

EOSC Beyond

Evolution of Federating Capabilities and Federation Models

BoS: Services and capabilities for the EOSC Federation

03 | 07 | 2026 by Nicola Fiore and Diego Scardaci (EGI Foundation)



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- What Federating Capabilities should the Federation offer ?
- How should they be delivered ?
- Four proposed evolutionary tracks
 - More federating capabilities
 - Actionability of the federating capabilities
 - Reduce dependency on central components
 - Multi-Hub Federation
- Conclusions

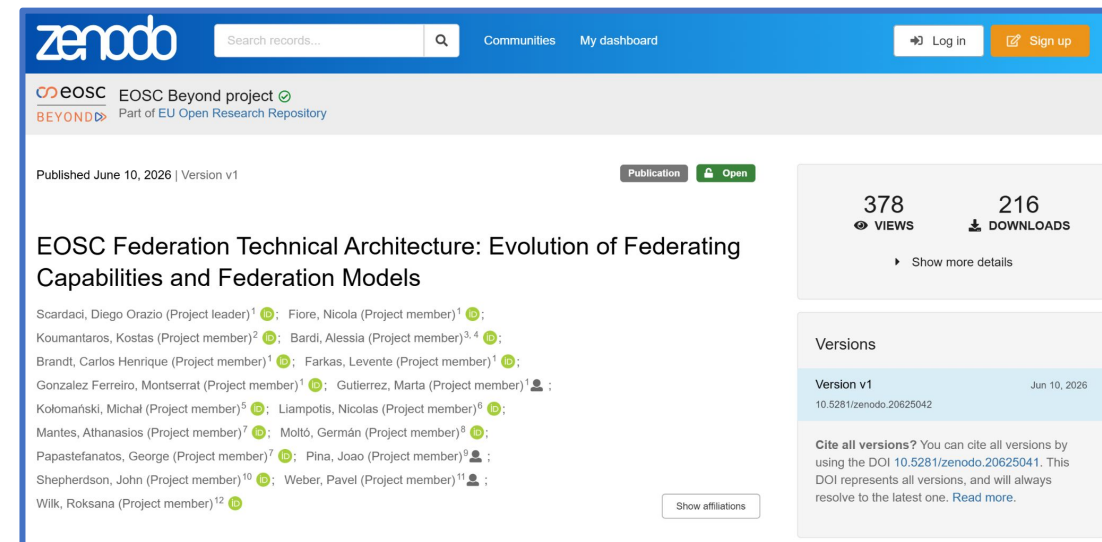


EOSC Federation Technical Architecture: Evolution of Fed Capabilities and Fed Models

- Analyses the current status of the **EOSC Federation technical architecture**
- Proposes a coherent **evolution strategy for the EOSC Federation** to support scalable, resilient, and interoperable cross-node scientific services.
 - Set of architectural evolution paths that could further strengthen the Federation.
- Document enriched with **practical experience and evidence from EOSC Beyond** on how the Federation architecture can evolve to address emerging requirements.

New EOSC Beyond Architecture paper:

<https://zenodo.org/records/20625042>



Moving from the current federation prototype towards a **fully operational EOSC Federation** able to

- Support complex scientific workflows
- Enable cross-node orchestration of services, data and other resources
- Offer advanced distributed services.

Four proposed evolutionary tracks

Evolutionary Tracks	Description
More federating capabilities	Operational, generic and thematic capabilities
Actionability of the federating capabilities	Machine-discoverable and machine-consumable capabilities
Reduce dependency on central components	Distributed implementations whenever appropriate
Multi-Hub Federation	Evolution from one Federator towards multiple interoperable Federators

The four tracks are complementary and together form a coherent architectural roadmap for the evolution of the EOSC Federation

The paper is intended to stimulate discussion on EOSC Federation architecture. The proposed evolutionary tracks are intended as a contribution to the ongoing evolution of the EOSC Federation.

Evolutionary Track 1: More Federating Capabilities

- EOSC has been defined as a **Web of FAIR Data and related Services or Data Space for Research**
 - According to the Handbook, EOSC is expected *to provide Europe's researchers with the necessary digital resources to conduct research within and across disciplines and borders according to the FAIR principles for data and open science*
- The EOSC Federation currently only offers 2 Federating Capabilities: AAI and Resource Catalogue
 - They provide fundamental functions to implement the EOSC Federation
 - **These are necessary, but not sufficient, to achieve EOSC's mission.**

Evolutionary Track 1: More Federating Capabilities

Operational Federating Capabilities

- Users expect a coherent and reliable experience across the Federation
- A Federated SMS establishes a common operational framework preserving Node independence
- Helpdesk, Monitoring, Accounting, etc.
- SMS, Helpdesk and Monitoring Fed Caps currently being implemented within the Build-up Group

Generic & Thematic Federating Capabilities

- To support advanced scientific workflows requiring distributed datasets, compute infrastructures, storage systems, and research platforms across multiple Nodes
- Application Deployment, Workflow orchestration, AI services, Data access, Compute orchestration, Semantic interoperability

A mature EOSC Federation requires a broader ecosystem of operational and specialised Federating Capabilities that support both **Federation operations** and **cross-node scientific workflows**.

Evolutionary Track 2: Actionable Federating Capabilities

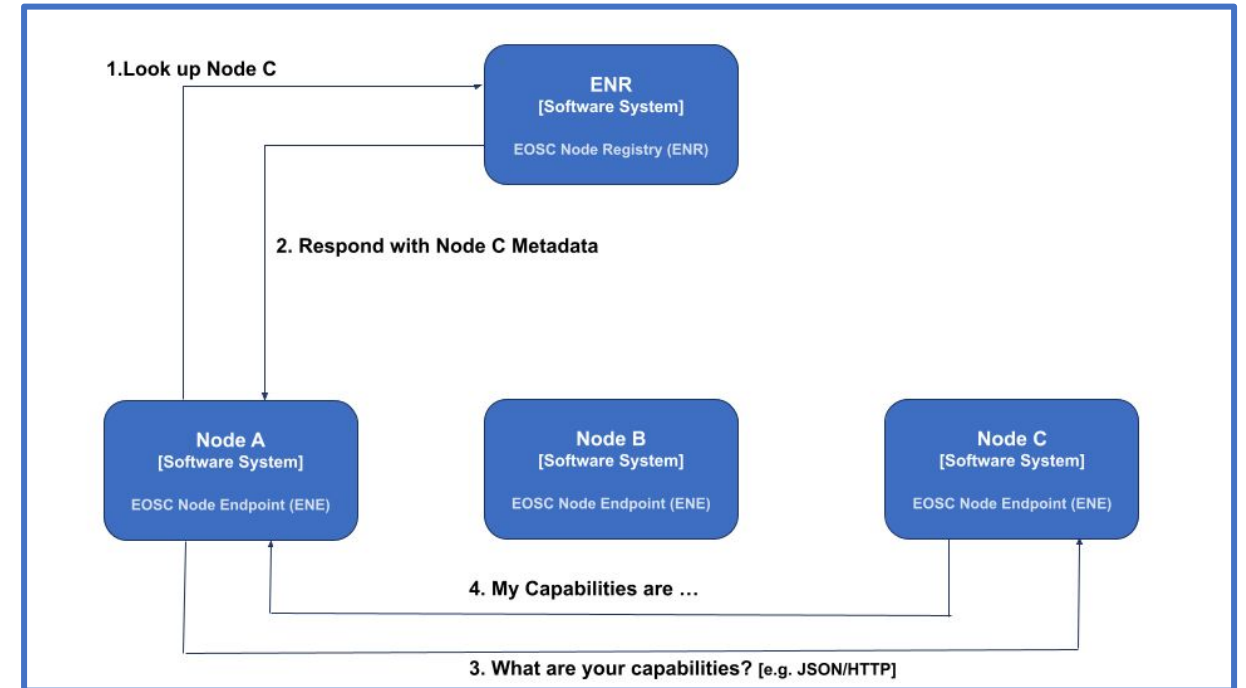
- Move from documentation to machine-actionable federation services
 - Service discovery
 - APIs
 - Machine-readable metadata
- Evolution aligned with the FAIR principles → Apply FAIR principles to Federating Capabilities
- Benefits
 - Easier onboarding
 - Automation
 - Interoperability
 - Foundation for more advanced Federation services (e.g. cross-Node service orchestration)

A Federating Capability is **actionable** when it can be **automatically discovered, understood, and consumed through standard interfaces** without requiring manual configuration or bilateral agreements.

- **Node Registry** to enable machine discoverability of Nodes' capabilities

- Registers and manages metadata describing EOSC Nodes
- Stores a minimal set of Node metadata locally
- Provides a standardised API to retrieve additional information on Node technical capabilities and services
- Deployment models: at Hub or Node level

Discovering capabilities of a Node through the EOSC Node Registry



- **EOSC Node Registry (ENR)**: the central registration authority exposing a public REST API
- **EOSC Node Endpoint (ENE)**: resides on each EOSC Node, exposing real-time metadata about that Node's capabilities

Evolutionary Track 3:

Reduce dependency on central components

Central components should be minimised when distributed alternatives can provide equivalent functionality while preserving interoperability and governance.

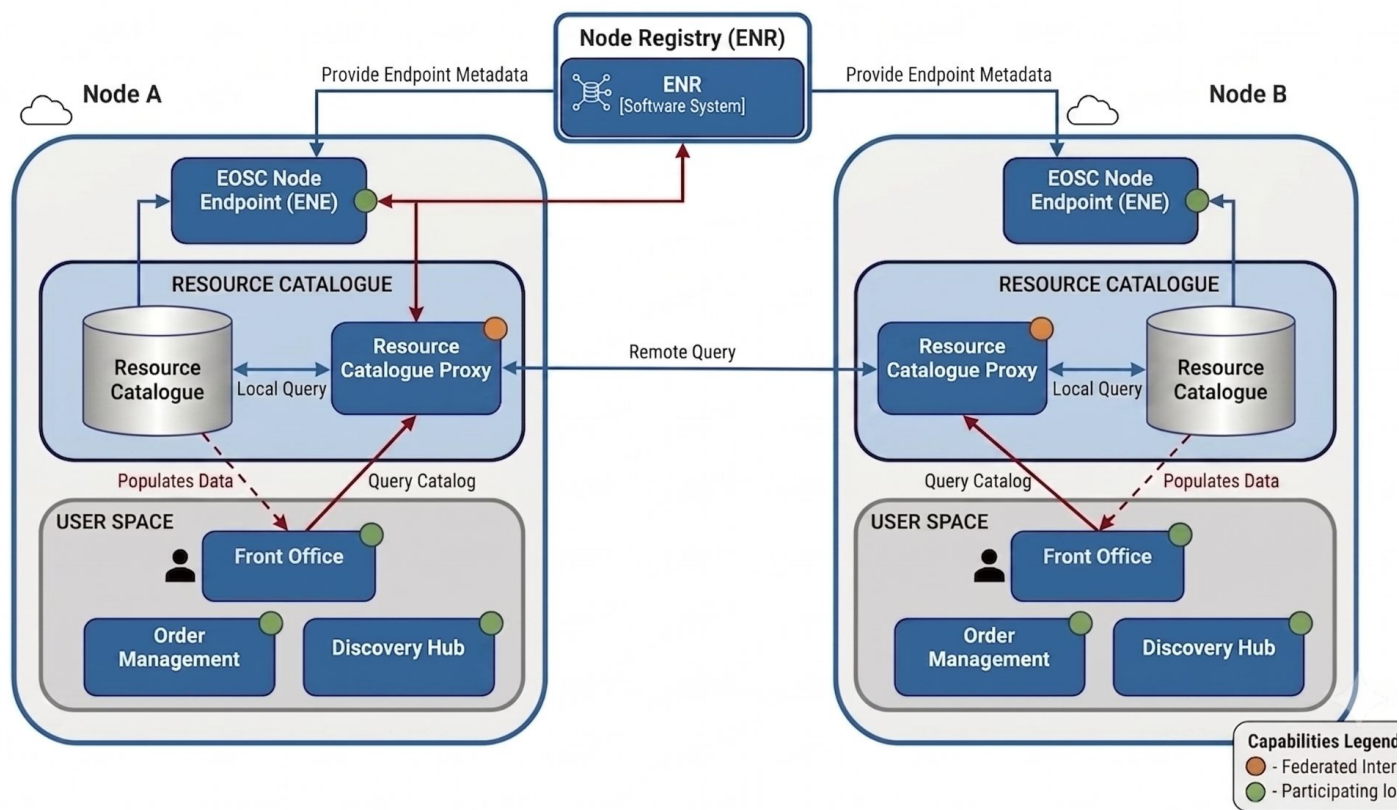
Challenges	Description
Central components may become operational bottlenecks	Scalability requirements, operational complexity, and maintenance costs of central components tend to grow proportionally with the size of the Federation
Central components may become single points of failure	The availability of Federation-wide capabilities can be affected in the event of technical incidents, cyber-security events, funding disruptions, or organisational changes
Governance and sustainability concerns	Dependence on central services can concentrate operational responsibilities and decision-making authority, potentially limiting the flexibility of participating Nodes to adopt local solutions

Reducing dependencies on central components does not imply eliminating Federation-level coordination or abandoning common interoperability frameworks

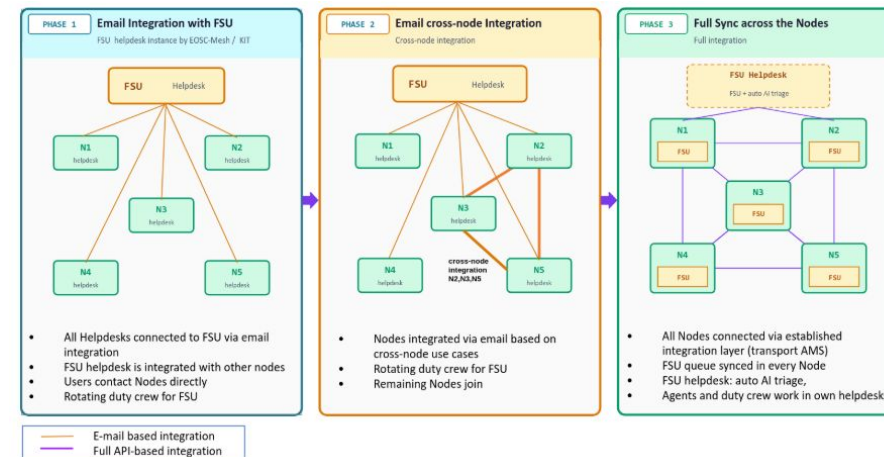
Evolutionary Track 3: Federated Catalogues, Helpdesk and ADM

Examples from EOSC Beyond

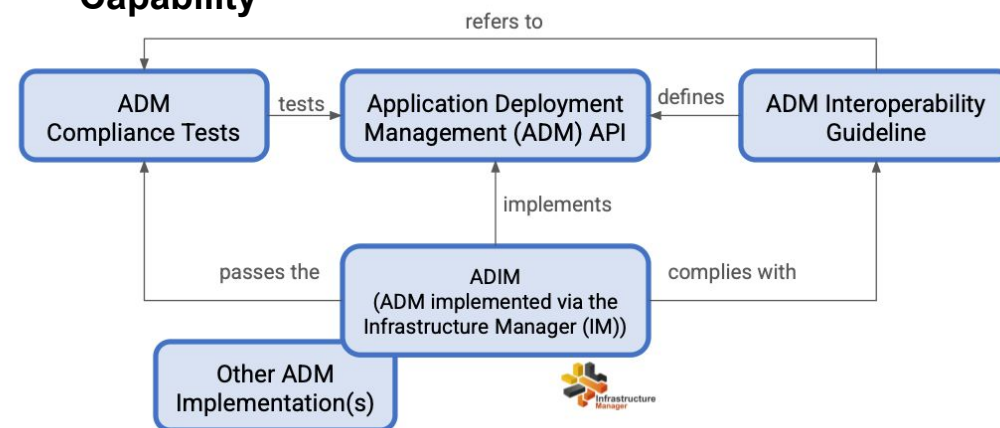
EOSC Federated Search information flow



Roadmap to enable the Helpdesk Fed Capability

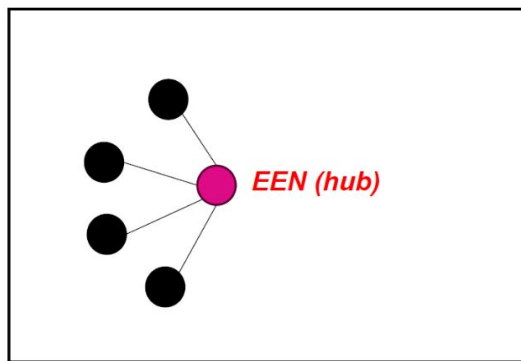


Application Deployment Management (ADM) Fed Capability

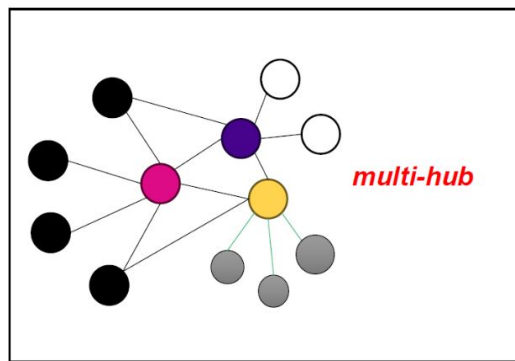


Evolutionary Track 4: From one Federator to multiple Federators

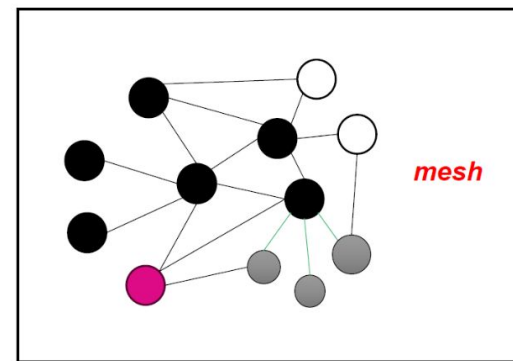
- A **multi-hub architecture** distributes federating responsibilities across multiple interoperable hubs operated by different organisations or communities
- Each hub can provide one or more Federating Capabilities (Helpdesk, Monitoring, SMS, Workflow, etc) while remaining compliant with EOSC interoperability guidelines and policies
- EOSC Nodes can consume services from one or more hubs according to their operational needs, scientific domains, maturity level, and governance preferences



TODAY



TOMORROW



FUTURE

From Peter Sezgedi DG CNECT C.1, “EOSC-01-01 Projects and the EOSC EU Node / Federation presentation”, May 2026

The adoption of a multi-hub architecture represents a natural evolution path to support the scalability, sustainability, resilience, and inclusiveness objectives of the EOSC Federation

- The current EOSC Federation prototype provides a solid foundation but should evolve along 4 complementary architectural evolutionary tracks:
 - (1) More federating capabilities, (2) Actionability of the federating capabilities, (3) Reduce dependency on central components, (4) Multi-Hub Federation
- **Expected benefits**
 - ✓ richer Federating Capabilities
 - ✓ machine-actionable federation
 - ✓ fewer central dependencies
 - ✓ more resilient and scalable federation
- **Questions for the Working Group**
 - Do you agree with the 4 evolutionary tracks identified by the paper? Is anything important missing?
 - Which evolutionary track should receive the highest priority?
 - Which of these tracks should be reflected in future versions of the Federation Handbook?
 - Should these architectural evolutions be reflected in future versions of the Interoperability Guidelines?

Thank you!

- Please fill in the survey and provide your feedback:
- www.eosc-beyond.eu/article/concept-paper-eosc-federation-technical-architecture-open-survey
- survey.egi.eu/522673?lang=en

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