Adoption of FAIR Implementation Profiles in Projects, User Communities and EOSC Services

Barbara Magagna & Wolmar Nyberg Åkerström

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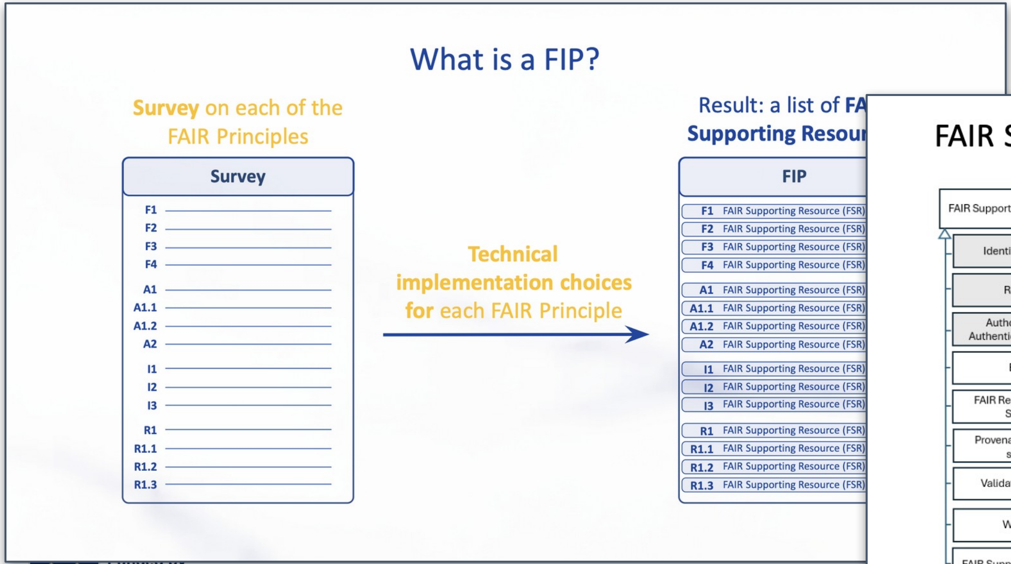
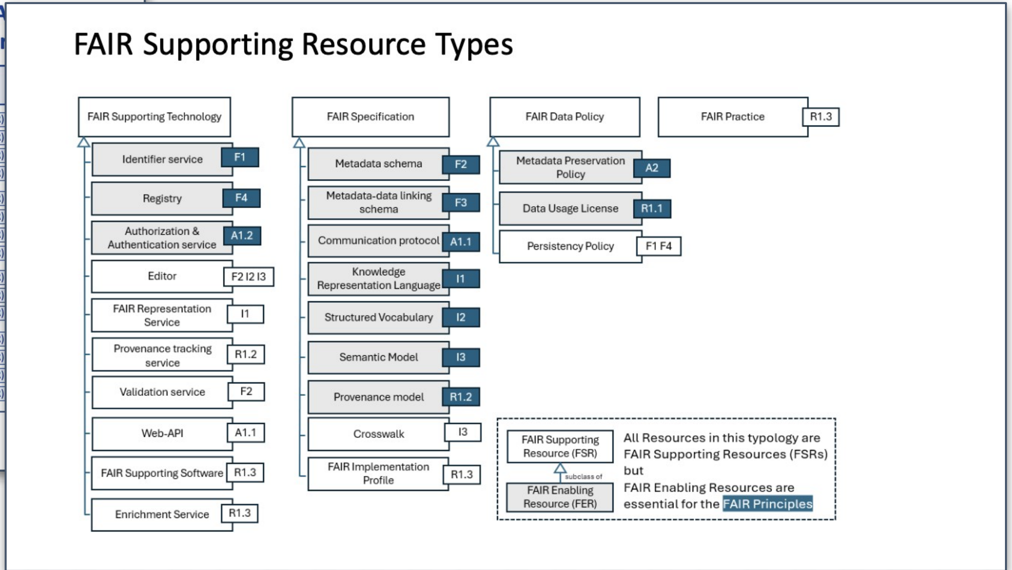
Adopting interoperability solutions in the EOSC Federation

Shared characteristics & evaluation criteria

Context: **The FIP is a collection of FAIR implementation choices made by a community of practice for each of the FAIR Principles. Referencing FAIR Supporting Resources.**





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- ❑ Maturity level: existing or in development, sustainable?
- ❑ Practical applicability: abstract or machine-actionable
- ❑ Usability: ease of adoption, accessibility
- ❑ Generality: cross-domain applicable, open, non-proprietary formats
- ❑ Formalisation: for training material and governance (FAIR practice) is the degree at which the resource exists as a documented, referenceable object
- ❑ Traceability: Is the resource adopted by a community really used?

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Defining a shared set of evaluation criteria

- Can be referenced when declaring and sharing FAIR implementation choices
- Addresses a specific gap in FAIR implementation
- Appropriate granularity to support relevant federating use cases
- Adopted by others

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Round Table: Resource categorization in the EOSC Federation and resource profiles - state of the Art in the Federation

Co-Chair: Roksana Wilk

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Adopting interoperability solutions in the EOSC Federation

Context and goals

In the past couple of years, EOSC projects and communities has developed certain concepts currently implemented in EOSC EU Node:

- **EOSC resource model** - understood as a categorisation and relations of (useful) *things* (we agreed, i think, to call them **resources**) EOSC wants to deliver to its end-users
- **EOSC resource profiles** - how we annotate these (useful) *things* (the eosc **resources**) so the technical infrastructure (platform) exposing EOSC Federation function(s) can work properly (where the main function is the federated and professional delivery of *things* needed/helpful for the science-making process)
- **EOSC service categorisation** - the way to categorise the services (one of the resource types) delivered to end-users that supports the interoperability and composability of resources in EOSC platform(s)

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HOWEVER!!!! , in EOSC Federation those have not been yet established as an official standard.

GOALS:

1. The analysis whether the EOSC community would like to acknowledge those output as the official standards in EOSC Federation
2. Are there any adjustments/enhancements needed to serve the current and future goals of the EOSC Federation and the nodes themselves
3. Propositions of the enhancements
4. Input from the eosc nodes/communities what models and categorisations they currently use

https://docs.google.com/document/d/1weULUrJTmVlAAabmjzzmnQmfBYmTgx9o9HVM7x9KaE4/edit?tab=t.0

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Adopting interoperability solutions in the EOSC Federation

Outputs and initial conclusions

- collection of resource models and service categorisations use and/or proposed by EOSC stakeholders
- general agreement that the existing models and categorisations are a good starting point for the EOSC Federation (to be acknowledged as the official standard for the time being)
- propositions of enhancements to the current models
- a need to collect this kind of input from all of the nodes

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Round Table: Metadata quality harmonisation and Integration

Round Table Topic: Metadata quality harmonisation and Integration
Round Table Co-Chairs: Paolo, Alexandra

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(Meta)Data Quality

- **Standardised Quality Flags (Marine Science)**
  - **Evaluation Criteria:** Assessments are based on standardised schemas (e.g., SeaDataNet L20 or Argo RD2/RR2) where flags range from 0 (no QC performed) to 1 (good data).
  - **Success Factors:** This enables researchers to perform highly specific queries, such as filtering only for "quality controlled good data" based on a standard assessment method.
- **Broad Processing/Calibration Categories (Astronomy and Space Science)**
  - **Evaluation Criteria:** Data is typically self-declared as either **'science-ready'** (processed by standard pipelines) or **'raw'** (unprocessed).
  - **Success Factors:** Large Research Infrastructures (RIs) use internal standards; best practice involves providing detailed metadata (e.g., exposure time) that allows users to independently assess quality for their specific purpose.
- **Journal Publication and Peer Review (Astronomy, Planetary, and Space Science)**
  - **Evaluation Criteria:** Quality is verified through the selection of data from **refereed publications or formal peer reviews of the archive structure,** content, and documentation.
  - **Success Factors:** This relies on guidelines for authors and the availability of funding specifically for archive preparation.
- **Validation and AI Enrichment Services (Scholarly Communication)**
  - **Evaluation Criteria:** Use of guidelines for incoming data and a **validation mechanism that assigns confidence scores t**o AI-assisted enrichments.
  - **Success Factors:** Success is marked by records that fully describe research works, increased entity relations, and institutional adoption.
- **CDIF Quality Profiles (Climate Adaptation)**
  - **Evaluation Criteria:** Testing and developing a set of initial criteria that can be adapted to specific project needs while remaining generic enough for broad use.
  - **Success Factors:** The creation of implementable criteria that assist data providers and users in the data selection process.
- **Certification and Standard Identifiers (Health and Life Sciences)**
  - **Evaluation Criteria:** Use of **ISO certifications**, metadata vocabularies for sample quality (e.g., BBMRI-ERIC), and the application of standard concept identifiers like **CURIEs** or **URIs** (e.g., MONDO ontologies).
  - **Success Factors:** Guidelines for reporting in common models (like OMOP CDM) and providing easy ways to map data to standard ontologies.
- **Schema-based and Semantic Validation (Life Sciences, Mass Spectrometry, and Astronomy)**
  - **Evaluation Criteria:** Automated compliance checks against **XML/GML schemas** and semantic validation against minimal information standards. This includes "weather reports" of service compliance and Pass/Fail assessment reports.
  - **Success Factors:** Best practices include asking for missing metadata at the time of upload, combining metadata with data to allow for **recalculated statistics**, and using compliance levels as a filter for high-quality reference data.

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(Meta)Data Harmonisation

- **Controlled Vocabularies and Officially Endorsed Mappings (Climate and Cross-Domain)**
  - **Evaluation Criteria: User validation** (does the solution solve the research problem?) and the **adoption rate** within the community.
  - **Success Factors:** Relying on standards and guidelines that have been officially endorsed by a trusted body.
- **Cross-Domain Mappings (AquaINFRA)**
  - **Evaluation Criteria:** The ability to make diverse data types (e.g., socioeconomic and freshwater catchment) comparable despite different grids, bounding boxes, or units.
  - **Success Factors:** Enabling researchers to answer complex correlation questions, such as how population density shifts in relation to river pollution in a specific area.
- **Common Metadata Schemas and Formats (Material Science)**
  - **Evaluation Criteria:** The number of datasets published using a standard format (e.g., **NeXus**) and the number of different schemas improved or shared among partners.
  - **Success Factors:** Data collectors producing standard formats for central validation.
- **Reference Metadata Schemas and Vocabulary Alignment**
  - **Evaluation Criteria:** The quality of linkages between different ontologies.
  - **Success Factors:** Achieving a high level of documentation and clear linkages within general reference schemas (e.g., FIRI).

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(Meta)Data Integration

- **Virtual Collection Registry (CLARIN)**
  - **Evaluation Criteria:** The **genericity of the service** and its ability to be adopted by other nodes or communities.
  - **Success Factors:** Creating virtual datasets based on **persistent identifiers (PIDs)** so they can be handled with the same rigor as standard datasets.
- **Uniform Data Access Layers and Demand Registries (FAIR-EASE)**
  - **Evaluation Criteria:** The support for independent implementations that provide services or cached copies.
  - **Success Factors:** Using tools like UDAL to revolutionise data fairness and accessibility.
- **National Metadata Directories and Catalogues (Multidisciplinary and National)**
  - **Evaluation Criteria:** Efficiency in assisting with **initial discovery** in a single location.
  - **Success Factors:** Using **AI to enrich metadata** (e.g., affiliations) and keeping the solution simple enough that it does not attempt to replace authoritative community-level repositories.
- **Central Resource Catalogues (Biobanking)**
  - **Evaluation Criteria:** Ongoing evaluation of whether to introduce **quality labels** into the integration process.
  - **Success Factors:** Rigorous **onboarding procedures** and (ideally) repeated training for those providing data to the catalogue.

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Summary of Evaluation Criteria and Success Factors

Synthesised Evaluation Criteria

Across all three domains, evaluation is driven by three primary dimensions:

- **Standardisation and Formal Compliance:** The most immediate measure of success is the adherence to **standardised schemas and protocols**. This includes quality flags in marine science, **XML/GML schema validation**, and the use of **ISO standards** for spatial data. In harmonisation, this extends to the number of datasets published using common formats like **NeXus**.
- **Scientific Rigour and Provenance:** Quality is often evaluated through the "status" of the data, such as whether it is **"science-ready"** versus raw, or if it has been extracted from **refereed publications** and passed formal **peer review**. This ensures that data is not just technically valid but scientifically trustworthy.
- **Utility and Discovery Efficiency:** For integration and harmonisation, the ultimate metric is **user validation**—specifically, whether the system allows a researcher to solve a cross-domain problem. Success is measured by how effectively a central catalogue or a **virtual collection** assists with initial discovery without compromising the authoritative nature of the original source.

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Summary of Evaluation Criteria and Success Factors

Universal Success Factors

The sessions identified several cross-cutting best practices that facilitate successful data and metadata management:

- **Community Adoption and Official Endorsement:** Technical solutions only succeed if they achieve a high **adoption rate**. This is best secured by using vocabularies, ontologies, and guidelines that have been **officially endorsed by trusted bodies**.
- **Automation and Proactive Enrichment:** To handle large-scale data, successful infrastructures implement **automated validation** and **AI-assisted enrichment**. A key best practice is to request or extract metadata at the point of upload to ensure completeness from the start.
- **Interoperability through PIDs and Mappings:** The use of **Persistent Identifiers (PIDs)** is a foundational success factor for creating virtual datasets that are as robust as physical ones. Similarly, successful harmonisation relies on the **alignment of vocabularies** and the creation of clear linkages between domain-specific and national schemas.
- **Sustainability through Training and Simplicity:** For integrated services, success is maintained through **rigorous onboarding** and repeated training for data providers. Furthermore, keeping discovery solutions **reasonably simple** ensures they remain implementable and scalable across different research communities.

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Round Table 4

Round Table Topic: Service Discoverability and Interoperability
Round Table Chairs: Kostas Koumantaros, Urpo Kaila

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Shared characteristics & evaluation criteria

A round table discussion on technical and semantic interoperability, service discovery, and security management highlighted the need for standardised metadata and automated discovery mechanisms to enable efficient service location and consumption. Preferably Machine Actionable. Participants highlighted alParticipants proposed an EOSC CSIRT to manage cybersecurity incidents across distributed nodes and explored the trade-off between federation's technical overhead and zero-configuration approaches that reduce integration complexity. Service classification based on maturity levels, security best practices, and operational trust and security frameworks like SIRTFI were also discussed. The discussion reflects a collective effort to establish shared standards, governance models, and responsibilities for a secure, interoperable, and sustainable EOSC infrastructure.

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Adopting interoperability solutions in the EOSC Federation

Defining a shared set of evaluation criteria

Produce a shared set of evaluation criteria and guiding principles to assess the readiness and suitability of interoperability solutions for adoption in EOSC Nodes.

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Round Table #5

Round Table: Federating Services & Technical Interoperability
Round Table Chair: Diego Scardaci

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Adopting interoperability solutions in the EOSC Federation

What is missing in the current set of EOSC Federating Capabilities

- Implementation guidelines for nodes to enable federated search and other core capabilities with well defined protocols and APIs that can be used for data interchange
- Define a real semantic federation (aligning vocabularies, resolving concepts, navigating across knowledge graphs) to enable the easy combination/query of research objects across Nodes
- Define a federated data access / cross-node querying that allow to find resources across Nodes
  - Common way to query/use data cross-node
- PID Capabilities
- Support for machine-actionable resources (FDOs) in all (core or federating) services
- Security/cybersecurity across nodes is missing as a core federating capability
- Offer a standardised, dynamic way to identify who offers a specific capability (Node registry)
- Stronger focus on scientific usage/use cases and workflows

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Round Table #6

Round Table: Semantic Interoperability with FAIR Digital Objects in EOSC
Round Table Chair: Esteban González

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Adopting interoperability solutions in the EOSC Federation

Shared characteristics & evaluation criteria

We have identified several implementations of FDOs:

- PID-based approach
- RO-Crate approach
- Nanopublications

FDO-Forum is now creating definitions for the "supported" FDO flavours. PID-based and RO-Crate FDOs are the 2 selected flavours for the first round.

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Shared characteristics & evaluation criteria

Several challenges have also been identified:

- How to implement FDO operations across the different implementations.

Example: If there is an image, you can convert it intodifferent formats. You need a d**iscovery service, which is a FDO** and you can **invoke with this PID**. It is need to describe in a machine actionable thing. **Metadata and service description is FDO**

- In the case of RO-Crates, there are RO-Crate profiles, which are extensions of RO-Crates. How can interoperability between these profiles be ensured?

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