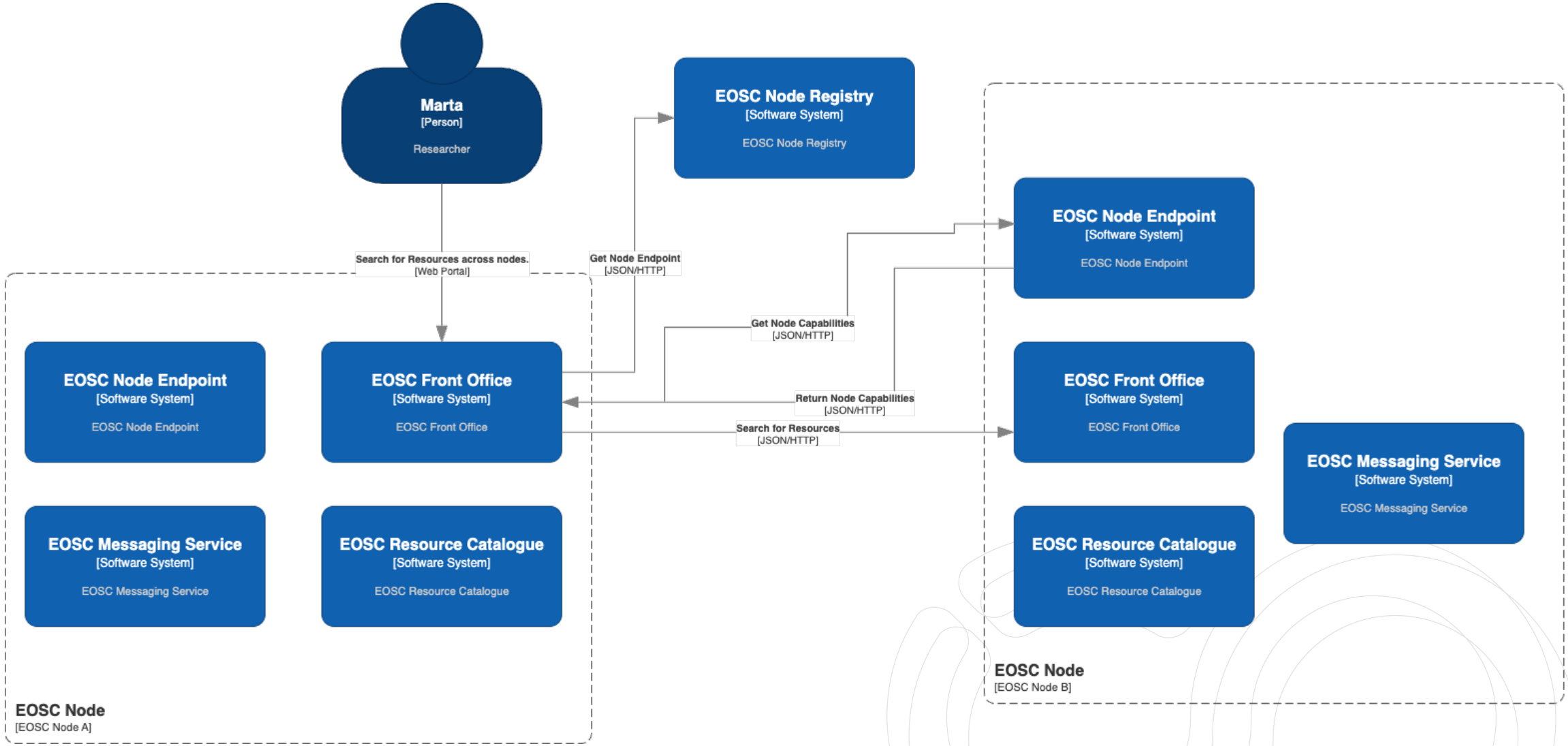
Node Endpoint * https://endpoint.mrezhi.net/api/endpoint
Returns the capabilities of the Node

Persistent Identifier (PID) * 21.T15999/NI4OS-EUROPE
Automatically generated unique identifier ensuring permanent reference to this entity.

Logo https://ni4os.eu/wp-content/uploads/2019/10/NI4OS_logo_title-e1570180082953.jpg
URL that points to a logo image.

Node Website URL https://ni4os.eu/

Federated Search Use Case (Marta's Journey) -Behind the scene



Thank you!

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Email eosc-beyond-po@mailman.egi.eu

Funded by
the European Union

EOSC-specific incident handling/mitigation

EOSC Winter School, January 28th, 2026

Urpo Kaila <urpo.kaila@csc.fi> , Head of Cyber Security Policies

- Cybersecurity is a well defined requirement and objective for all EOSC activities
- Elevated risk levels and evolving cyber regulation (NIS2, CRA) require robust and transparent security
- EOSC is establishing a cybersecurity policy
  - In preparation by EOSC Cybersecurity Group
  - First priority: EOSC CSIRT service and in incident handling procedures
- Service management includes incident coordination between nodes
- Compliance with data protection requirements requires also a technical and organisational (security) procedures

Cybersecurity at EOSC nodes/ EOSC Handbook

- Appoint a Cybersecurity Officer as contact person for all cybersecurity issues
- Report non-compliance with security policy or regulations to **security@eosc.eu**
- Provide a security incident response capability to handle incidents promptly
- Incidents affecting all or major parts of EOSC to be reported to **csirt@eosc.eu**
- Implement a comprehensive security framework

References

- A Security Incident Response Trust Framework for Federated Identity (SIRTFI 2.0)
- EOSC Security Operational Baseline
- FitSM standard on security roles and processes
- ISO/IEC 27001 standard
- IT Security Risk Management Methodology

Incident handling checklist

When incident occurs on your Node

- ❑ Stay calm, act professionally and responsibly
- ❑ Keep relevant stakeholders informed, don’t spread unverified information
- ❑ Your Information Security Officer is in charge of handling the incident
- ❑ Identify and assess the incident, secure evidence with forensic procedures
- ❑ Contain and limit damages
- ❑ Promptly escalate and notify ongoing your relevant stakeholders
- ❑ Start recovery
- ❑ Keep records of handling the incident, improve security based on lessons learned