EOSC Federation Handbook

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EOSC Federation Handbook

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	Name
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Document revision history

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Contents

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Introduction: Scope, target audience and outline of the Handbook

The EOSC Federation Handbook provides an overview of the organisational and operational structure and technical characteristics of the EOSC Federation.

It aims to serve as a practical guideline for organisations that are interested in making their resources available within and across the EOSC Federation. Such organisations can achieve this objective by creating and operating an "EOSC Node", and "enrolling" it as part of the EOSC Federation, and/or by "onboarding" their resources in one or more EOSC Nodes operated by other organisations.

The intended users of the Handbook include primarily facility managers, policy makers and technical staff of research performing and funding organisations, research infrastructures, providers of scientific services and other resources, and e-infrastructures.

The "end-users" of the resources accessible through the EOSC Federation, i.e. the researchers, are not directly targeted by the Handbook, but they may still find useful information about the scope and organisation of the EOSC Federation. It is important to build the EOSC Federation in the most transparent manner and with the understanding of the research community.

Chapter 1 lays the foundations on which the rest of the Handbook is built. It includes the purpose of the EOSC Federation, its primary users, its main advantages and expected outcomes and success criteria.

Chapter 2 concerns the governance framework and legal structure. It describes the governance structure in its current state, communication and relations with other initiatives, and how to manage possible risks. Chapter 2 identifies governance roles for the Federation as well as for candidate Nodes.

Chapter 3 defines and describes the operational structure of the EOSC Federation. The requirements to become an EOSC Node, technical or otherwise, are outlined here.

Chapter 4 details the architecture of an EOSC Node, how services can be set up and interlinked, and specifically the requirements for federated capabilities and relationships with the EOSC EU Node.

Chapter 5 contains a description of the different categories of FAIR data and scientific resources that can be made available through the EOSC Federation.

Chapter 6 describes the process of enrolling an EOSC Node and onboarding a service in an existing EOSC Node.

Building the EOSC Federation out of EOSC Nodes will structure data and services in Europe into a coherent set of research services for researchers. The aim of the Handbook is to be the guide of how to build the EOSC Federation to move from individual non-federated services and data to a web of federated data and services (see the diagram below).

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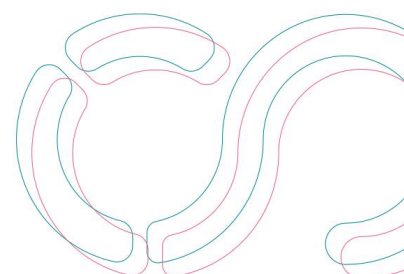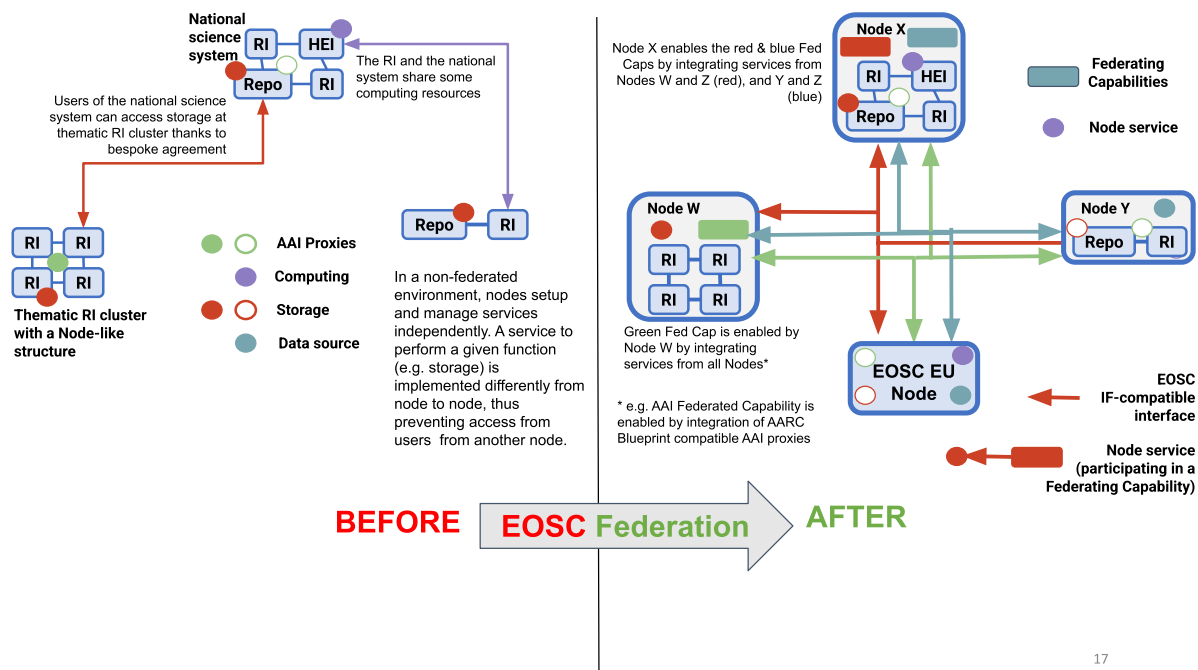
Figure 1: Before and After - Schematic showing effect of EOSC Federation on research services

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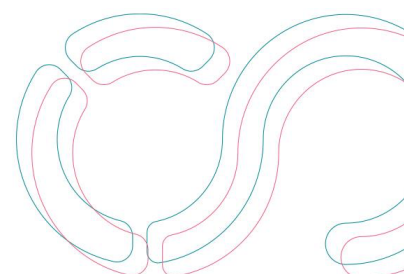
1   Purpose, expected outcomes and measures of success

1.1   Purpose

The EOSC Federation aims to provide Europe's researchers with the necessary digital resources to conduct research within and across disciplines and borders according to the principles of FAIR data and open science, in a trustworthy and secure environment driven by the scientific communities.

This will be done by putting in place a so-called 'system of systems'[1] with an appropriate organisational and operational structure, between institutional, regional, national, and European data repositories, research infrastructures, e-infrastructures and other scientific service providers federated into a network of nodes — the EOSC Nodes. An EOSC Node may be made up of a single organisation or a consortium of organisations, each with its own internal governance structure and providing resources and services to the Federation. EOSC Nodes must be represented in the Federation by a legal organisation and must adhere to its decisions, rules, and policies.

The target end-users of the resources of the EOSC Federation are primarily researchers working at research performing organisations and research infrastructures across Europe and beyond. Potential users of the EOSC Federation also include citizen scientists and researchers in industry.

The organisations that participate in the EOSC Federation will work together to better understand and address the needs of researchers, providing them with appropriate support and equipping them with the right tools.

The EOSC Federation will seek to provide a seamless experience to its users, aiming for a high degree of integration and interoperability of the provided resources. It will count on the latest community know-how, adopting and building on well-established and well-functioning structures and frameworks.

It will increase adoption of the FAIR principles through standardised FAIR practices and improved data and service interoperability and will foster a more collaborative and integrated scientific environment.

The EOSC Federation will act to secure long-term preservation of selected data and will contribute to the alignment of national guidelines facilitating openness wherever possible. It will monitor the activity of the Federation, the included resources and opportunities for consolidation.

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[1] https://www.techtarget.com/searchapparchitecture/definition/system-of-systems-SoS

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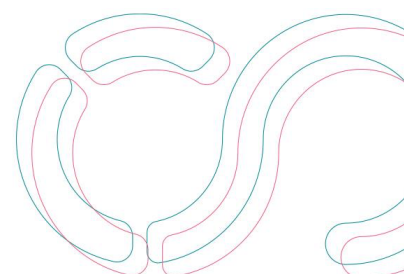
To fully succeed in enabling Open Science and achieving global impact, the EOSC Federation will seek to establish links with similar initiatives in other regions of the world.

The development of the EOSC Federation will make a key contribution to the overall policy objectives of EOSC to mobilise, align and scale resources and engagement across Europe towards accelerating Open Science, FAIR data management, higher productivity and increased reproducibility in research. It will establish the Common European Data Space for R&I[2], which is the EU's flagship initiative for the digital transformation of research and will also contribute to delivering the objectives of the EOSC Partnership, as set out in the EOSC Research and Innovation Agenda (SRIA)[3].

1.2   Expected outcomes and measures of success

The expected outcomes of the EOSC Federation are as follows:

- **Enhanced access to and use of digital resources**: The EOSC Federation will facilitate access to and use of digital resources needed to conduct research such as research data and metadata, publications, software, compute and storage capacity, analysis services and tools;
- **Facilitated research reproducibility**: The EOSC Federation will enable researchers to connect available data, tools and services into methodologically grounded, integrated, reproducible workflows based on Open Science practices;
- **Increased collaboration, community and knowledge sharing:** The EOSC Federation will foster a culture of collaboration, community and knowledge sharing;
- **Improved efficiency and higher impact of investment in research**: The EOSC Federation will make research more efficient, accelerate scientific discovery and make scientific outcomes more visible, facilitating re-use and cross domain research;
- **Increased standardisation and interoperability:** The EOSC Federation will promote the development and adoption of common standards and best practices to improve data quality, facilitate research across disciplines and borders and ensure compliance with national and European legislation;
- **Better support for thematic initiatives:** The EOSC Federation will contribute to the continued advancement and readiness of thematic communities participating in the EOSC Federation;
- **Improved research integrity**: The EOSC Federation will enable and encourage the adoption of Open Science practices to produce FAIR data, contributing to improved integrity and excellence of research.

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[2] https://digital-strategy.ec.europa.eu/en/library/second-staff-working-document-data-spaces
[3] The Strategic Research & Innovation Agenda and its Multi-Annual Roadmap - EOSC Association

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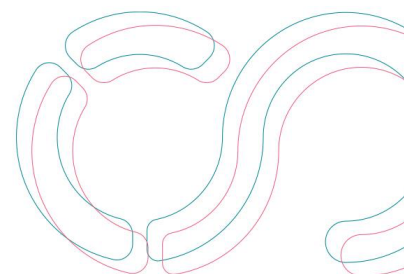
- **Increased robustness and trustworthiness**: The EOSC Federation will foster quality-control and authenticity of the FAIR digital objects by the research community and pursue robustness from cyberattacks and malicious infiltration of unreliable digital objects.
- **Increased data sovereignty:** The EOSC Federation will enable Member States to exercise their full rights over documents, data and software, seeking to strike the right balance between ensuring sovereignty and ease of use. This will be achieved through inclusion of capabilities for identity and rights management that offer individuals, organisations or governments the required control to ensure credit is attributed to the originators while keeping knowledge 'as open as possible, and as closed as necessary'.

The success of outcomes of the EOSC Federation will be measured via the following **Key Performance Indicators**:

1. **User engagement:** The number of unique users of the EOSC Federation services; activity of users of the EOSC Federation services as measured by the frequency and duration of user sessions on federated services; user satisfaction and feedback.
2. **Digital resource accessibility and usage:** The number of digital resources accessed via the EOSC Federation by EOSC Federation users e.g. number of publications citing the EOSC Federation for datasets; the level of compliance with FAIR principles in research data management (RDM). The number of long-term preservation records and reuse of high-quality digital resources.
3. **Service efficiency and availability**: The uptime and reliability of the EOSC Federation services and platforms; response time for user queries and support requests; time and effort required to on-board resource providers and services and enrol new nodes; efficiency and availability of EOSC Federated Capabilities.
4. **Service portfolio**: The number of new services and tools integrated into the EOSC Federation including metrics of their usage;
5. **Collaboration, community and knowledge sharing**: The number of collaborative projects and initiatives facilitated across the EOSC Federation (among and between the EOSC Nodes); participation in community events, workshops, and training sessions; number of interdisciplinary research projects supported; number of reproducible research workflows published.
6. **Standardisation and Interoperability**: The level of success of interoperability guidelines as measured by the number of node services which adopt and conform to guidelines on interoperability.

Overall, the EOSC Federation will contribute through its outcomes to the sustainability of research organisations in Europe, by taking advantage of commonly pooled resources, know-how and capabilities, reducing duplication of research and development costs.

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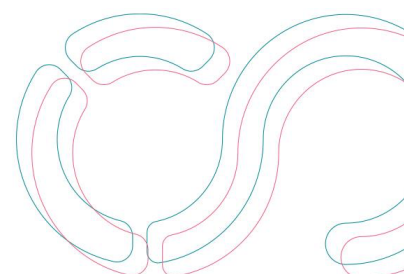
2   Governance

This chapter describes the current governance structure of the EOSC Federation during the build-up phase. **The structure described is a transitional governance structure**. It utilises the structure that was put in place in 2021 to provide the strategic steering of the EOSC initiative and to implement the EOSC co-programmed Partnership. It is expected to remain in place at least until the build-up phase of the EOSC Federation is completed.

The future governance structure will need to include a decision-making body, a body responsible for implementing these decisions and for running the day-to-day operations of the EOSC Federation, advisory bodies representing the EOSC Nodes and the wider EOSC stakeholder community, as well as working groups of specialists tasked with addressing specific topics.

The future governance of the EOSC Federation will be shaped and implemented by the current governance. Any developments will be reflected in updated versions of the Handbook.

2.1   Structure of the current (transitional) EOSC Federation governance

EOSC Tripartite Governance

The structure that was put in place in 2021 in order to drive the development of the overall EOSC initiative, including its objective of setting up a federation of data infrastructures and scientific service providers, is composed of a) the **European Commission** (Directorates-General for Research and Innovation [DG RTD] and for Communications Networks, Content and Technology [DG CNECT]); b) the **EOSC Association**[4], a non-profit organisation seated in Brussels representing the broader EOSC stakeholder community; and c) the **EOSC Steering Board**[5], a European Commission expert group (**E03756**[6]) whose Members are representatives of the EU Member States and countries associated with Horizon Europe. These bodies follow a consensual approach regarding the key strategic decisions for the development of EOSC, and organise their discussions and decisions under the so-called '**EOSC Tripartite Governance**'. The three parties also have their individual roles and contributions to the development of the EOSC Federation.

The EOSC Tripartite Governance is the ultimate decision-making body responsible for setting out the overall strategy and operational planning, including at this stage the process towards

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[4] https://eosc.eu

[5] Informal group set-up with the agreement of Commissioner Gabriel and Vice President Vestager, and published on the Register of Expert Groups on 16 February 2021, pursuant to the provisions of Commission Decision C(2016) 3301 of 30.5.2016 establishing horizontal rules on the creation and operation of Commission expert groups.

[6] https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?lang=en&groupID=3756

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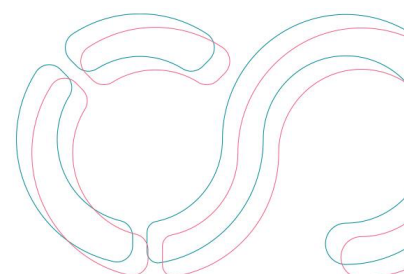
establishing an operational EOSC Federation. It can also establish additional groups and/or task forces as it deems necessary in order to effectively carry out its activities.

The **European Commission** is a partner in the EOSC co-programmed European partnership[7], whereby it co-develops the EOSC Strategic Research and Innovation Agenda[8]. It provides funding opportunities under the Horizon Europe programme to support the development of the EOSC Federation and the overall open science and FAIR research data ecosystem. It also owns and operates – through a public procurement contract – the 'EOSC EU Node'[9], a fully operational platform providing access to a portfolio of professional-quality research services and resources and enabling with Federating Capabilities the development of the EOSC Federation.

The **EOSC Steering Board** is an expert group of the European Commission composed of representatives of the 27 EU countries and countries associated with Horizon Europe to strategically advise on EU policy for research data infrastructures and services and the alignment of EU and national policy developments and investments with the EOSC objectives. The expert group also supports the Commission in coordinating and implementing the EOSC as part of the ERA Policy Agenda, in line with the Council conclusions of 26 November 2021[10] on the new ERA Governance. It is co-chaired by a representative of the European Commission and a representative of the other members of the group.

The **EOSC Association** was set up in July 2020 as an international non-profit organisation under Belgian law with the aim to provide a single voice for advocacy and representation for the broader EOSC stakeholder community. It is the European Commission's partner in the EOSC co-programmed European partnership, whereby it co-develops the EOSC Strategic Research and Innovation Agenda. It currently has 166 members and 91 observers[11] from public organisations with a research mandate in Europe. Further to participating in the EOSC Tripartite Governance, the EOSC Association also provides the operational capacity of the current transitional EOSC Federation governance. This includes organising consultations of the broader community, coordinating and carrying out activities related to the build-up phase of the EOSC Federation, including the drafting of the present Handbook, carrying out communication activities related to the EOSC Federation, providing administrative support to groups related to the EOSC Federation (e.g. the group of the Handbook's drafters, the EOSC Nodes Forum).

The EOSC Nodes

The EOSC Federation will consist of multiple "EOSC Nodes" that are interconnected and can collaborate to share and manage scientific data, knowledge, and resources within and across
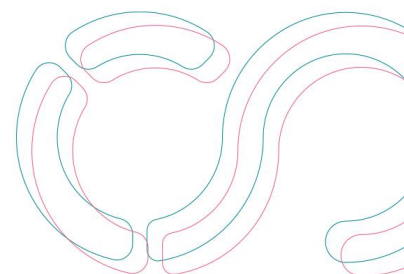
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[7] https://eosc.eu/wp-content/uploads/2023/08/EOSC_Memorandum_30_July_2021-1.pdf
[8] https://www.eosc.eu/sites/default/files/EOSC-SRIA-V1.0_15Feb2021.pdf
[9] https://open-science-cloud.ec.europa.eu/
[10] https://data.consilium.europa.eu/doc/document/ST-14308-2021-INIT/en/pdf
[11] https://eosc.eu/members/

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thematic and geographical research communities. The EOSC Nodes will be entry points for users to the EOSC Federation, with each node offering its own and possibly third-party services, including data repositories and accessing services.

The EOSC Nodes will need to comply with decisions, rules and policies that are agreed to be applied across the EOSC Federation. Other than that, each EOSC Node will be fully autonomous to set its own rules and internal management of its consortium as long as they do not contradict those of the EOSC Federation. For example, an EOSC Node may decide to set up additional Rules for Participation and/or separate access and use policies of the resources it offers through the Federation, or it may set up specific requirements for onboarding services.

An EOSC Node can consist of a single organisation, or a consortium of organisations with its own internal governance structure. In the latter case there must be a 'coordinating' organisation within the consortium that will represent the Node in the **EOSC Nodes Forum.**

The EOSC Nodes Forum is an advisory body, composed of members which are representatives of the EOSC Nodes. During the build-up phase of the EOSC Federation, organisations that are in the process of becoming Nodes (so called 'Candidate EOSC Nodes') will be the Members of the EOSC Nodes Forum. The EOSC Nodes Forum advises the EOSC Tripartite Governance and the EOSC Association on issues related to the EOSC Federation activities and priorities.

2.2 Responsibilities of the EOSC Federation bodies

During the build-up phase of the EOSC Federation, the EOSC Federation bodies, i.e. the EOSC Tripartite governance and the EOSC Nodes Forum, will develop, under their respective roles, the key elements of the EOSC Federation, such as:

- **Federation strategy**: defining the long-term objectives of the EOSC Federation and the roadmap for achieving them.
- **Membership:** selection criteria and process for enrolment of new Nodes, their ongoing obligations, compliance measures, removal and mechanisms for appeal, possible membership fees.
- **Federated services**: common services that will be implemented across the EOSC Federation and the requirements for the Nodes when participating in federated services. These can include e.g. a common EOSC Authentication and Authorization Infrastructure (AAI), a common catalogue of EOSC resources etc.
- **Technical standards and requirements**: which technical standards will be part of the EOSC Interoperability Framework and what the technical requirements will need to be fulfilled by the Nodes when joining the Federation, e.g. cyber-security, Persistent Identifiers (PIDs) etc.

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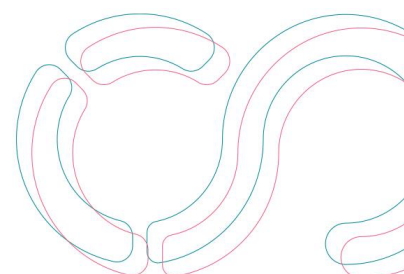
- **Federation policies**, for example a security policy, ethics policy, or Rules for Participation and policies related to the access and use of resources that are provided across the Federation.
- **Monitoring**: mechanisms to measure the Key Performance Indicators (KPIs) listed in chapter 1.
- **Collaborations**: establishing partnerships or other forms of cooperation with other organisations in and beyond Europe.
- **Governance:** what should be the characteristics of the bodies of the eventual EOSC governance, their roles and the relations amongst each other.
- **Service Level Agreement** (SLA), including the terms of the service expected from providers and precautions and actions to be undertaken in the case the terms of the SLA are not met.

The EOSC Federation bodies will develop these elements in close cooperation with and consultation of the wider EOSC stakeholder community.

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3 Operational structure and responsibilities
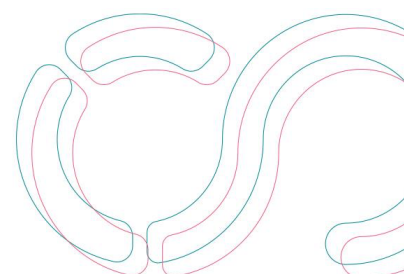
3.1 Operational tasks across the Federation

The day-to-day operations of the EOSC Federation during the build-up phase include the following tasks:

- Inform the stakeholder community about ongoing activities and progress of the EOSC Federation and decisions made by the Tripartite Governance.
- Contribute to and support the development of the procedures for enrolling Nodes in the Federation and of the Federation's common policies and technical standards.
- Coordinate and support the EOSC candidate Nodes in joining the Federation.
- Support the activities of the EOSC Node Forum.
- Establishing and supporting working and stakeholder groups to further develop the EOSC Federation.
- Support the activities of the EOSC Tripartite Governance.
- Represent the EOSC Federation governance in discussions with the EOSC Nodes and with external stakeholders.
- Carry out the administration of the applications by candidate EOSC Nodes
- Assess the compliance of candidate EOSC Nodes wishing to join the Federation.
- Maintain the web presence of the EOSC Federation.
- Promoting the EOSC Federation in Europe and internationally.

Once an operational EOSC Federation is put in place, additional tasks will need to be carried out, such as:

- Measuring and reviewing the performance of the Federation against agreed objectives and KPIs.
- Coordinating, updating and reviewing compliance with the EOSC Federation Interoperability Framework of the EOSC Nodes.
- The preparation and management of the contracts with the EOSC Nodes.
- Gathering and reporting monitoring data of the EOSC Federation.
- Coordinating the technical implementation of the Federation and providing technical advice, guidelines and recommended tools to members of the Federation and those planning on joining it.
- Coordinating the EOSC Federation on a daily basis including coordinating the legal and policy framework within the EOSC Federation and reviewing compliance of the EOSC Nodes with the legal and policy framework of the EOSC Federation.

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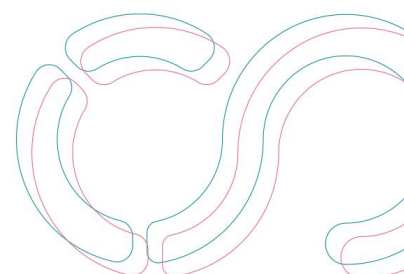
3.2   EOSC Nodes

An EOSC Node will be typically formed by multiple research institutes, universities and other stakeholders with a common geographical (European, regional or national) or thematic scope. A Node will support a thematic, regional, national or pan-European community, and represent, coordinate, operate and maintain resources made available to the EOSC Federation. The resources that a Node should provide or contribute to are defined in Chapter 4 and 5 (for federating capabilities and scientific resources respectively).

3.2.1   Application process to become an EOSC Node

The application process for organisations to become EOSC Nodes will be developed during the build-up phase of the EOSC Federation and decided by the EOSC Tripartite Governance.

This process should also specify the eligibility and evaluation criteria for an organisation that is interested in operating an EOSC Node ('EOSC Node Host'). These criteria should be in line with the basic 'Requirements for EOSC Nodes'[12] that have been developed by the EOSC Tripartite Governance, and will be further formalised as the "Rules of Participation for EOSC Nodes".

It should also specify how the enrolment of an EOSC Node would be formalised. Readers are referred to Chapter 6 for more information on the application process as it is currently defined.

3.2.2   Operations

An EOSC Node represents a specific community of reference (national, regional, or thematic), or large collaborations at a European level (e.g. e-infrastructures, science clusters, etc.), and onboards a set of resources to the Federation (the "EOSC Federation Resources" or "Node Exchange", see chapter 4) for which it is responsible. These resources may be provisioned by the Node itself, by members of the community associated with the Node or by third-party providers. Regardless of the provider, the EOSC Federated Resources (referred to as EOSC Exchange) must conform to the technical and operational requirements of the EOSC Federation, which include the EOSC Interoperability Framework[13] and the EOSC Rules of Participation[14] for the EOSC Exchange. Compliance and monitoring procedures, agreed among the parties, will be put in place to ensure conformity with the requirements to be laid out in the Node's EOSC Collaboration Agreement (to be developed). A non-conforming Node will be asked to address

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[12] https://bit.ly/EOSC-Node-requirements-May-2024

[13] European Commission: Directorate-General for Research and Innovation, Corcho, O., Eriksson, M., Kurowski, K., Ojsteršek, M. et al., *EOSC interoperability framework – Report from the EOSC Executive Board Working Groups FAIR and Architecture*, Publications Office, 2021, https://data.europa.eu/doi/10.2777/620649

[14] European Commission: Directorate-General for Research and Innovation, *EOSC rules of participation*, Publications Office, 2021, https://data.europa.eu/doi/10.2777/30541.

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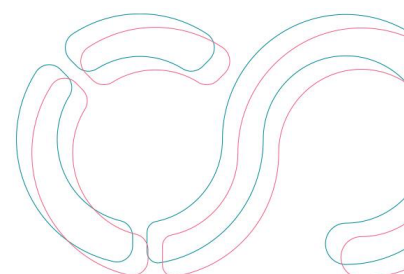
any issues identified and may be subject to suspension from the Federation. In addition, EOSC Nodes are expected to collaboratively deliver Federating Capabilities to augment their offer to EOSC users.

3.2.3   Roles for EOSC Nodes

In order to facilitate the interaction of the Node with the Federation, each Node must nominate a number of persons in the following roles:

1. A **Coordinator** who represents the Node in the Federation.
2. An **Operation Manager** who is the contact person with the Operations Team of the Federation on operations.
3. A **Technical Coordinator** who is the contact person with the Technical Coordination Team of the Federation on technical issues (mainly IT issues).
4. A **Security Officer** who is the contact person for all security related issues.
5. Thematic Nodes will nominate a **Scientific Officer** who represents the Node's scientific content.
6. A **Legal/Privacy Officer** for legal issues

The Node will nominate the persons in these positions once the Node has been accepted to join the Federation and will communicate their names to the Operations Team of the EOSC Federation.

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3.2.4   Proposed Timeline for an operational EOSC Federation

The following diagram shows the current proposed timeline for going from the build-up phase to an operational EOSC Federation by November 2025.

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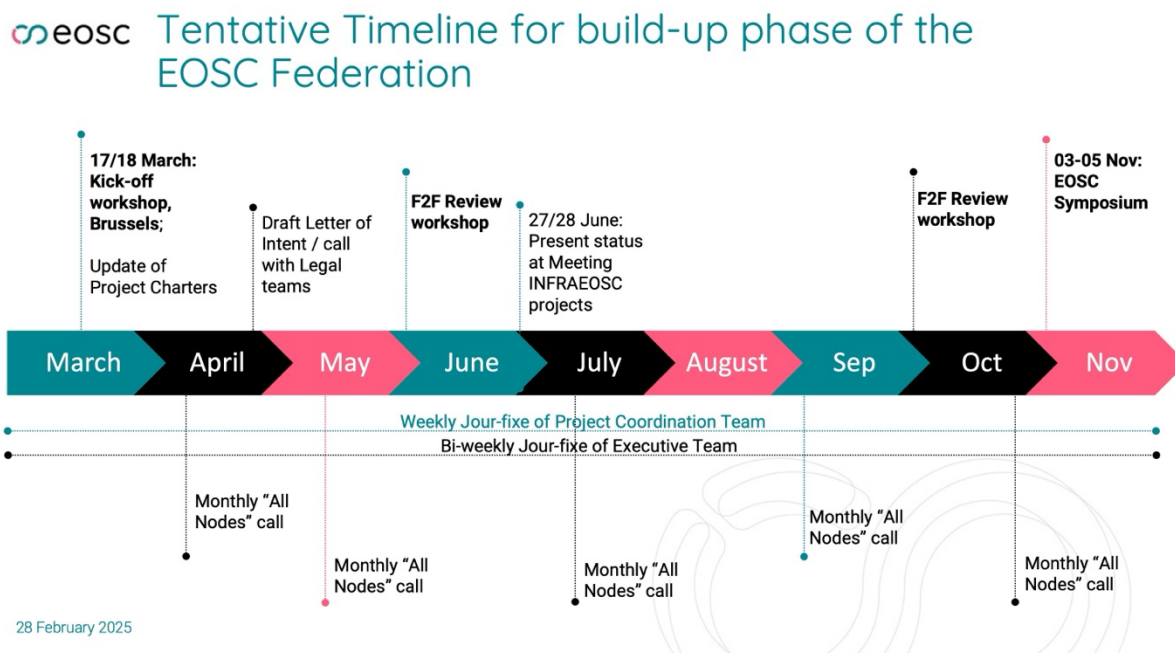
4   EOSC Federation and Node Architecture

This chapter describes the architecture and structure of the EOSC Federation, giving details about how its components—the EOSC Nodes—are to be set up. The architecture of the EOSC Nodes is established by specifying a set of capabilities (referred to as "Node Capabilities") they need to have in place. The capabilities define in practice an integrated digital platform that can be realised with the tools of preference of the communities engaged in the EOSC Nodes. The architecture of the EOSC Federation during the build-up phase is defined by specifying how the Node Capabilities "link" to each other. The Chapter is intended to become the reference document for organisations interested in setting up an EOSC Node in the EOSC Federation.

The chapter begins with a high-level description of the EOSC Federation Architecture, and then provides details about the capabilities foreseen to be offered by the EOSC Nodes ("Node Capabilities"), the EOSC Federating Capabilities, and the EOSC Interoperability Framework. The chapter follows the definitions, models, procedures and diagrams for the Federation Architecture developed in the EOSC Beyond project (https://www.eosc-beyond.eu)[15]. Besides defining the components of the EOSC Federation Architecture, the chapter includes the following technical information:

- a description of the Federating Capabilities and underlying services enabled during the build-up phase of the EOSC Federation, currently offered by the EOSC EU Node (Section 4.3.1);

- a description of the technical operating procedures (Section 4.5) and security requirements (Section 4.6) for EOSC Nodes.

4.1   EOSC Federation Architecture

The EOSC Federation is conceived as a network of autonomous nodes—the EOSC Nodes—that interact with each other to deliver additional capabilities to users, according to the objectives described in Section 1.1.

Figure 4.1 provides a high-level view of the components of the EOSC Federation, consisting of

- the **EOSC Nodes** (blue boxes), encompassing national, regional, thematic, as well as nodes of European scope (i.e. those formed by e-infrastructures that provide services across the continent), including the EOSC EU Node;
- additional capabilities that allow end-users and providers to exploit services, data and other resources in the Federation, referred to as **Federating Capabilities** (depicted as coloured "sticks"), enabled by one or more Federating Services provided by the EOSC Nodes;

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[15] D. Scardaci et al. (2024), EOSC Beyond Concept Document - *EOSC Federation: Architecture and Federating Capabilities,* https://zenodo.org/records/13939396.
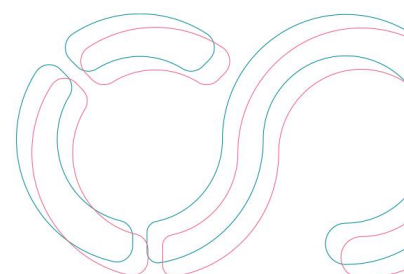
- and interfaces (black lines), comprising APIs and metadata schemas, that connect Node services (shown as coloured "circles") to the Federating Capabilities. As indicated in the figure below, the interfaces between EOSC Nodes have to comply with the guidelines and standards in the **EOSC Interoperability Framework**[16] (EOSC IF).
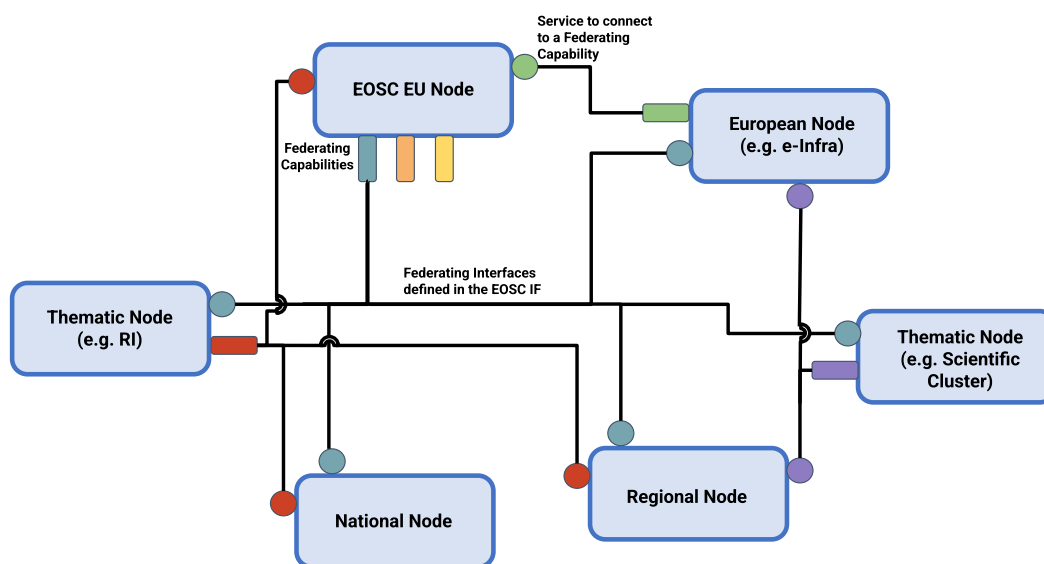
Figure 4.1 - Schematic (or "conceptual") view of the EOSC Federation Architecture

In the following, the term *Node Capability* is used to refer to the tasks performed by an EOSC Node. A Node Capability is implemented by one or more services within one EOSC Node. When this is extended to the EOSC Federation, those tasks performed by Nodes "on behalf" of the Federation are named *Federating Capabilities* (a detailed definition is given in Section 4.3). In both cases, Node Capabilities and Federating Capabilities are implemented using *services*, which can be *federating services*. For example, the assistance expected to be provided by Nodes to its users via a "helpdesk" requires a federated "helpdesk service" that is operated by the Node. Federating Capabilities can refer to hardware, software or processes which are federated.

4.2   EOSC Node Architecture

This section describes the Node Capabilities that EOSC Nodes need to have in place in order to participate in the EOSC Federation, and which define the reference **EOSC Node Architecture**. A Node can be modelled as described in Figure 4.2, where four main elements are identified:

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[16] See European Commission: Directorate-General for Research and Innovation, Corcho, O. et al. (2021), *EOSC interoperability framework – Report from the EOSC Executive Board Working Groups FAIR and Architecture, Publications Office*, https://data.europa.eu/doi/10.2777/620649. An operational EOSC Federation IF will be developed during the build-up phase of the EOSC Federation.

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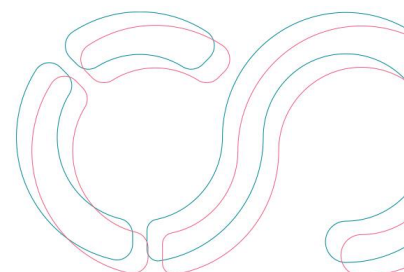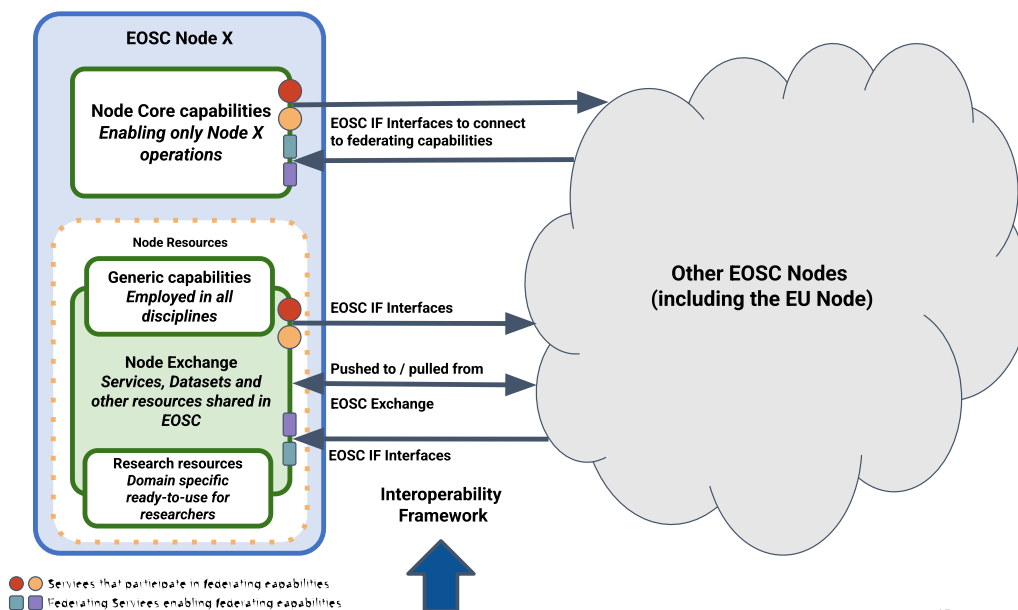
Figure 4.2: EOSC Node Architecture

- **Node Core capabilities** that enable the operations of the Node (e.g. AAI, Helpdesk, Monitoring, etc.).
- **Node Resources**: services, data and other research products, usually listed in a catalogue, that end-users of this Node can access directly. These are split into three categories:
  - **Node Generic Capabilities**: employed in the vast majority of scientific disciplines (and therefore relevant to all EOSC Nodes) to perform everyday tasks related to research data management (e.g. a data transfer service or a cloud infrastructure).
  - **Node Research Resources**: domain specific services, datasets and other research products ready-to-use only for researchers of the Node (e.g. domain-specific datasets or an application to process thematic datasets). See Chapter 5 for a description of Research Resources to be provided by EOSC Nodes.
  - **Node Exchange**: subsets of the generic capabilities and Research Resources a Node makes available to the EOSC Federation. They contribute to the collective EOSC Exchange.
- **Services enabling or participating in Federating Capabilities**.

The resulting Node architecture defines a system-agnostic integrated digital platform for organisations establishing an EOSC Node. This will further evolve into a reference architecture in future versions of the Handbook[17]. In line with the general principle that members of a

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[17] A "reference architecture" provides a general solution or template for the (software) architecture of a system. It defines the functions services and interfaces required for the system to work, but does not specify a particular implementation. See e.g. https://en.wikipedia.org/wiki/Reference_architecture.

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federation retain autonomy to perform certain operations, organisations willing to establish an EOSC Node can implement the reference architecture with the technologies of their choice to create a platform where services and resources are made available. The EOSC EU Node (see Annex 1 for a list of Federating Capabilities offered by the EU Node) can be seen as the first implementation of the EOSC Node Architecture, with some extensions and modifications.

Considering the EOSC Node Architecture, the EOSC Federation Architecture diagram can be further detailed in Figure 4.3. Section 4.3 describes the EOSC Federating Capabilities in more detail.
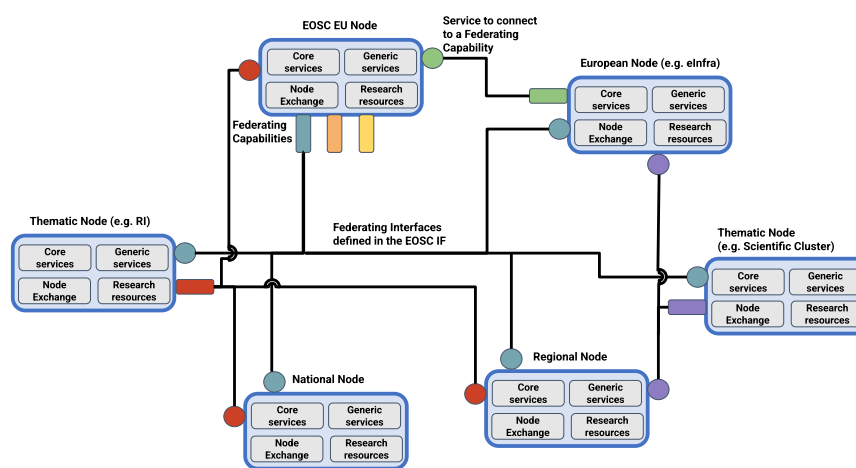
Figure 4.3: EOSC Federation Architecture with the internals of the EOSC Nodes

Building on the EOSC Platform Architecture proposed by EOSC Future[18], with enhancements introduced by EOSC Beyond[19] and the EU node, a list of Core and Generic capabilities for the EOSC Nodes is provided in sections 4.2.1 and 4.2.2. Tables 4.1 and 4.2 list respectively the capabilities that are currently recommended to be implemented in the platforms operated by the EOSC Nodes, and can therefore be employed as a guide by candidate EOSC Nodes. The final status of these capabilities (i.e. whether they become mandatory) will be decided during the build-up phase (see Section 3.3).

4.2.1   Node Core Capabilities

The Node Core Capabilities enable the basic operation of an EOSC Node. A reference implementation of these Node Core Capabilities has been implemented by the EOSC EU Node (see Annex 1). The Node Core Capabilities can be implemented by an EOSC Node as capabilities

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[18] EOSC Future D3.3b: D. Scardaci et al., *Architecture and Interoperability Guidelines for Operational Services of the EOSC Core,* https://bit.ly/architecture-interoperability-EOSC-Core.

[19] D. Scardaci et al. (2024), EOSC Beyond Concept Document - *EOSC Federation: Architecture and Federating Capabilities,* https://zenodo.org/records/13939396.

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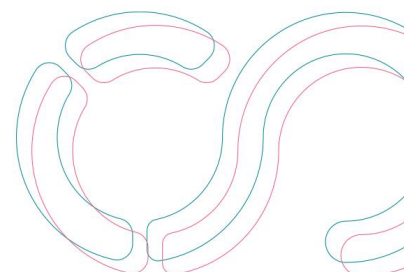
of a platform, individual services, or acquired through the EOSC Federation (offered as-a-Service or using the technology of the reference implementation).

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 offers and a unique interface for end-users to request access to resources
Configuration Management System	Shared space to store information on Node capabilities and on how services are provided through the node to ensure consistent service delivery (only for internal use)
User space	Dynamic customisable dashboard, where the node user logs-in, offering easy access to the Node resources.
Application Workflow Management	Orchestrate services, datasets and other research objects on the underlying Node provisioned infrastructure
Resource provisioning	Support users on identifying all available resources for a project and then assigning them to the project

Table 4.1: EOSC Node Core Capabilities

4.2.2   Node Resources

The Node Resources are services, data and other research products a Node directly offers to its end-users. They are classified in Generic Capabilities and Research Resources as introduced in the beginning of section 4.2. Generic Capabilities are presented in this section, while Research Resources are thoroughly described in Chapter 5. Both Generic Capabilities and Research Resources contribute to the definition of the Node Exchange.

4.2.2.1   Node Generic Capabilities

The Generic Capabilities are employed in the vast majority of scientific disciplines to perform everyday tasks in research data management, and are therefore expected to be relevant to all EOSC Nodes. The capabilities listed in Table 4.2 were compiled from earlier discussions with research communities and are recommended to be included in the offer of all EOSC Nodes. That

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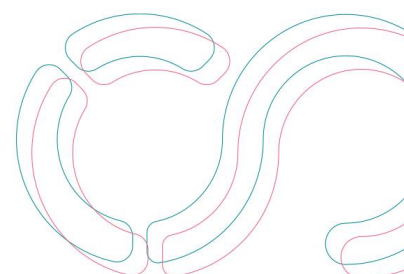
way, Node users will be able to perform all tasks related to the management of research data from their own local node. EOSC Nodes can enable Node capabilities by leveraging services provided by other nodes (e.g. e-Infrastructures, EU Node, or another EOSC Node) to make these capabilities available to its users.

Node Capabilities	Description
Data Transfer	Transfer of data between storage locations
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

4.2.2.2 Node Exchange

The EOSC Federation expects EOSC Nodes to make a relevant portion of their resources available to the rest of the EOSC Federation under the appropriate User Access Policy. The decision of which Node Resources are made available will be taken by the Governance of the Node, and/or the providers of specific resources. Resources shared with the Federation will be labelled by the EOSC Node as **Node Exchange** and they will be discoverable, accessible and usable by any EOSC User[20] according to the conditions laid out in the respective Access Policies decided by the EOSC Nodes. They will therefore have to comply with the EOSC Federation Policies. Other services and resources that are *not* made available in the EOSC Federation do *not* need to be compliant with the EOSC Federation Policies.

In the Node Exchange, we can identify either resources which are generic by nature enabling capabilities and resources which can be used by the majority of research communities and researchers (e.g. Generic Capabilities, see section 4.2.2.1) or resources that are more science-/domain-specific, for example, domain-specific notebooks/workflows, virtual research environments, datasets and/or research software. Chapter 5 provides more information about the scientific research services and resources which can be provided by EOSC Nodes via the EOSC Federation.

4.3 EOSC Federating Capabilities

EOSC Federating Capabilities are the added-value capabilities offered by the EOSC Federation that allow all EOSC end-users and providers to exploit services, data and other resources in the

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[20] Restrictions for some resources, or for some users are still possible as long as they are clearly stated in the UAP

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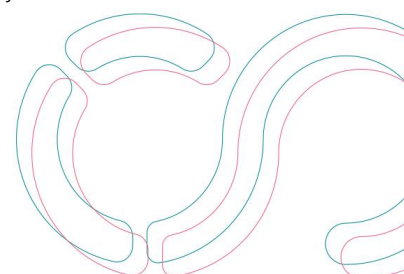
Federation. Because of their federated nature, the Federating Capabilities realise their value only when one or more EOSC Nodes act as federators, enabling the capability by delivering federating services, and other nodes connect to the Federating Capabilities through the federators. For example, access to a federation of cloud computing and/or storage resources available in multiple Nodes becomes possible if the Nodes integrate their computing and storage resources and at least one Node acts as federator[21].

The EOSC Federating Capabilities can be:

- **Mandatory**: subset of Federated Capabilities in which all EOSC Nodes must participate to enrol in the EOSC Federation;
- **Recommended/Optional**: subset of Federated Capabilities that EOSC Nodes should consider to federate with (i.e. connect to), but will not be a requirement to EOSC Nodes to enrol in the EOSC Federation.[22]

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); or
  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. for example a Node participating in the federated AAI by integrating its AAI proxy with the AAI Federation enabled by the EOSC EU Node).

The procedures to assign the Node or Nodes that enable a given Federating Capability will be decided by the EOSC Federation Governance.

The Federating Capabilities are enabled by one or more **EOSC Federating Services** provided by the EOSC Nodes[23]. The Federating Services expose interfaces (e.g. APIs and metadata schemas, point A above) that allow Nodes to federate their services (point B). In order to be accepted in the Federation, the interfaces of the EOSC Federating Services have to be described as part of an EOSC Interoperability Guideline included in the EOSC Interoperability Framework (see Section 4.4), which also details the procedures required to connect a node to a given Federating Capability.

To summarise, an EOSC Federating Capability is defined by the combination of EOSC Federating Services (enabling the capability) and the related EOSC Interoperability Guidelines (defining the interfaces).

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[21] Note that although the term "integrating" indicates the collective delivery of a service in the Federation, the details of service integration will differ between Federating Capabilities.

[22] The classification of a Federating Capability may change with time; e.g. the initial designation as "recommended" may be employed to give time to Nodes to understand how to connect with/federate to it, and then become mandatory once its importance for the Federation has been accepted.

[23] Federating Capabilities are to be distinguished from EOSC Node Capabilities, see the Glossary.

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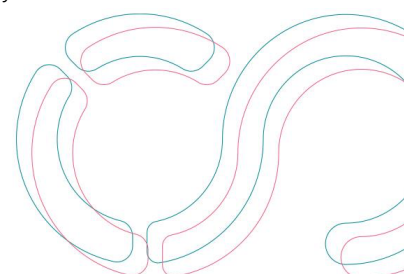
4.3.1 Federating Capabilities in the build-up phase of the EOSC Federation

The EOSC Federation will begin operating with an initial set of Federating Capabilities identified by the EOSC Forum as key to enable the sharing, discovery, access, and composition of services and research products that cater to the diverse needs of researchers and scientists. These capabilities, listed in Table 4.3, currently enabled by the EOSC EU Node, will be implemented by other EOSC Nodes.

Federating Capability	Description	Classification
Resource Catalogues and Registry services	● Federated EOSC Resource Catalogue making the Node exchange resources discoverable ● Search engine over the whole EOSC Federation ● Interfaces to allow EOSC Nodes to publish (push) and retrieve (pull) resources to/from the federated catalogue	Mandatory
AAI	Allows users to log in with their own institute credentials (eduGAIN) to access EOSC resources	Recommended[24]
Application Workflow Management	Orchestrate services, datasets and other research objects on multiple federated nodes	Recommended
Service Monitoring	Provide information about the availability and quality of EOSC services (Core and Exchange)	Recommended
Service and Research Product Accounting	Provide information about usage of services and resources in EOSC (Core and Exchange)	Recommended
Order Management	Offer a framework for providers to define offers and a unique interface for end-users to request access to resources	Recommended
Helpdesk	Federation of integrated helpdesks	Recommended
Management System	FitSM-based Service Management System (SMS) that can be federated with SMS from other EOSC Nodes. This includes Security Coordination between Nodes too.	Recommended

Table 4.3: Federating Capabilities enabled by the EOSC EU Node

This list of Federating Capabilities might be further refined and extended as a result of the dialogue with the candidate EOSC Nodes during the build-up phase of the EOSC Federation.

Documentation on Federating Capabilities of the EOSC EU Node is expected to be published soon and will be used as a starting point during the dialogue with the candidate nodes. As a

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[24] Although joining the AAI Federation to enable the single sign-on over the federated nodes is only recommended, each node should enable access to its services and other resources via eduGain IdPs (see Section 4.5).

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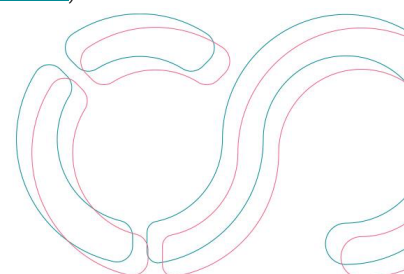
result of the dialogue, a more stable and community-accepted documentation is expected to be available.

4.3.2 Extending the initial set of Federating Capabilities

The initial set of Federating Capabilities is expected to evolve and be extended during the build-up phase of the Federation, to support more sophisticated use cases taking into account the characteristics of the Nodes that will be enrolled. New Federating Capabilities can either be defined by the EOSC Federation Governance by considering requirements from users, research communities, Nodes, funders or other relevant stakeholder, or they can be proposed by the EOSC Nodes themselves, following the procedure established by the EOSC Federation Governance. The decision on whether to add a new Federating Capability has to be made by the EOSC Federation Governance body who will determine whether it is mandatory or recommended/optional, task suitable providers to design and implement the Federating Services and Interfaces required, and finalise Service Level Agreements with the EOSC Nodes selected to operate them.

4.4 The EOSC Interoperability Framework

To enable users to interact with resources from different providers or in different EOSC Nodes as seamlessly as possible, the EOSC Federation requires the Nodes to implement the interoperability standards it selects. These will be described in the **EOSC Interoperability Framework (EOSC IF)**[25], a key part of the EOSC Federation Architecture that compiles all standards, best practices, and technical guidelines accepted by the Federation for the interoperability and composability of resources offered by the EOSC Nodes, including the EOSC Federating Capabilities. The EOSC IF facilitates the cross-discipline collaboration of researchers, providers, and research communities using best practices and standards to work within and across research infrastructures established in the communities.

The EOSC IF is formed by:

- the **EOSC Interoperability Guidelines (EOSC IG)**, which detail the mechanisms for communication between nodes, and the procedures to connect the Nodes to the Federating Capabilities of Section 4.3;
- the **EOSC Interoperability Registry** that registers the EOSC IG promoted in the EOSC Federation;
- the **EOSC IF Governance** that will be defined during the build up phase of the Federation.

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[25] See D. Scardaci et al. (Technical Interoperability of Data and Services Task Force) (2023), *A landscape overview of the EOSC Interoperability Framework - Capabilities and Gaps*: https://zenodo.org/records/8399710, and M. Williams et al. (2023), EOSC Future D3.2b: *EOSC Architecture and Interoperability Framework,* https://bit.ly/EOSC-architecture-and-interoperability.

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The term "framework" refers to the fact that the EOSC IF is the result of combining the three elements into a unified approach to interoperability, following the model of the European Interoperability Framework[26].

The EOSC IGs define the mechanisms for interoperation at various levels of integration, from which a Node joining EOSC can select the option that best fits its needs. The EOSC IF is thus not normative in that it offers the freedom to providers and Nodes to develop and operate provider- or Node-specific implementations as long as they conform to the EOSC IF guidelines and standards.

The EOSC Interoperability Registry is currently operated by the EOSC EU Node as part of the Resource Hub[27], and contains the EOSC IGs developed in EOSC Future[28]. Refer to the EU Node documentation for further details.

4.5   EOSC Node Technical Operations

To ensure high-quality provision of services, EOSC Nodes are required to have a Service Management System (SMS) in place that complies with accepted standards like FitSM[29] or ISO-20000-1[30], and that is compatible with the best practices contained in the Information Technology Infrastructure Library (ITIL)[31]. The SMS will contribute to ensure that each Node respects the service levels agreed with the EOSC Federation Governance, as well as those defined internally by the nodes with their service providers. The service levels are expected to cover all aspects of service performance management across all components of the Nodes, including

- Service provisioning, including provisioning towards other Nodes,
- System integration,
- Performance monitoring,
- Support and coordination activities,
- Service quality,
- Change Management.

EOSC Nodes that do not already have an SMS in place are recommended to adopt the FitSM standard to build it. FitSM was developed to ensure a seamless experience when integrated

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[26] See e.g. *The New European Interoperability Framework* https://ec.europa.eu/isa2/eif_en/ adopted in 2017, now superseded by the Regulation (EU) 2024/903, adopted on 11 April 2024. For more details see Interoperable Europe https://interoperable-europe.ec.europa.eu/interoperable-europe.

[27] https://open-science-cloud.ec.europa.eu/resources/interoperability

[28] The EOSC IGs will be revised and updated during the build-up phase of the EOSC Federation.

[29] https://www.fitsm.eu/

[30] https://www.iso.org/standard/70636.html

[31] https://www.axelos.com/certifications/itil-service-management/what-is-itil/

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services are provided by multiple providers, and is particularly suited to the federated nature of service delivery in EOSC. FitSM has been adopted as the IT Service Management standard in the EOSC EU Node, and is compatible with both ISO-20000 as well as with ITIL. The SMS of the EOSC EU Node can be used as a reference by EOSC Nodes.

4.6 EOSC Node Cybersecurity

EOSC Nodes have to ensure that their service providers follow the regulations, security standards, risk management policy, best practices and guidelines that apply to their activities, operations, and services. Roles, responsibilities, workflows, and processes need to be defined, including the security controls that are applied. Any occurrence of non-compliance with the security policy or with relevant regulations has to be handled properly and reported.

In particular, EOSC Nodes have to:

- Establish an efficient framework to control all security aspects covering participating services, users, and other related parties. The framework should follow industry standards and European information security regulations, taking into aspects all specifics of EOSC (such as distributed security capabilities, a high level of heterogeneity among the EOSC stakeholders, etc.). As part of the risk management process, proper policies and procedures necessary for the security framework should be built and maintained implementing an adequate Risk Management methodology. **The IT Security** Risk Management Methodology of the European Commission (ITSRM²) is recommended for adoption.
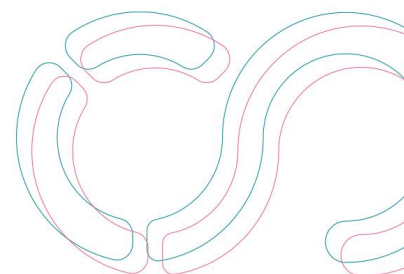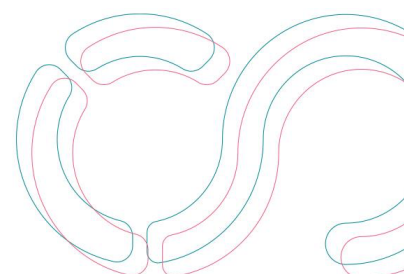- Use the best practices and guidelines of the ISO/IEC 27000 series of standards, which provides a framework for information security management systems.
- As part of Vulnerability Management, conduct regular risk assessments to identify and evaluate the potential threats and vulnerabilities that could affect services in terms of their availability, integrity, and confidentiality of processed data. Implement appropriate technical and organisational measures to prevent and minimise the impact of incidents, such as vulnerability scans, penetration testing, encryption, network segmentation, logging, automation, authentication, hardening, access control, monitoring, etc.
- Regularly monitor and review EOSC Node security performance and effectiveness, and continuously improve security measures based on the results. Conduct regular reviews to ensure compliance and improvement.
- Provide an incident response capability, through a Computer Security Incident Response Team (CSIRT), that ensures security incidents are investigated and proper actions taken according to current measures. Guidelines, tooling, forensics expertise and investigation capabilities to investigate a security incident should be provided, all incidents should be tracked, and a final report should be produced on their resolution.

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- Provide adequate Access Control mechanisms via a Federated Authentication and Authorization Infrastructure (AAI) and Single-Sign-On (SSO) solutions.
- Ensure Data Protection and Encryption
  - Data Minimisation: Processes and stores only the data necessary for intended operations, following GDPR principles.
  - Adopt Encryption Standards when needed to ensure Data Protection In-Transit and At-Rest.
  - Privacy by Design: Ensures that all systems prioritise user data protection from the initial stages of development.
- Organise Training and increase awareness: provides stakeholders with ongoing education on security best practices and regulatory compliance.

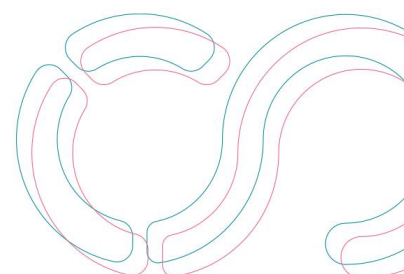|		Document type:	Handbook
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5 Research Resources

This chapter describes the categories of services and resources ready-to-use for researchers to be integrated in the EOSC Federation via the EOSC Nodes, and their requirements to be part of the EOSC Federation.

5.1 Research Resources Categories

The following table defines the categories of Research Resources for the EOSC Federation:

Resource	Category	Description
Research Publications	Publications	Textual output of scientific research that gives the possibility of verification of research findings or their use in new research; mostly but not only refers to peer reviewed publications in journals, can also be publications that are not peer reviewed (such as preprints)
Research Data sources	Data	Sources where data can be found and retrieved, offering APIs or direct access to data searches across various query fields. Data repositories and archives, knowledge bases and scientific databases fall into this category
Research Data	Data	Data from scientific research; referenced by a PID; following the FAIR guidelines as best possible
Research Software	Software	Software for simulating, generating, processing and analysing research data. This includes notebooks and workflows. Software is referred to via a software PID
Research Tools	Software	Analytical and visualisation and other types of tools to aid in the interpretation, transformation and presentation of data. These tools may include dashboards, plotting software, data anonymization software and machine learning frameworks
Research Services	Products	Services that provide management, processing, and storage capabilities for research data. These may include DMPs, data cleaning, transformation, analytics, and computational power to support large-scale studies
Research Training	Documentation	Educational resources designed to improve data literacy, technical skills, and knowledge of best practices in all aspects relevant to EOSC. This includes structured courses and schools, webinars, and hands-on workshops
Research Interoperability guidelines	Documentation	Guidelines to ensure compatibility and seamless data exchange between systems. This category includes metadata standards, data-sharing protocols, and frameworks for harmonizing metadata and data formats

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Resource	Category	Description
Research Competence Centres	Mentoring	A Competence Centre (CC) is a virtual hub dedicated to fostering research excellence through training and knowledge transfer. The CCs are community-based initiatives supported by a collaborative network of people providing expertise, best practices and services in relation to Open Science, and the promotion of cross-disciplinary collaboration
Research Resources and Services Discovery	Service	Search engine for research resources and services for domain specific searches tuned for researchers

Table 5.1: Resource Categories

5.2   Research Resources

EOSC aims to promote the 'Web of Data and Services' as a place to find FAIR digital resources for scientific research. An essential part of the EOSC Federation will therefore be FAIR data stored in data repositories and research databases, as well as any other FAIR digital objects[32] provided by the EOSC Nodes. This section describes what is meant by and required for each category to be onboarded to the EOSC Federation.

5.2.1   Research publications

Scientific publications are a major output of scientific research. Publications are most often published by journals and referenced by a PID. The EOSC Federation will automatically reference publications through OpenAIRE and be searchable via the EU Node resource catalogue. In the case where a Node has its own publishing and/or publication search service that is registered with the Node they should be made accessible via the EOSC AAI.

EOSC strongly recommends that publications should be Open Access and published in Open Journals as much as possible.

5.2.2   Research data sources

Research data sources provide data to the EOSC Federation to make up the "Web of Data". Data sources can be further divided into two categories - data repositories and databases. Data repositories hold data from a specific or a variety of different scientific domains and provide basic services like metadata, PIDs, searching and data access. Databases are domain specific repositories which curate data for a specific scientific domain or application area e.g. the Protein

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[32] For a definition of "FAIR Digital Object" see e.g. K. De Smedt et al. (2020), *FAIR Digital Objects for Science: From Data Pieces to Actionable Knowledge Units,* Publications 8, 21; doi:10.3390/publications8020021.

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Data Bank (PDB). Databases provide domain specific searches and analysis tools and often link to data in data repositories e.g. the original raw data. Linking between data repositories and databases is strongly encouraged and is fundamental to creating the Web of Data.

5.2.2.1   FAIR Data repositories

The EOSC Federation aims to provide FAIR data through repositories shared by the EOSC Nodes. The repositories must be onboarded as a service in one of the EOSC Nodes, be findable in the EOSC Federation catalogue and searchable through a custom search interface. Data repositories should implement a search function which is optimised to find data from the scientific domain they serve. EOSC Node data repositories should align with the FAIR principles and aim to implement them as rigorously as possible. In the case of sensitive data, they should be as open as possible but as closed as necessary. Data repositories should implement the *EOSC Guidelines for Research Data Sources*[33].

Data repositories in the EOSC Federation should measure the FAIRness of their data through FAIR metrics[34] and they should be able to demonstrate compliance to the FAIR principles by implementing at least the Findable and Accessible guidelines.

Each data repository should have a (documented) plan for the continuous improvement of the FAIR compliance of the data in the repository in order to approach full compliance with the FAIR principles in their domain e.g. via a dedicated committee or community effort tasked with improving the FAIRness of the data by reviewing metadata standards, with regular review processes.

Data repositories must have a data policy that governs the access to the data which conforms with the general data policy of the EOSC Federation.

Data must be citable via a Persistent IDentifier (PID) according to the "*Guidelines for creating a user tailored EOSC Compliant PID Policy*"[35] and the Persistent Identifier (PID) policy for the European Open Science Cloud (EOSC)[36]

Data repositories must have a long-term support sustainability plan for at least the next five to ten years, with the goal to be available for even longer for certain datasets (e.g. unique high quality datasets which are of high value and unique i.e. cannot be reproduced).

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[33] Paolo Manghi (2023), *EOSC-IF Interoperability Guidelines for Data Sources to onboard Research Products (0.2)*. Zenodo. https://doi.org/10.5281/zenodo.8362321.

[34] FAIR metrics are defined e.g. in https://quality.nfdi4ing.de/en/latest/FAIR/1_FAIR_Metrics.html.

[35] "Guidelines for creating a user tailored EOSC Compliant PID Policy" by FAIR-IMPACT (https://doi.org/10.5281/zenodo.14092489)

[36] European Commission: Directorate-General for Research and Innovation, Hellström, M., Heughebaert, A., Kotarski, R., Manghi, P. et al., A Persistent Identifier (PID) policy for the European Open Science Cloud (EOSC), Publications Office, 2020, https://data.europa.eu/doi/10.2777/926037

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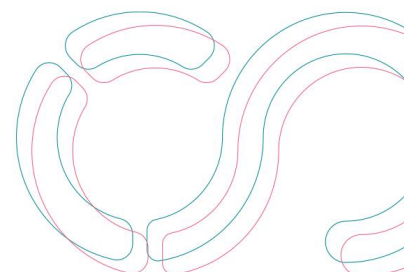
Data repositories are strongly encouraged to be certified by a community-endorsed certification scheme, such as[37]:

- CoreTrustSeal[38]
- Nestor Seal[39]
- ISO 16363 certification[40]

Data repositories must ensure that Metadata are harvestable via the standard protocols OAI-PMH (https://www.openarchives.org/pmh/).

The EOSC Federation aims to provide high quality research data for as many scientific domains as possible. Data repositories that are considered standards for their domain or community will be tagged as Trusted Data Repositories and promoted as such in the Federation. In the cases where the EOSC Node repositories are not community standards, they should link to community standard repositories if they exist, to increase their impact and reduce proliferation of data repositories.

5.2.2.2   Research databases

In addition to research data repositories, the EOSC Federation will provide access to research databases. Research databases go beyond providing data only: they provide curated results for a specific scientific domain or research area which are curated to provide scientists with easy access to peer reviewed data in their field. They usually include the tools for displaying insights based on the database contents. Some well-known databases have been in existence for over 50 years and are the "gold standard" for scientists and journals alike (e.g. the Crystallography Open Database[41]). The EOSC Federation will encourage and promote databases which are community standards, or that could potentially become standards. Research databases integrated as a scientific resource in the EOSC Federation must conform to the following criteria:

- Be accepted by the community as a standard source of FAIR data
- Be managed by a clear data policy for data reuse
- Provide machine access to data
- Be as open as possible (and as closed as necessary)
- Have a sustainability plan for 10 years or longer

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[37] An inventory of community-endorsed repositories can be found in Jahn, N. et al. (2023). *Study on the readiness of research data and literature repositories to facilitate compliance with the Open Science Horizon Europe MGA requirements (Version 1.0)*. https://doi.org/10.5281/zenodo.7728016.

[38] https://www.coretrustseal.org/

[39] https://www.langzeitarchivierung.de/Webs/nestor/EN/Zertifizierung/nestor_Siegel/nestor_siegel_node.html

[40] Equivalent to *Recommended practice CCSDS 652.0-M-1* from the Consultative Committee for Space Data Systems, https://public.ccsds.org/Pubs/652x0m1.pdf.

[41] https://www.crystallography.net/cod/

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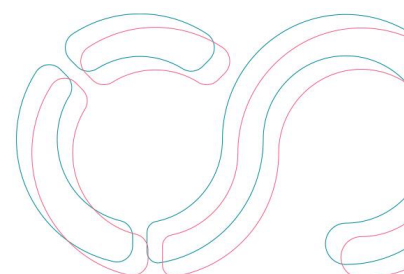
Research databases must register the resource metadata required by the EOSC Federation to be onboarded as a FAIR Resource in an EOSC Node. Refer to the guidelines for onboarding services to EOSC[42].

5.2.3   Research Data

Research data are provided by the Research Data Sources (see section 5.2.2) and are the evidence that underpins the answer to research questions, and can be used to validate findings regardless of its form (e.g. print, digital, or physical). These might be quantitative information or qualitative statements collected by researchers in the course of their work by experimentation, observation, modelling, interview or other methods, or information derived from existing evidence. Data may be raw or primary (e.g. direct from measurement or collection) or derived from primary data for subsequent analysis or interpretation (e.g. cleaned up or as an extract from a larger data set). Data may be defined as 'relational' or 'functional' components of research, thus signalling that their identification and value lies in whether and how researchers use them as evidence for claims. They may include, for example, statistics, collections of digital images, sound recordings, transcripts of interviews, survey data and fieldwork observations with appropriate annotations, an interpretation, an artwork, archives, found objects, published texts or a manuscript.
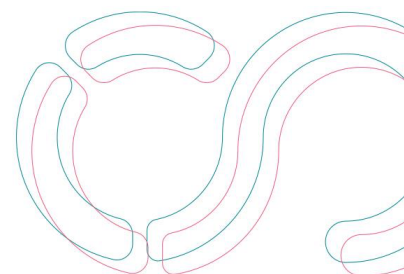
5.2.4   Research Software

Research Software is defined[43] as source code files, algorithms, scripts, computational workflows, and executables that were created during the research process or for a research purpose. Software components (e.g., operating systems, libraries, dependencies, packages, scripts, etc.) that are used for research but were not created during or with a clear research intent should be considered software in research and not Research Software. The EOSC Federation recognises that software plays a critical role in the scientific process to collect, process and interpret data. Software should be developed following best practices for scientific software and should be registered in a software repository and ideally in a software catalogue which EOSC Nodes can then register as a service in the EOSC Federation to make them findable in the EOSC Federated Catalogue. EOSC Nodes providing Research Software should follow the guidelines for software metadata in *"Research Software Metadata Guidelines (RSMD)"*[44] developed by the FAIR-IMPACT project.

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[42] Dietrich, M., & Scardaci, D. (2024). *Guidelines for Onboarding Resources to EOSC Exchange (v5.0)*. EOSC-Future. https://doi.org/10.5281/zenodo.10621226

[43] Gruenpeter, M. et al., 2021. Defining Research Software: a controversial discussion. Zenodo, https://doi.org/10.5281/zenodo.5504016

[44] Gruenpeter, M. et al. (2023), *Guidelines for recommended metadata standard for research software within EOSC*, Zenodo. https://doi.org/10.5281/zenodo.8199104.

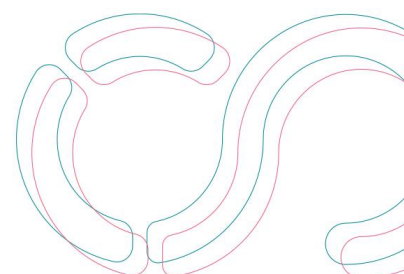|	
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5.2.5 Research Services

Scientific services, also referred to as Node Generic Capabilities (see Chapter 4), include those dedicated to supporting scientific research e.g. Virtual Research Environments (VREs), scientific data processing and inference services. Researchers require a diverse set of tools to help them be productive in their daily research tasks, these include writing, maintaining, packaging and sharing software, using workflows to process, publish and share data etc. Typical tools used in research which will be made available via the EOSC Federation include the following:

- **Notebooks** are widely used for processing data. The EU Node offers a generic Jupyter Notebook execution service. Nodes offering Notebooks services should offer virtual environments customized for the research domain(s) they serve with direct access to research data to avoid having to move them especially if they are large data.
- **Workflow engines:** many scientists make use of workflow engines to process data. There currently exists a wide variety of workflows, and it is expected that scientific domains (or EOSC Nodes) will have their preferred workflow engine(s). Nodes should provide workflow engine services close to the research data so data does not need to be moved and the results can be archived or persisted easily.
- **Virtual Research Environments** are temporary compute environments that contain tools and data enabling researchers to work interactively and remotely[45]. They may include services like Notebooks, Workflows and data management. They offer a complete desktop environment with the relevant scientific software. Nodes should provide direct access to data.
- **Digital Publishing Services** are used across disciplines for all parts of the research process. This includes scientific publishing as well as digital editions of sources, objects and texts or data publications. The service can be part of a workflow, including one or more repositories, metadata interfaces and data management consultation.
- **Other** - Nodes will offer other services for scientific products depending on the needs of their community. Services which include access to experimental facilities are currently not considered as part of the EOSC Federation.

All Research Services must be accessible either anonymously e.g. for open data repositories, or through an EOSC compliant AAI (cf. Chapter 4) in accordance with documented User Access Policies (see Chapter 6). The capacity of the services must be sufficient for the number of active user sessions foreseen when the Node enrolled.

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[45] https://bit.ly/virtual-research-environments.

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5.2.6   Research Training

Training material for research services and other services is essential for scientists to use them properly. Training material should be made available as an integral part of service delivery and discoverable via thematic domain/national/institutional training platforms.

EOSC Nodes are encouraged to have domain specific training platforms where domain specific training materials are registered and findable. EOSC Nodes should register domain specific training platforms with the EOSC Federation so they can be made findable under training. In future, user needs should be gathered to determine the benefits of a central EOSC training registry.

5.2.6.1   Inclusion criteria for training resources

In addition to meeting the common inclusion criteria to onboard all resource types, these criteria must be met to onboard training resources:

- Specify the learning outcomes, resource type (e.g. recorded lesson, textbook, activity plan, etc.), content resource type (e.g. video, slides, audio, etc.), and estimated duration (e.g. estimated work hours).
- Be in at least one of the European languages[46] except from metadata information, which shall be available in English.
- Incorporate information about the expected level of training and expertise to be achieved (beginner, intermediate, advanced, all) and required qualifications to access the training resource.

Providers should be encouraged to use the Quality Assurance Certification Framework produced by Skills4EOSC[47].
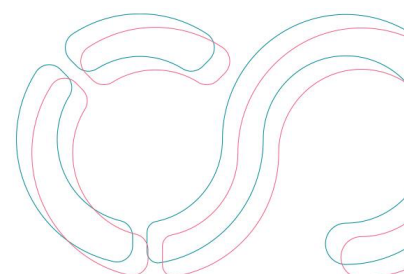
5.3   Research Interoperability guidelines

In order to enable seamless exchange of research resources across repositories intra- and inter-disciplines, thus fulfilling the Interoperability pillar of FAIR, protocols are needed to ensure compatibility among systems. The key to making datasets, tools and services inter-operable is standardisation[48]. Standards are by nature rather technical, but should always be informed by clear science goals to be fulfilled. To this end, they are expected to be domain specific and

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[46] https://european-union.europa.eu/principles-countries-history/languages_en
[47] https://www.skills4eosc.eu/resources/quality-assurance-certification-framework
[48]For example the Virtual Observatory Alliance https://www.ivoa.net/

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developed within technical working groups of the target science community. A layered architecture is likely required to connect the resources layer to the users in a seamless and transparent manner.
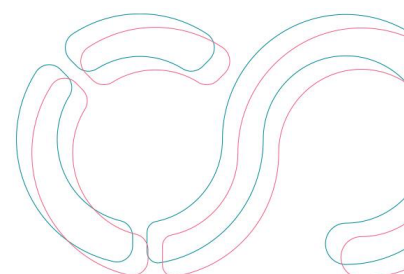
5.4   Scientific Competence Centres

Scientific communities are key to the EOSC Federation. They have the expertise necessary to carry out scientific research in their domain as well as process and analyse the data. Their competences are therefore essential for scientists who are new to the domain and/or want to reuse data. EOSC Nodes are encouraged to create Competence Centres which can gather these competences and make them available to users of the EOSC Federation Nodes. Competence Centres are encouraged to join the Competence Centre Network[49] established under the Skills4EOSC project. As the Federation develops, common understandings of Competence Centres and their relationships to Nodes should be defined, considering existing (national, thematic, institutional) centres developed outside of EOSC.

5.5   Scientific Resource and Service Discovery

This section describes the Resources Hub i.e. how research resources and services will be made discoverable via the EOSC Federation. It explains how EOSC Nodes have to publish their services to make them discoverable, and the means to access the discovery services.

It is recommended that each Node provide a User Space area (see Section 4.2.1 on Node Capabilities) offering a resource search engine service organised according to the categories described above in Section 5.1 so that EOSC Federation Users have a consistent user experience when navigating across Nodes. EOSC Nodes are therefore encouraged to have a landing page which follows a common look-and-feel, provides the same information per node and offers searching and discovering results for their resources in commonly defined categories. Domain knowledge is best (and in many cases only) understood by the domain experts at each node. Therefore, the Node search engine must be optimised according to the domain knowledge to find resources. A high-level search will be provided by the EOSC Federation main site which will use the metadata provided by each Node to help users find the right node(s) where the resource in question can be found. Once at the right Node Users will then use the Node's search engine to discover and access the resources they are looking for.

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[49] https://www.skills4eosc.eu/network/competence-centres

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6 Joining the EOSC Federation

The EOSC Federation is being built as a collaborative project between the European Commission, Member states, EOSC Association, and the EOSC Nodes. The process of how to become an EOSC Node is being defined as the build-up phase advances (see figure 3.1 for a tentative timeline of the build-up phase). This section defines the current state of the process and will be updated regularly to reflect new developments.

6.1 Build-up phase of the EOSC Federation

The EOSC Federation is currently being built in a succession of waves. The process of becoming a Node was kicked off in mid-2024 with a call to the community for expressions of interest. Following which a selection procedure was set up by the Tripartite Governance to assess the capacity of each candidate and to select the first wave of EOSC Nodes. In total 13 of the candidate nodes[50] were selected to join the EU Node to build the first implementation of the Federation in 2025. Work to identify and define the minimum Federating Capabilities the first wave of EOSC Nodes will need to implement is still underway. The outcomes will be integrated into the next version of the Handbook.
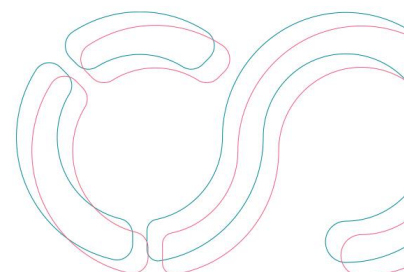
6.2 Applying to become an EOSC Node

The selection of the next wave of EOSC Nodes will be carried out in mid-2025 based on the list of expressions of interest from 2024 and new ones submitted in 2025. The exact dates for the call for candidate nodes will be announced by the EOSC Association on their website and newsletter. The EOSC Federation Governance will then proceed with the selection of the second wave of EOSC Nodes. Candidate nodes need to comply with the minimum requirements[51] summarised here:

1. **Legal status**: the organisation responsible for the EOSC Node must be a public-benefit legal entity (for now located in an EU Member State or an Associated Country) with legal personality and full legal capacity recognised in all Member States and Associated Countries, or an intergovernmental research organisation of European interest. The organisation must be able to conclude agreements with other partners participating in the activities of the node itself (e.g. providers making their data or services available to

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[50] BBMRI ERIC, CERN, CNR (Blue-Cloud 2026), CNRS (Data Terra), CSC – IT Center for Science, CVTI SR, Life Science Research Node (ELIXIR, EMBL, Euro-BioImaging ERIC, Instruct-ERIC), ESRF (PaNOSC), EUDAT, Foundation ICSC, NCN, NFDI, SURF
[51] https://eosc.eu/wp-content/uploads/2025/02/20250203_EOSC_Nodes_requirements-DRAFT-v24052024.pdf

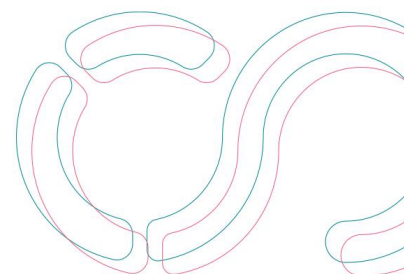|	
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EOSC through the node), with other nodes and/or with a potential future organisation representing the EOSC Federation.

2. **Large-scale, quality service provision**: EOSC Nodes shall be able to provide services at scale that are commonly used and endorsed by the research communities, operating in a compliant, sovereign, and secure environment.

3. **Capacity to onboard third-party services**: beyond offering its own services, an EOSC Node may have the capacity to onboard third-party services on it and to ensure that these services comply with the common quality standards, rules, and policies of the federation, including those related to security, sovereignty, transparency, and trustworthiness of these services.

4. **Capacity to contribute to EOSC core capabilities**: EOSC Nodes shall have the capacity to utilise and contribute to specified core capabilities to be offered across the federation such as Authentication and Authorization Infrastructure, resource catalogues and registry services, monitoring, accounting and helpdesk.

5. **Compliance with EOSC Federation rules and standards**: organisations that are responsible for EOSC Nodes retain autonomy to select which services they offer or share within the EOSC Federation, and to set specific policies for access and use of these services, including pricing-related policies for cost-intensive services. EOSC Nodes shall provide access to their services under documented policies and be able to comply, or to provide action plans to achieve such compliance with possible federation-wide agreed policies, protocols, standards and participation and access rules, including the EOSC interoperability framework, security (incl. cybersecurity) and sovereignty standards.

6. **Effective monitoring**: EOSC Nodes shall be able to monitor and report the activity of the services they provide within the EOSC Federation (e.g. monitoring usage of data, services and other relevant activities) to ensure the quality of the provided services, including the onboarded services provided by third parties, and the compliance with the Federation's rules and standards.

7. **Community engagement**: EOSC Nodes will strive to contribute to community engagement activities of the EOSC Federation, such as training activities, consultations, usability testing, communication, etc.

8. **Sustainability**: EOSC Nodes shall be able to confirm continued operations compliant to the EOSC Federation's requirements for ideally 5 years or more to ensure that they are reliable members of the EOSC Federation,

6.3 Establishing an EOSC Node

Establishing an EOSC Node means identifying the organisation and partners which can fulfil the minimum requirements. They need to identify a legal organisation which will represent them. Once they have ensured they can fulfil all the minimum requirements plus the requirements

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described in the EOSC Federation Handbook they are invited to apply to the EOSC Federation Governance to become an EOSC Node.

6.4   Legal and organisational steps

The node partners need to agree on how they will manage themselves and how they will comply with the policies of the EOSC Federation. At a minimum they will need to sign a Memorandum of Understanding that defines the role and responsibility of each partner. In some cases, partners could be required to sign a contract which defines the specific rules and regulations governing the EOSC Node. It is up to each node to decide how to manage themselves and will depend on the links existing between the partners and providers or resources which will be onboarded.

Once a node is accepted to be part of the EOSC Federation it will need to sign a legal agreement with the EOSC Federation Management Organisation which describes the conditions and policies of the EOSC Federation Nodes must comply with. The exact form of the agreement is not decided yet and will be added here once it is known.
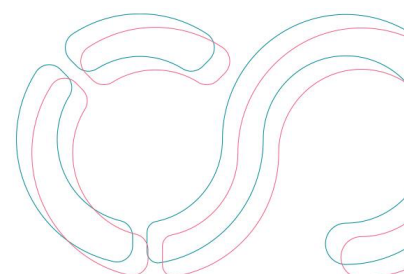
6.5   Policies and procedural steps

The EOSC Federation needs to ensure that all its members i.e. all EOSC Nodes, comply with a common set of policies concerning the different aspects which are considered to be part of the Federation e.g. privacy, cybersecurity, data, user access etc. The exact list of policies is not known yet but a document containing proposals produced during the writing of the Handbook could serve as the starting point. The list of policies will be updated here once they have been decided by the EOSC Federation Governance.

6.6   Technical steps to set up an EOSC Node

An organisation willing to join the Federation and become an EOSC Node should understand how its infrastructure can be mapped to the Node functions, as depicted in Section 4.2, identify potential gaps to be filled, and implement the connections to the federating capabilities. This can be translated into the steps described in table below:

Table 6.1: Steps to setup an EOSC Node
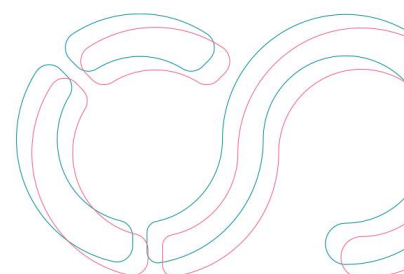
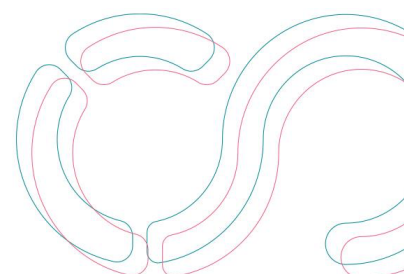|	Steps	Description
1	**Compliance with the EOSC Node reference**	The digital infrastructure behind each Node of the EOSC Federation should offer services and other resources to its users with an adequate

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Steps		Description
	architecture (Recommended)	quality. To achieve this, the EOSC Node should embed key support functions such as helpdesk, monitoring and accounting system, etc. The EOSC Node reference architecture of Chapter 4 assembles all the services to support organisations in making their digital infrastructure an EOSC Node. The list of EOSC Node recommended functions is available in Section 4.2 (Tables 4.1 and 4.2).
		While this is currently not a mandatory step, Nodes are strongly encouraged to align as much as possible (when meaningful) the architecture of their infrastructure to the EOSC Node reference architecture.
2	**Professionally operate the digital infrastructure (Mandatory)**	EOSC Node digital infrastructures should implement a Service Management System based on IT Service Management (ITSM) standards for their Technical Operations (see Section 4.5) and ensure Cybersecurity (Section 4.6).
3	**Publish/expose resources in/to the EOSC Federation Catalogue (Resource Hub) (Mandatory)**	Each Node must identify its Node Exchange selecting a subset of resources (services, datasets or other research products) that can be discovered and accessed by EOSC users under proper AUPs.
		Resources in the Node Exchange must be published in the EOSC Federation Catalogue operated by the EOSC EU Node (Resource Hub - Tier 3). Details on how to register resources in the EOSC EU Node Resource Hub are reported in Annex 1.
4	**Access to the Node resources via eduGain IDPs (Mandatory)**	Each node must operate an AARC Blueprint compliant AAI infrastructure made up of a Community AAI and an Infrastructure Proxy. The Node also needs to join the eduGAIN Federation as Service Provider[52].
5	**Connect to existing Federating Capabilities (Recommended)**	Each Node should analyse the Federating Capabilities of the EOSC Federation, connect its services to the mandatory ones, and select with which of the recommended ones it would like to federate. To connect, EOSC Nodes should follow the instructions of the relevant Interoperability Guidelines. Nodes can use technologies of choice or the reference implementation delivered by the EOSC EU Node to connect (see Annex 1). The list of the Federating Capabilities available in the EOSC Federation are listed in Table 4.3 of Section 4.3.1.

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[52] https://wiki.geant.org/display/eduGAIN/How+to+Join+eduGAIN+as+Service+Provider

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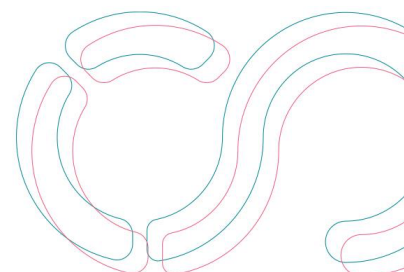| Steps		Description
6	**Enable new Federating Capabilities (Optional)**	Each Node can decide to enable new Federating Capabilities in the EOSC Federation in accordance with the EOSC Federation Governance.

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7 Annex 1 - EOSC EU Node Federating Capabilities

The following table presents the current EOSC EU Node[53] Federating Capabilities.

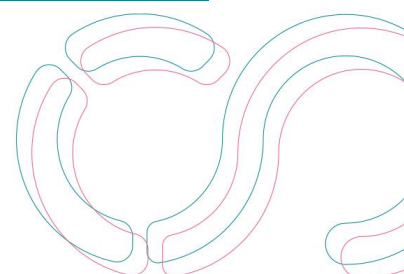| Resource Catalogues and Registry services	
Description	Catalogues that provide resource records to the EOSC EU Node and the [EOSC Resource Hub](#) and interfaces for resource publication and harvesting. The EOSC EU Node Service Catalogue include 3 different categories: ● **Tier 1 - EU Node native services:** Core and Generic services directly funded by EC through procurement; ● **Tier 2 - Services onboarded in the EOSC EU Node:** after onboarding via the appropriate process, these services are expected to be integrated with the EU Node Core services, respecting similar service level agreements; ● **Tier 3 - Services and Research Products discoverable in the EOSC EU Node Resource Hub:** resources registered in other EOSC Nodes made discoverable in the EOSC Federation by the EU Node through the Resource Hub.
Federating Capability (enabled by this service)	**Tier 2 Services onboarded in the EOSC EU Node:** This integration option applies to providers willing to make available their resources in the EOSC EU Node. It is expected that this option would require a tight integration with the EOSC EU Node. Integration guidelines for this option are not available yet. **Tier 3 Resources discoverable in the Resource Hub of the EOSC EU Node:** This integration option applies to organisations willing to establish their own EOSC Node and make their services and research products discoverable in the EOSC EU Node Resource Hub (mandatory step to join the EOSC Federation, see Section 4.6). It allows to connect resource catalogues from other EOSC Nodes to the federated catalogue hosted in the EU Node to enable other EOSC Nodes to: ● publish their resources in the EOSC EU Node Federated Catalogue; ● retrieve and add to their catalogue resources from the EOSC EU Node Federated Catalogue.
Relevant Interoperability Guidelines	● [EOSC Profiles: Guidelines for Onboarding Resources to EOSC Exchange (V5.0)](#) ● [Service Catalogue: Architecture and Interoperability Guidelines](#) ● [EOSC Interoperability Guidelines for Data Sources to onboard Research Products](#)

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[53] https://open-science-cloud.ec.europa.eu/

![EOSC Tripartite logo]

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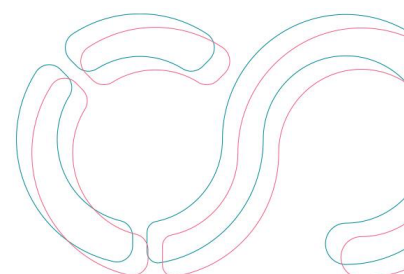| User Space	
Description	The User Space is a web interface that allows EOSC Node users to access all the underlying services of the EU Node. It allows users to manage their profile that includes information such as identifiers, preferences, affiliations, credits, notifications, etc.
Federating Capability (enabled by this service)	Not available
Relevant Interoperability Guidelines	Not available

Identity Management	
Description	Access to the EOSC EU Node services via federated credentials.
Federating Capability (enabled by this service)	AAI federation to enable the single sign-on over multiple EOSC Nodes.
Relevant Interoperability Guidelines	● AARC Blueprint Architecture ● AARC Guidelines

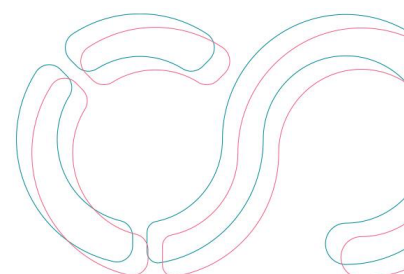| Application Workflow Management	
Description	The Application Workflow Management (AWM) allows EOSC users to deploy applications in the underlying EOSC EU Node cloud that have an associated deployment recipe (e.g. TOSCA templates, Ansible Playbooks, Helm charts). The AWM takes care of orchestrating applications described in TOSCA templates and Ansible playbooks, and supports their deployment defined through Helm charts, Docker compose files or other specification through Ansible commands.
Federating Capability (enabled by this service)	In addition to the EOSC EU Node Cloud, AWM can deploy applications in multiple cloud infrastructures. It offers a large and easy extensible set of interfaces and plugins, that will be soon exposed to end-users, towards public cloud providers such as Amazon EC2, Google Cloud Platform, Microsoft Azure, T-Systems OTC, Orange flexible engine, on-premises cloud management platforms such as OpenNebula, OpenStack and federated environments such as the EGI Cloud Compute. A Cloud Infrastructure can be connected to AWM using one of the available plugins, or developing an ad-hoc plugin.

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Application Workflow Management	
Relevant Interoperability Guidelines	● Definition of virtual infrastructures for supported AWM back-end and specification of credentials for backends. ● Plugins for new backends are developed by creating a new "CloudConnector" class. Detailed documentation will be available soon.

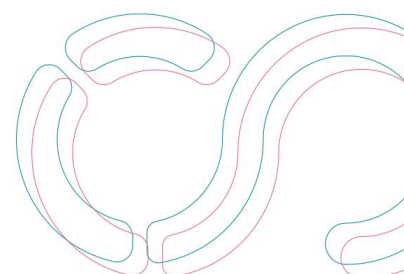| Service Monitoring	
Description	Monitoring is the key service needed to gain insights into the distributed infrastructure of EOSC. It needs to be continuous and on-demand to quickly detect, correlate, and analyse data for a fast reaction to anomalous behaviour before they affect end-users and productivity. Management teams can monitor the availability and reliability of the services from a high-level view down to individual system metrics and monitor the conformance of multiple SLAs. The Monitoring service was designed to support multiple entry points (different types of systems can work together) and be easily interoperable with other monitoring systems. The Monitoring service combines two operational monitoring services: the EOSC Core and the EOSC Exchange Monitoring Services, respectively monitoring the EOSC EU Node Core services and the services onboarded in the EU Node (tier 2 and tier 3).
Federating Capability (enabled by this service)	The Service Monitoring offers the following integration options: ● *Monitor an Onboarded Service*: monitor a single EOSC Service onboarded in the EOSC EU Node (Tier 2 or Tier 3); ● *Monitor an EOSC Node:* monitor a complete infrastructure (including EOSC Nodes) supporting multiple Services and Resources; ● *Integrate External Monitoring service:* configure the EOSC Monitoring service to accept monitoring data from third-party monitoring engines (e.g. other EOSC Nodes); ● *Combine Monitoring Results from multiple EOSC Nodes:* allow to combine the topology and the results of multiple infrastructures in a number of reports; ● *Third-party services exploiting EOSC Monitoring data:* a customer retrieves results from the EOSC Monitoring Service to use them in an external service/dashboard.
Relevant Interoperability Guidelines	● EOSC Monitoring: Architecture and Interoperability Guidelines

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Service Accounting	
Description	The Service Accounting is a platform designed to streamline metric collection, aggregation, and exchange across diverse infrastructures, providers, and projects. This comprehensive solution offers a REST API, empowering clients to seamlessly integrate their metrics into the system. This API accepts input from various resources, securely stores it in a database, and performs intelligent aggregation of incoming data.
Federating Capability (enabled by this service)	The Service Accounting offers the following integration options: ● Integrate with an aggregator (e.g. an EOSC Node) of accounting data; ● Integrate with a service provider; ● Make use of the accounting data.
Relevant Interoperability Guidelines	● [EOSC Accounting for Services interoperability Guideline](#)

Research Product Accounting	
Description	The EOSC Research Products Accounting collects usage activity from events from EOSC Data sources, i.e. EOSC services that host collections of research products, like articles, books, datasets, etc. and include data repositories, software repositories, and publication repositories. The service forms metrics of usage activity of these Data sources, categorizing the data retrieved by number of downloads, number of views, number of repositories and all derivative quantitative open metrics, comprehensively. UsageCounts service provides standards for usage data exchange, it complies to the COUNTER Code of Practice for reliable and comparable reports, it respects user's privacy via IP anonymization of usage events, it offers global coverage and enables accumulation of usage for the same research products by exploiting the metadata deduplication functionality of the EOSC Research Graph.
Federating Capability (enabled by this service)	EOSC data source managers (including EOSC Nodes) can participate in the Research Products Accounting Service following the interoperability guidelines of this service (see below) that specify methods and standards used to collect and process usage data in order to generate comparable, standards-based usage statistics. The guidelines follow the Release 4 and Release 5 of the COUNTER Code of Practice for e-Resources.
Relevant Interoperability Guidelines	● [EOSC IF Interoperability Guidelines for Research Products Accounting](#)

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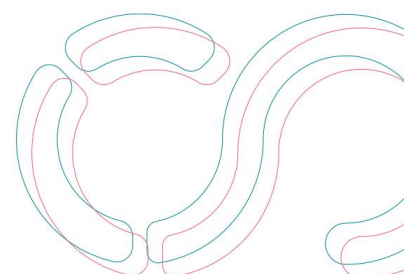| Order Management |
|---|
| **Description** | The Order Management Services facilitates the order processing, offering providers and communities several flexible options to integrate their own ordering process with the EU Node, enabling them to track all the orders received and to propose different actions on these orders. End-users can order resources, monitor user requests, and communicate with resource providers. Providers can specify offerings for their resources, configure their offerings using an API or ergonomic UI, handle orders placed in the system using Ordering API (integrate any existing OMSs). |
| **Federating Capability** (enabled by this service) | Not available |
| **Relevant Interoperability Guidelines** | ● [Order Management System Interoperability Guideline](#) |

Helpdesk
Description	The Helpdesk is the entry point and ticketing system/request tracker for issues concerning the available EOSC EU Node services. It implements efficient communication channels between users and providers of the EU Node services.
Federating Capability (enabled by this service)	The Helpdesk offers the following integration options: ● *Direct Usage:* an EOSC Node uses the EOSC EU Node helpdesk as a service with a dedicated tenant. Users of the EOSC Node can login to use the service in a dedicated area for that Node. ● *Ticket redirection:* an EOSC Node uses the EOSC EU Node helpdesk as first line of support. Any ticket created in the EU Node helpdesk related to this EOSC Node will be automatically redirected by email. ● *Full Integration:* an EOSC Node can integrate its own Helpdesk software with the EU Node Helpdesk, which enables full synchronisation by way of an API and is technology-agnostic of the Provider's Helpdesk solution. ● *Dedicated instance:* EOSC Nodes can also deploy a dedicated instance of the Helpdesk and to integrate that with the EU Node helpdesk. This requires bilateral discussion between the EOSC Node and the EU Node Helpdesk operator.
Relevant Interoperability Guidelines	● [EOSC Helpdesk: Architecture and Interoperability Guidelines](#)

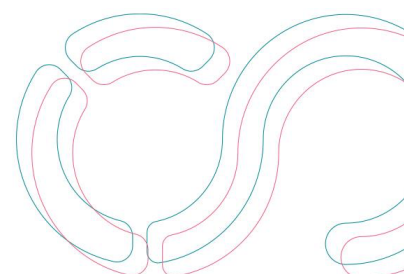| Document type:	Handbook
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PID Service	
Description	The PID Service offers a distributed service for storing, managing and accessing PIDs, including their essential metadata (PID records). The service offers a REST API and a native Handle API supporting the HDL protocol. Both APIs can be used by middleware applications, end-user tools and other services to reliably identify data objects over longer time spans and through changes in object location or ownership. The PID namespace is organised on the basis of the PID Prefix, while the PID Suffix identifies individual objects registered within the Prefix namespace. PID Prefixes are acquired through ePIC of which the PID service providers are members of. PIDs are globally resolvable through the DONA Global Handle Registry network.
Federating Capability (enabled by this service)	The Resource Catalogue of the EOSC Node and each approved EOSC Node catalogue will receive their own Prefix to clearly identify the individual catalogues and the services onboarded within. Through the onboarding policies and processes for enrolling EOSC Nodes, the PID namespace can be coordinated and deduplication can be managed. The PID service is offered both for EOSC Nodes and service providers.
Relevant Interoperability Guidelines	Not available

Table below lists the EOSC EU Node Exchange services part of the Tier 1 native services.

Service	Description
Compute/Storage	The EOSC EU Node offers cloud compute and storage resources to support processing, analytics, and other data and compute-intensive use cases. These resources are delivered to users and user communities via a resource discovery and resource allocation processes (i.e.VM Orchestration function) that interacts and integrates with the EOSC Core.
Containers	The Container Service enables the deployment of cloud native applications for scientific research communities on the EOSC EU Node. The container orchestration function automates the deployment, management, scaling, and networking of containers.
Bulk Data Transfer	The Bulk Data Transfer allows managing and transferring large data sets (e.g. in terabyte scale) in a reliable fashion, ensuring

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Service	Description
	data accuracy and integrity.
File Sync and Share	The File Sync and Share service allows users to securely share documents, audio-visual content and other file-based resources across multiple devices and with multiple people.
Interactive Notebooks	The Interactive Notebooks services provide a powerful and flexible environment for data scientists, analysts, and developers to create, run, and share Notebooks, enabling faster iteration, better collaboration, and more efficient data exploration and analysis.
Large File Transfer	The Large File Transfer service allows end-users to transfer large files between computers or devices over the Internet.

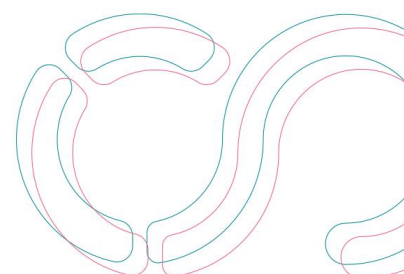| | Document type: | Handbook |
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8 Annex 2 - Recommended Guidelines

The goal of the EOSC Federation is to ensure that EOSC Nodes provide high quality resources by implementing a set of recommended guidelines. The EOSC Federation Handbook currently recommends adopting the following guidelines:

1. **"Guidelines for creating a user tailored EOSC Compliant PID Policy"** by FAIR-IMPACT (https://doi.org/10.5281/zenodo.14092489)
2. **"Guidelines for recommended metadata standard for research software within EOSC"**, produced by FAIR-IMPACT (https://doi.org/10.5281/zenodo.10786147)

The following guidelines are required but currently missing and should be produced in the future by the expert groups working projects or as part of the EOSC Association Taskforces activities:
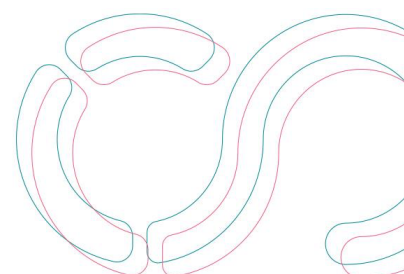
3. *Trustworthiness of data repositories* - guidelines should follow on the work by FAIR-IMPACT and FIDELIS INFRAEOSC projects
4. *Machine actionable data access* - guidelines needed to describe how machine will access research data.

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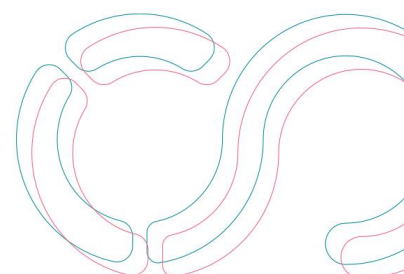Confidentiality level: Public
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9 Annex 3 - Definitions

The EOSC Federation is under development and therefore many terms are not yet clearly defined. The following definitions explain the concepts and vocabulary used in the EOSC Federation Handbook. These definitions aim to concisely describe the meaning of the terminology used.

- **EOSC User:** Anyone who is granted access to the EOSC Federation resources based on the recognition of their identity by a service provider registered with the EOSC AAI system.
- **Resource:** Services, catalogues, digital research objects (e.g. data, software), training resources, infrastructure and other assets that may be available in an EOSC Node and offered in the EOSC Federation.
- **Node Capability**: can be implemented by one or more services within one EOSC Node.
- **Federating Capabilities**: System of services provided by more than one EOSC Node in order to provide functions for research in the EOSC Federation.
- **Node Exchange**: services and other resources a Node makes available to the EOSC Federation. They contribute to the collective EOSC Exchange.
- **Resource Provider:** an organisation making a Resource available.
- **EOSC Resource Provider**: an organisation making a Resource available to the EOSC Federation, the resource is then called an EOSC Federation Resource and becomes part of the EOSC Node Exchange and of the overall EOSC Exchange.
- **EOSC Node Architecture:** A reference architecture that can be implemented by each Node of the federation for the operation of their services and resources.
- **EOSC Node:** An organisation complying with the EOSC Federation policies and legal framework, working at local, national, regional, thematic or European level. An EOSC Node offers Resources which provide added value to the EOSC Federation and delivers Federating Capabilities in collaboration with other EOSC Nodes. Each EOSC Node has its autonomy, its own governance model and offer in terms of resources. It operates its own platform, complying to the technical framework, and the EOSC Node architecture.
- **EOSC Node Host**: The legal entity representing an EOSC Node, and entering into the EOSC Collaboration Agreement.
- **EOSC Interoperability Framework (IF):** An extensible framework of guidelines that acts as the glue to support the interoperability and composability of EOSC Federated resources. The EOSC IF is a reference framework to promote standards and best practices but offers the freedom to providers to develop and operate provider-specific implementations while conforming to the EOSC IF guidelines and standards.
- **EOSC Federation:** the network of EOSC Nodes.

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- **EOSC Tripartite Governance:** The strategic coordination between the EU (represented by the EC), the Member States and Associated Countries represented by the EC Expert Group ('EOSC-Steering Board'), and the EOSC Association (represented by EOSC-A Board).

- **EOSC Tripartite Group:** The group of appointed representatives of the three parties of the EOSC Tripartite Governance.

- **Onboarding:** Resources are onboarded in an EOSC Node when they are integrated into an EOSC Node. The provider selects the most appropriate node based on the characteristics of the resource. For example, if a provider has a domain-specific data repository, it may choose a thematic node that best represents and serves that domain.

- **Enrolling:** an EOSC Node is enrolled in the EOSC Federation when the node is registered and integrated into the EOSC Federation. Once a node has been enrolled, it shares its resources, which can include resources provided by the node itself or by other resource providers onboarded on the EOSC Node.

- **EOSC Thematic Node**: Communities working in a specific scientific domain of research or with specific techniques. A technique can cover a large number of scientific domains, e.g. life sciences, photon sources.

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10 How the Handbook was written

The EOSC Federation Handbook (or "Handbook" for short) was written collaboratively by a team of Writers, Reviewers and Editors. The Editors' team was led by Andy Götz (EOSC Association and ESRF) together with Miguel Rey Mazón (TU Graz) from the EOSC Focus project, Mark Dietrich (EGI), and Robert Jones (EOSC-A and CERN). The Handbook is coordinated and owned by the EOSC Association.

A first draft of Chapters 1-3 was written by the Editors, Writers and Reviewers and provided to the EOSC Community for review in October 2024. The first full draft was provided to the EOSC Tripartite Governance in December 2024 for review. They gave extensive feedback and comments which were then reviewed and integrated into the second full draft by a subset of the Writers and Editors (marked with an asterisk below).
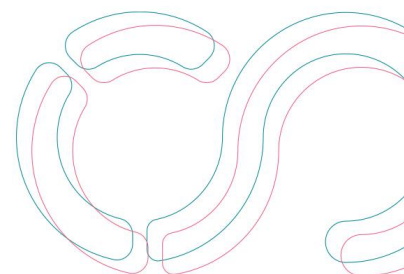
Contributors

The following groups of people contributed to the Handbook:

1. **Writers** - Abdulrahman Azab* (Sikt/Sigma2), Susanne Blumesberger* (Uni Wien), Korbinian Bösl (Uni Bergen), Sally Chambers* (DARIAH-EU), Helen Clare* (JISC), Oscar Corcho (UPM), Matthew Dovey* (JISC), Annika Glauner (ETH Zurich), Petr Holub (BBMRI-ERIC), Emma Lazzeri (CNR), Josefine Nordling* (CSC), Jana Pavlic-Zupanc (BBMRI-ERIC), Nanette Rissler-Pipka* (MWS), Martino Romaniello* (ESO), Davide Salomoni (INFN), Diego Scardaci* (EGI), Carlos Oscar Sorzano (Instruct-ERIC), York Sure-Vetter (NFDI), Jonathan Tedds (ELIXIR), Mark van de Sanden* (SURF), Kannan Venkatesh (ICHE), Alen Vodopijevec* (CESSDA).
2. **Reviewers** - Victoria Dominguez Del Angel (INRIA), Daniel Garijo (UPM), Natalia Galica (NCN PL), E. Gonzalez (UPM), Paolo Manghi (OpenAire), Peter Maccullum (ELIXIR), Tanja Maier (GÉANT), Jana Pavlic-Zupanc (BBMRI-ERIC), Tommi Suominen (CSC), Eirini Xemantilotou (Instruct-ERIC).
3. **Editors** - Andy Götz* (EOSC-A + ESRF), Bob Jones* (EOSC-A + CERN), Mark Dietrich (EGI/EOSC Focus), Miguel Rey Mazón* (TU Graz/EOSC Focus).

Process

The process of writing is being done one chapter at a time in the following steps:

1. In the first step, the Writers prepare a first draft of the chapter based on the pre-agreed sections. The contributions are discussed in weekly meetings with the Editors.
2. Based on the first draft, the Editors make an improved draft which flows more smoothly, taking care to avoid repetitions and inconsistencies. This second draft is submitted to the Writers to check and comment.

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3. Following this, the Reviewers are requested to review the draft and comment on it. Their comments are discussed in a common meeting where it is agreed upon how to integrate them.
4. The Editors prepare a new draft which is then submitted to the EOSC Tripartite Group (made up of representatives of the European Commission, the Member States and the EOSC Association) for comments. The Editors integrate the comments from the Tripartite Group into a consolidated version.

Current Version

The present document constitutes the first version of the EOSC Federation Handbook. This version of the Handbook focuses on the period up to the end of 2027, when the current Framework Programme Horizon Europe will finish; more specifically, it serves as starting point for the build-up phase of the EOSC Federation during 2025-2026. During this period, the goal is to demonstrate how the EOSC Federation could function with a limited budget, when participating organisations will be expected to finance their contributions using their own resources (national, regional, thematic). Although the Handbook makes recommendations about the components that should be put in place to ensure a successful transition from 2027 and beyond, at the time of writing (2024-2025) many topics remain undefined and will require input from the first wave of EOSC Nodes. The results of the build-up phase will establish a long-term, sustainable plan on which the EOSC Federation can be based. The Handbook will need to be updated in consequence to reflect changes in governance, and structure of the EOSC Federation.

Acknowledgments