EOSC Architecture and Interoperability Framework

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Dissemination Level of the Document

Public

Abstract

This document builds on the output of the *EOSC Interoperability Framework* Report produced by the EOSC Executive Board Working Groups FAIR and Architecture, past EOSC projects (EOSC Enhance, EOSC-hub, OpenAIRE Advance, etc.) and on work carried out during the EOSC Future project preparation.

The document highlights why an *EOSC Interoperability Framework* (EOSC IF) is needed and defines a light-weight process to build such a framework. It focuses primarily on the definition of the Interoperability Framework governance and on aspects related to interoperability in the *EOSC-Core* and *EOSC-Exchange* platforms.

Important Note

This document has been prepared for the purposes of public consultation to elicit feedback on the EOSC Inoperability Framework concept and its proposed governance. It is currently in draft form.

Version History

Version	Date	Authors/Contributors	Description
V0.1	26/10/2021	Licia Florio (GEANT), Michelle Williams (GEANT)	Initiation – Proposed ToC – First draft
V0.2	13/12/2021	Mark Van de Sanden (SURF), Paolo Manghi (OpenAIRE), Diego Scardaci (EGI), Licia Florio (GEANT), Michelle Williams (GEANT), Keith Jeffery (EPOS ERIC)	Second Draft
V0.3	13/12/2021	Mark Van de Sanden (SURF), Paolo Manghi (OpenAIRE), Diego Scardaci (EGI), Licia Florio (GEANT), Michelle Williams (GEANT), Keith Jeffery (EPOS ERIC)	Version sent to the TCB for review
V1.0	22/12/2021	Mark Van de Sanden (SURF), Paolo Manghi (OpenAIRE), Diego Scardaci (EGI), Licia Florio (GEANT), Michelle Williams (GEANT), Keith Jeffery (EPOS ERIC), Owen Appleton (EGI), Ron Dekker (TGB), Mike Chatzopoulos (ATHENA)	Final Version submitted to EC

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Table of Contents

Table of Tables

Table of Figures

Glossary

EOSC Future project Glossary is incorporated by reference: https://wiki.eoscfuture.eu/x/JQCK

List of Abbreviations

Acronym	Definition
AAI	Authentication and Authorisation Infrastructure
AARC	Authentication and Authorisation for Research and Collaboration
AD	Area Directors
AEGIS	The AARC Engagement Group for Infrastructures
AP	Authentication Profile
API	Application Programming Interface
CC-BY	Creative Commons Attribution Only 4.0 license
CC0	Creative Commons CC0 1.0 Public Domain Waiver
EIAB	EOSC Interoperability Advisory Board
EIAC	EOSC Interoperability Area Chairs
EOSC IF	EOSC Interoperability Framework
ESWG	EOSC Sustainability Working Group
IAB	Internet Architecture Board
IESG	Internet Engineering Steering Group
IETF	the International Grid Trust Federation
IGTF	Interoperable Global Trust Federation
ISA	Information Sharing Architecture
FAIR	Findable, Accessible, Interoperable, Reusable
MVE	Minimum Viable EOSC
PID	Persistent Identifier
PMA	Policy Management Authority
RDA	Research Data Alliance
RI	Research Infrastructures
SME	Small and Medium-Sized Enterprise
TCB	Technical Coordination Board (TCB)
W3C	W3C (World Wide Web Consortium)
WG	Working Group
WP3	EOSC Future Work Package 3 Architecture and Interoperability

Executive Summary

This document builds on the output of the *EOSC Interoperability Framework Report*[1] produced by the EOSC Executive Board Working Groups FAIR and Architecture, past EOSC projects (EOSC Enhance, EOSC-hub, OpenAIRE Advance, etc.) and on work carried out during the EOSC Future project preparation.

The document highlights why an *EOSC Interoperability Framework* (EOSC IF) is needed and defines a lightweight process to build such a framework. It focuses primarily on the definition of the Interoperability Framework governance and on the aspects related to interoperability in the *EOSC-Core* and *EOSC-Exchange* platforms.

The EOSC IF is built from a wide range of components, referred to here as interoperability guidelines or simply guidelines. These components can be anything ranging from a guideline, standards, API, a policy framework, etc. The EOSC IF consists of governance and services for the purpose of proposing, accepting, registering and promoting EOSC Interoperability Guidelines. The EOSC IF comprises the *EOSC-Exchange* Interoperability Framework and the *EOSC-Core* Interoperability Guidelines.

The *EOSC-Exchange* Interoperability Framework implicitly includes all standards, formats, and guidelines used in science, provided they meet the criteria defined by the EOSC IF governance.

A governance process for the EOSC IF is needed to define and apply the same criteria for inclusion for all interoperability guidelines that will be part of the EOSC IF. Appendix A describes a draft process for requesting inclusion in the *EOSC Interoperability Framework*, along with a description of the governance overseeing the process. Such a process will ensure that a fair and transparent assessment is applied to all requests, from within the project or outside.

Section 2 describes the EOSC Architecture to which the EOSC IF applies. The EOSC Architecture envisages different interoperability and integration models that can be encountered in the EOSC landscape. One of them is the interoperability with the *EOSC-Core* platform, which is described in detail in Section 4.

Section 3 reports on the analysis done in Work Package 3 (WP3) to collect science use cases to identify requirements and gaps in the EOSC IF, which resulted in *D3.1 Science Cases for Development of EOSC Architecture and Frameworks*; this section summarises the results of D3.1 and explains how WP3 Working Groups (recently established) are working to produce the required interoperability output to support the identified requirements.

Section 4 describes the interoperability with *EOSC-Core*, whilst Section 6 describes the interoperability between research collaborations and between e-Infrastructures and research collaborations.

Section 6 describes the proposed governance of the *EOSC Interoperability Framework*.

The first version of this document has solicited inputs by the members of the Technical Coordination Board (TCB) as well as WP3 members. Following the consultation with the larger EOSC community, inputs will be captured in the updated version(s) of the EOSC IF framework, which will managed as a stand-alone document prior to the publication of the final version of this document (D3.2b).

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[1] https://dx.doi.org/10.2777/620649

1 Introduction

EOSC Future is working to improve and enhance the federated entry point to EOSC and the *EOSC-Core* capabilities behind it. The *EOSC Interoperability Framework* (and the set of *EOSC-Core* services that are being delivered) aim to facilitate interdisciplinary research, and anticipate the realisation of wide-ranging benefits:

- **Users** (researchers, research organisations) will be able to find, compose, and reuse resources (e.g., services, research publications, data, software, etc.) across disciplines and communities through a resource sharing framework.
- **Providers** of resources will be able to describe and publish their resources through EOSC into multiple locations, including the *EOSC Portal*.
- **Researchers** will be able to gain access to and use resources beyond their discipline of practice with a single set of credentials and openly share their scientific results.
- **Research communities** will be able to describe their Open Science practices and implementation roadmaps via common frameworks and be inspired by Open Science roadmaps shared by other communities.
- **Policy makers** (including funders, organisations, and ministries) will be able to access the overall, up-to-date view of EOSC resources, to build, implement, and consult Open Science indicators (such as for openness and FAIRness).
- **Industry actors** (such as SMEs and large enterprises) will be able to access, value, reuse, and build innovation out of research results and procure their resources to providers and EOSC end users.

EOSC Future Work Package 3 Architecture and Interoperability (WP3) is a key driver in the technical delivery of these objectives to facilitate the cross-discipline collaboration of researchers, providers, and research communities. The scope of WP3 is to further enhance the EOSC architecture, as well as the interoperability guidelines and frameworks needed for the *EOSC-Core* and EOSC MVE capabilities[2] to offer an integration layer for Research Infrastructures (RIs), providers (operating in the research sector as well as commercial) and researchers. To achieve this, WP3 collaborates with WP4 and WP5 regarding design implementation, and with WP7 on the operational aspects, and seeks input from the clusters in the EOSC Future project as well as from other research communities and the projects funded under the INFRAEOSC-07 and INFRAEOSC-05 regional projects.

Relevant prior work, some of which was carried out during the preparation of the EOSC Future Description of Work, has resulted in a clear and accepted EOSC Architecture that can be used as a solid foundation to build upon. The architecture, which is presented in the following sections, highlights functionalities and components, but requires an additional 'layer' to define how they are interconnected to work seamlessly. This is the role of the *EOSC Interoperability Framework*. As indicated in the *Interoperability Framework Report*[3] from the EOSC Executive Board Working Groups FAIR and Architecture, 'achieving interoperability within EOSC is essential in order for the federation of services that will compose EOSC to provide added value for service users, no matter which scientific disciplines they work on'.

This document, which builds on the output of the *EOSC Interoperability Framework* Report (as well as on prior results) highlights why an *EOSC Interoperability Framework* is needed and defines a light-weight process to build such a framework. The document focuses primarily on the definition of the Interoperability Framework governance and on the aspects related to the interoperability with the *EOSC-Core*.

The EOSC IF recognises that research infrastructures have been working on interoperability within and across their infrastructures for many years. Interoperability guidelines are being created with the goal to help Resource Providers to integrate within research infrastructures and with the *EOSC-Core* (where the *EOSC-Core* components are also interoperable). The EOSC IF builds upon this existing foundation, creating an overarching framework that encompasses *EOSC-Core* and the interfaces necessary to accommodate links to community interoperability frameworks. For example, in EPOS ERIC the delivery framework covers the central integrated core services (portal/catalogue etc) and all the other portals (community-based) and all the asset (digital object) suppliers. Governance (legal, organisational interoperability) and technology (semantic, technical

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[2] *D2.5a Inventory of Core Functions and Inclusion Criteria*, https://wiki.eoscfuture.eu/x/wQAhAQ
[3] https://dx.doi.org/10.2777/620649

interoperability) are the main two pillars. Similar interoperability frameworks may exist within other research infrastructures.

The EOSC IF is also composed by the same two main elements: governance and technology. Together, they support the interoperation of Core and Exchange resources across multiple research contexts. The EOSC IF consists of governance and services for the purposes of proposing, accepting, registering and promoting EOSC Interoperability Guidelines. The EOSC IF comprises the *EOSC-Exchange* Interoperability Frameworks and the *EOSC-Core* Interoperability Guidelines. The *EOSC-Exchange* Interoperability Frameworks implicitly consist of policies (organisational intent) refined as guidelines (operational recipes) implemented as appropriate in IT architecture as assets such as: documents, procedures, workflows, scripts, code, datasets, formats, and guidelines used in science, which are inter-related with rich semantics and can be (re-)used by IT services, provided they meet the criteria defined by the EOSC IF governance.

Arguably, interoperability will not be achieved until the results of EOSC Future (and previously defined best practice, profiles and guidelines) are actively used by the research community and e-Infrastructures. To facilitate the adoption, it is proposed that the *EOSC Interoperability Framework* maintains within its governance a registry of those guidelines to acknowledge and promote this foundation. However, whilst research communities, e-Infrastructures, 07 projects and service providers still retain their freedom to use any standard and best practice that suits their needs, they will need to deploy some of the EOSC interoperability guidelines to achieve interoperability with the *EOSC-Core* (more details on the capabilities for the *EOSC-Core* can be found in the deliverable *D2.5 Inventory of Core Functions and Inclusion Criteria*).

WP3 is working to establish a basic governance structure around the EOSC IF to provide and manage procedures to populate the EOSC IF with standards, best practices and guidelines that are already being used by the research communities and e-Infrastructures or that will be developed during the EOSC Future lifetime. An initial list of main standards and interfaces per technical area was captured in the EOSC Future Description of Work (see Appendix D); this is the starting point to populate the EOSC IF.

1.1   In scope for this document

It is known that the EOSC Future project operates in a multifaceted landscape, where many thematic and regional projects have sought to create and implement their own community best practices and standards. The EOSC Future project does not intend to create new practices and standards impose them on the research community, rather, the *EOSC Interoperability Framework* is the wrapper that sits around the elements that have already been widely agreed and presents an opportunity to structure those elements and to identify (and fill) the gaps.

The EOSC Executive Board Interoperability Framework Report identified different interoperability layers (all of which are important to achieve full interoperability) and provided high-level recommendations for each (see Appendix E). This document, however, focuses on Technical and Semantic Interoperability, whilst legal and organisational interoperability is outside WP3's scope.

Whilst WP3 acknowledges the need to provide practical value to communities and help researchers to answer questions such as, What metadata do I need to provide to be interoperable with other resources in the EOSC? and What license should I apply to my work? Licencing will not be addressed in this version of the document.

Finally, the high-level principles defined in the EOSC *Rules of Participation*[4], are taken into account for the interoperability framework, namely:

- EOSC is based on the principle of openness,
- EOSC resources align with FAIR principles[5],
- EOSC services align with EOSC architecture & interoperability guidelines,
- EOSC is based on principles of ethical behaviour and research integrity,
- EOSC users are expected to contribute to EOSC,
- EOSC users adhere to terms and conditions associated with the resources they use,

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[4] https://dx.doi.org/10.2777/30541
[5] https://www.go-fair.org/fair-principles/

- EOSC users reference the resources they use in their work,
- Participation in EOSC is subject to applicable policies and legislation.

2 Overview of the EOSC Architecture and Interoperability Framework in WP3

This section provides an overview of the EOSC Architecture and Interoperability Framework which has been defined by the EOSC Sustainability, Architecture and FAIR Working Groups; this model was further enhanced during the EOSC Future proposal preparation, and it has been adopted by the EOSC Future project. Work is currently ongoing to implement different components. WP3 coordinates the further enhancements of the architecture based on the experience gained during the implementation and emerging needs from the EOSC Community.

2.1 A Minimum Viable EOSC

While definitions and the components of EOSC were developed in previous projects (e.g., EOSCpilot, EOSC-hub), the prevailing definition of Minimum Viable EOSC has risen from the work done within the EOSC Sustainability Working Group (ESWG) and Architecture Working Group (EAWG).

Via an open consultation process, the ESWG has developed the concepts of the *EOSC-Core*, *EOSC-Exchange* and Minimum Viable EOSC (MVE). These concepts have been described in the *Solutions for a Sustainable EOSC* report[6], also known as the FAIR Lady report. On the basis of the FAIR Lady report, the EAWG has developed a high-level view (see Figure 2.1) to place the *EOSC-Core*, EOSC-Exchange and MVE in context with the Research Infrastructure and e-Infrastructures (i.e., EOSC Federation) and the research community at large.

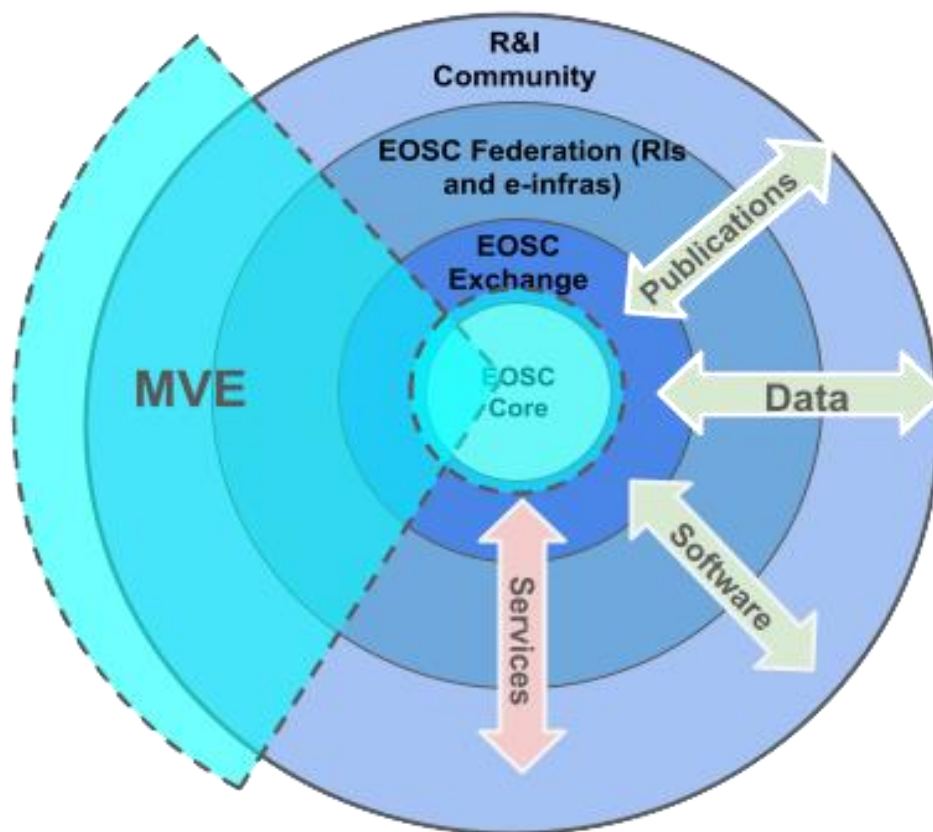*Figure 2.1: High-level diagram of the EOSC depicting the relationship between EOSC-Core, EOSC-Exchange, EOSC-Federation and the MVE*

The EAWG has defined the *EOSC-Core*, *EOSC-Exchange*, EOSC Federation, and MVE as:

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[6] EOSC Sustainability Working Group: Solutions for a sustainable EOSC: A FAIR Lady (olim Iron Lady) report from the EOSC Sustainability Working Group (2020), DOI: 10.2777/870770

- *EOSC-Core*: the set of enabling services required to operate the EOSC.
- *EOSC-Exchange*: the set of federation resources registered to the EOSC by Research Infrastructures and Science Clusters to serve the needs of research communities and eventually widening to the public and private sector.
- EOSC Federation: the set of resources provided by Research Infrastructures and Science Clusters to the respective communities.

The Minimum Viable EOSC acts as a container for EOSC resources:

- The subset of EOSC resources necessary to provide added value for users at a given moment in time, i.e., to allow essential services and research products (e.g., publications, datasets, software) to be discovered, composed, accessed and analysed via the EOSC;
- The subset of *EOSC-Core* components and services required to operate and deliver such resources.

An initial or 'beta' version of the MVE has been created collaboratively by other projects, including: EOSC-hub, EOSC-Enhance, eInfraCentral and OpenAIRE, incorporating early work of the thematic clusters and regional projects. EOSC Future will bring the MVE (as depicted in Figure 2.1) into production.

2.2   EOSC (Future) Architecture

Considering the framework described above, the EOSC Future project is working to expand and develop this vision into a concrete end result that can be designed, implemented, tested, improved and refined throughout the project lifecycle. This involves not only defining the 'layers' of EOSC but also the elements and the glue within them and how they are interconnected. A high- level view of the EOSC architecture is shown below in Figure 2.2
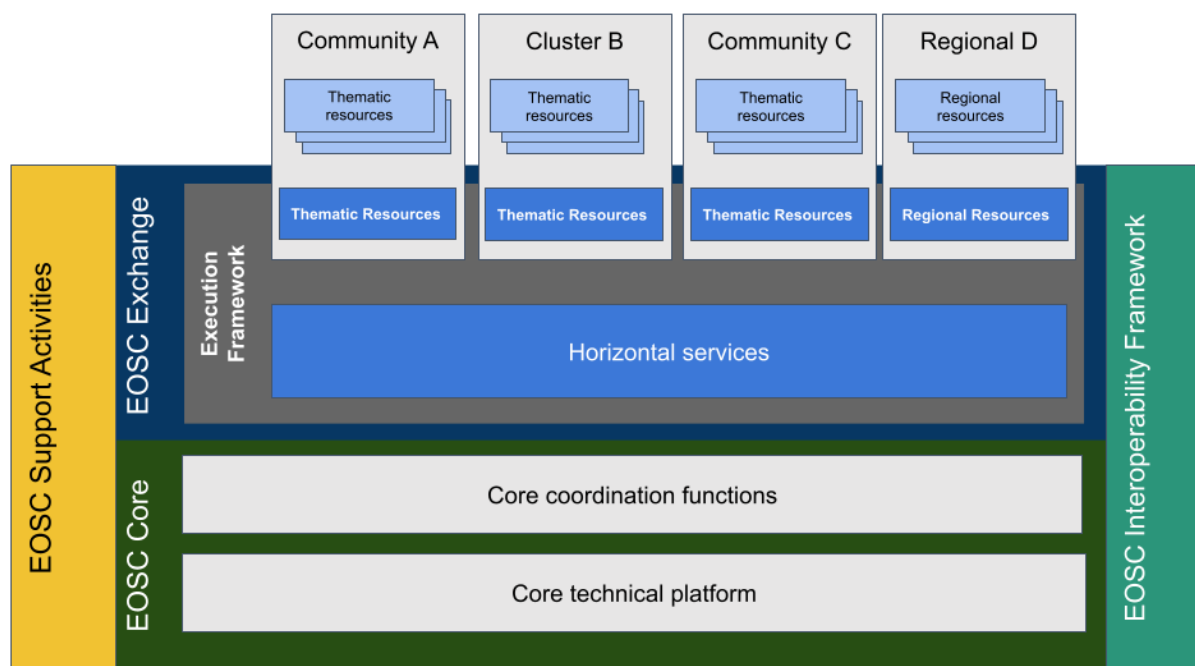
Figure 2.2: EOSC (Future) High-level Architecture

This high-level architecture for EOSC comprises the following elements:

- *EOSC-Core* is the set of internal services which allow EOSC to operate. It includes a core technical platform that facilitates EOSC operations, upon which the researcher-facing resources in the *EOSC-Exchange* can rely and integrate as appropriate. It also includes non-technical coordination functions, such as the onboarding and security coordination, which operate and facilitate the technical platform.
- *EOSC-Exchange* is the set of federation services and other resources registered into the EOSC by Research Infrastructures and Science Clusters to serve the needs of research communities and the widening to the public and private sector. Generic services and resources which target heterogeneous scientific domains and research communities are identified as *Horizontal Services*. Resources that

target users from a specific science, community and/or regional domain are identified as Thematic and/or Regional Resources. The capability to compose resources across horizontal and thematic and/or regional resources in compliance with the *EOSC Interoperability Framework* is defined as the Execution Framework. While it is expected that the majority of the *Horizontal Services* are provided by the e-Infrastructures (e.g., EGI, EUDAT, OpenAIRE, GÉANT), generic services and resources offered by the Science Cluster communities will also be offered as a horizontal service.

- **EOSC Interoperability Framework (EOSC IF)** provides the procedures and services required to support a flexible framework of standards and guidelines that facilitate the interoperability and composability of EOSC resources in the *EOSC-Exchange* via the *EOSC-Core*. As such, it leverages a semantic overlay where EOSC resources can be associated to the standards and guidelines (the IFs) they comply to, and therefore, be related by composability and interoperability features, across communities and providers. The EOSC IF is defined as a Reference Architecture Framework, which enables and governs:
  - A 'System of Systems' *EOSC-Core* architecture, via consultation and consolidation with the communities: the set of interoperability guidelines required for EOSC Providers to engage with the *EOSC-Core* and benefits from its added value services;
  - A registry database of EOSC Interoperability Guidelines as defined, used, and proposed by the communities, which enables providers to clearly specify the interoperability boundary of EOSC resources and oversee the interoperability frameworks adopted by communities.
- **EOSC Support activities** sit alongside the *EOSC-Core* and *EOSC-Exchange*, and comprise the training, engagement, and other human-centric activities which make EOSC more attractive and easier to use, and help users benefit from it more easily once engaged.
- **Science Clusters and Communities** will be embedded in EOSC through the work of EOSC Future but will continue to operate outside of the EOSC for their specific community. These include the Science Clusters (from the INFRAEOSC-04 call), the Regional Initiatives (from the INFRAEOSC-05 call), as well as national communities, other research communities and less organised groups from the long tail of science and research. They will bring a rich set of resources to EOSC but will also have resources and other elements outside EOSC, which targeted to their own individual communities, including richer ontologies and domain-specific information and support.

2.3   *EOSC Interoperability Framework* Foundations

As already mentioned in this document, previous work has been done to identify relevant dimensions for the *EOSC Interoperability Framework*. This document builds on three main outputs: the ***EOSC Interoperability Framework* report**[7] from the EOSC FAIR Working Group and Architecture Working Group of the previous EOSC Governance, the **interoperability guidelines**[8] developed by EOSC-hub, and the work to prepare the ***EOSC Future Description of Work***. Whilst these are not the only contributions, they encapsulate feedback from many stakeholders and are described below.

During the discussions and preparatory work in developing these outputs, two architectural concepts were frequently used: the Reference Architecture model and the System-of-Systems approach. While these two concepts are different, the concepts are complementary to each other. Both concepts allow freedom to a large extent for system engineers to compose new and complex solutions based on existing services and resources from different domains based on guidelines, standards and APIs promoted through the EOSC IF without specifying the technical implementation details. The System-of-Systems approach allows communities to develop their own standards and best practices to be used within their own community domain to address their scientific challenges. While adopting the EOSC IF guidelines, System of Systems will lower the barriers for communities to use resources from other RIs and e-Infrastructures.

2.3.1   EOSC IF as a Reference Architecture as per EOSC Architecture and FAIR WG EOSC IF Report

In the *EOSC Interoperability Framework* report, the EOSC Architecture and FAIR WG presented the approach of the EOSC IF as a Reference Architecture. This approach was derived from the European Interoperability

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[7] https://dx.doi.org/10.2777/620649
[8] https://wiki.eosc-hub.eu/display/EOSCDOC/EOSC+Technical+interoperability+guidelines

Reference Architecture[9] developed via the ISA[2] programme.[10] In EOSC-hub, a similar approach has been taken to model the EOSC Technical Architecture[11] as a Reference Architecture. The reference architecture provides service providers and system engineers independence and freedom to make implementation technical choices to develop a service and/or to maintain research products while complying to the EOSC IF guidelines to support interoperability and composability.

The report provided various high-level recommendations, two of which listed below:

- Detailed specification of architectural building blocks. The architectural building blocks that compose the *EOSC Interoperability Framework* need to be further detailed. This should be done hand in hand with the communities, many of which already have their interoperability practices in place.
- Establishing governance structure and maintenance of the framework. Since the *EOSC Interoperability Framework* is designed with extension and evolution in mind it is of utmost importance to establish a governance structure and maintenance organisation to guide, organise and keep the work together. This is especially important when implementing the core framework that will set the foundation for the future. This recommendation is taken forward in this report.

The work done in the EOSC Architecture and FAIR WG was at a high-level, modelling the Reference Architecture, while EOSC-hub provided some initial guidelines[12] on Common (e.g., *Horizontal Services*) and Federation services (e.g., *EOSC-Core*). **The aim of EOSC Future is to make the EOSC IF operational for system engineers, research collaborations, service providers, to allow them to compose solutions on the basis of services and research products made available through EOSC.** Therefore, it is important to propose standards and guidelines with sufficient technical details to make them usable.

2.3.2 System-of-Systems approach: how EOSC IF enables Interoperability and composability models in the EOSC Architecture

The EOSC Future Description of work, defines the *EOSC Interoperability Framework* (EOSC IF) as the glue to connect different kinds of resources provided across thematic domains and infrastructure boundaries together. This aligns with the EOSC Future vision of a System of Systems, which is based on the idea that different independent systems, services, data and resources operated within different domains, can be composed to create a homogenous operational system (adopting a bottom-up approach rather than a top-down approach to interoperability). Such a system regulates and negotiates its rules of participation with the resource providers, based on a trade-off between enabling layer cost and providers integration cost, and on a general principle of 'opportunity' rather than 'obligation'. The *EOSC-Core*, via the *EOSC Interoperability Framework*, aims to implement this vision by offering EOSC Providers a flexible framework to integrate with the EOSC itself and to describe the relationship between their resources and existing standards and guidelines (IFs), thereby becoming an enabler to mediate, bridge, and interoperate between different domains.

The *EOSC Interoperability Framework* also states that 'the EOSC IF will be composed of a rich set of policies and guidelines on standards and APIs which will be promoted within EOSC. The EOSC IF will be an open and flexible framework to:

- Allow the inclusion of any guidelines (e.g., technical, non-technical and/or domain specific) which lowers the barriers of users to make use of resources made available through EOSC.
- Evolve over time when new standards and practices become popular replacing old and/or current standards and practices.

The EOSC IF needs to provide guidelines for providers to connect resources to *EOSC-Exchange* but will also provide guidelines to be adopted within services made available through *EOSC-Core*, supporting the composability and integration of resources across boundaries.

The diagram below shows the different types of composition, integration and interoperability that can be encountered in the EOSC landscape.

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[9] https://joinup.ec.europa.eu/collection/european-interoperability-reference-architecture-eira/solution/eira
[10] https://ec.europa.eu/isa2/isa2_en
[11] https://www.eosc-hub.eu/deliverable/d104-eosc-hub-technical-architecture-and-standards-roadmap, section 5.1
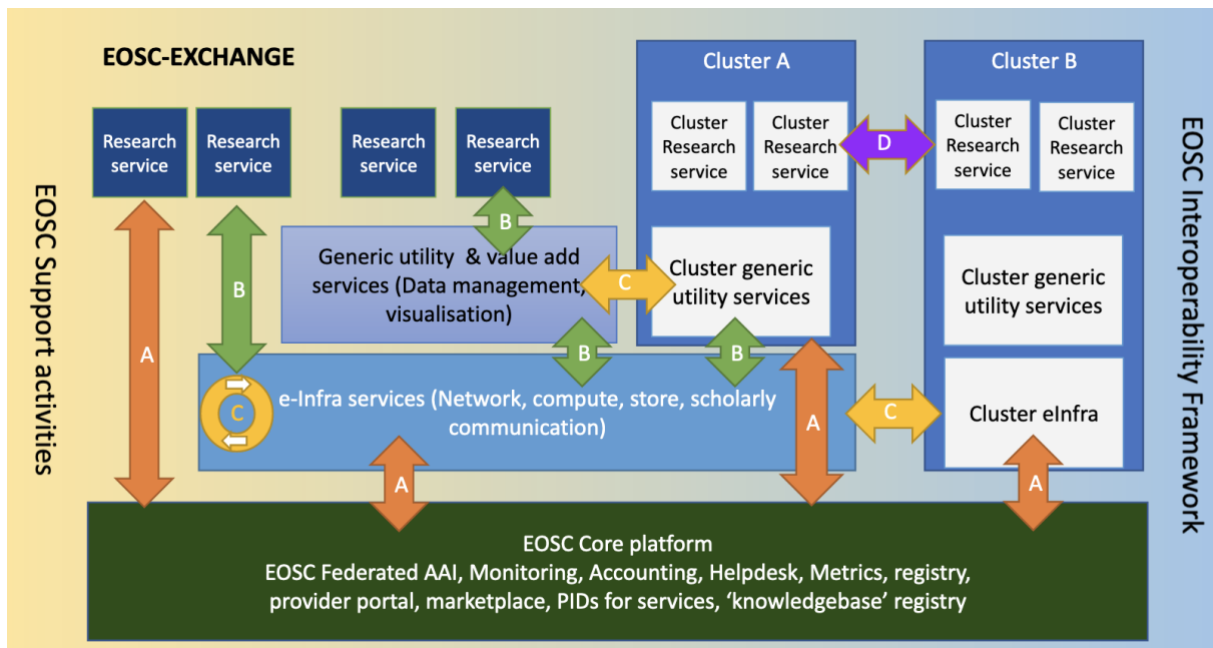[12] https://www.eosc-hub.eu/technical-documentation

Figure 2.3: EOSC Interoperability and composability models

The diagram shows the elements of *EOSC-Core* and *EOSC-Exchange*, connected and supported by the *EOSC Interoperability Frameworks* and Support activities. Vertical arrows represent **vertical integrations** (integrating a resource with more basic and/or common resources and functions), while horizontal arrows represent **horizontal integrations** (connecting peer resources) to add value. These two categories can be further divided into subcategories represented with the letters A, B, C and D:

- Vertical integrations:

  - **Type A**: Support composability of a resource with resources from the *EOSC-Core* to make the resources interoperable in EOSC (e.g., make resources discoverable via the *EOSC-Exchange*, integrate with the order management system and helpdesk to lower the barrier of access and to provide support to the users). Type A is related to the *EOSC-Core*; work to enable composability of Type A begun in prior projects where prototype core services were delivered such as in EOSC-hub and EOSC Enhance. It adds significant value for users and providers, as it makes the user experience more coherent, and for providers it adds value without them having to do further development or saves effort on developing the functionality themselves. This also occurs within the thematic clusters, as they create 'stacks' of resources themselves. EOSC Future will extend both efforts to make this a standard step for all sorts of resource providers.

  - **Type B**: Support composability of a resource with *Horizontal Services* to enrich the resource with additional features and easy/elastic/on-demand access of EOSC resources (e.g., a materials science service from a Science Cluster is integrated with a horizontal cloud computing service from an e-Infrastructure). Type B has been pursued by horizontal service providers such as the e-Infrastructures, each of which seek to engage with providers of thematic resources but needs to be broadened and shifted to being based on sector-agreed consensus approaches from the *EOSC Interoperability Frameworks*, rather than those from each provider.

- Horizontal integrations:

  - **Type C**: Support composability of resources based on horizontal resources from e-Infrastructures and clusters (e.g. a horizontal data management service from an e-Infrastructure is integrated with data management functions and data from a cluster, or integration between e-Infrastructure services from different organisations). Type C integrations are a relatively new occurrence: asking horizontal

providers to work with each other and make their resources interoperate. This happened to some extent in EOSC-hub where peer organisations that provide different resource types integrated their offerings. It is also important that the new *Horizontal Services* coming from the INFRAEOSC-07 projects are integrated with existing *Horizontal Services*. Composability of this type already occurs to a great extent within the thematic clusters, which try and collect their resources into coherent platforms. They plan to extend some of these resources as new *Horizontal Services* which are 'generalised' to be fully horizontal.

- **Type D**: Support composability of cross-domain resources to create added-value solutions to handle complex scientific problems (e.g., an epidemiological simulation service from one Science Cluster is composed with a rich data set on logistics and international trade from another Science Cluster to help track the spread of a global pandemic). Type D is perhaps the most challenging type of composability. This, like others, already happens within the Science Clusters and communities. For instance, inside EOSC-Life there is a significant diversity of research and supporting resources, but lateral connections between resources and datasets etc are possible and rational as all are in the same broad research domain. By connecting them and breaking down artificial or technical barriers, research is further supported and accelerated. Finding consensus across the larger EOSC community is even more challenging.

The initial focus of EOSC Future is to support science clusters, 07 and regional projects in making their resources and infrastructures available via EOSC and interoperable with *EOSC-Core*; therefore, the initial focus of the EOSC Future Interoperability Framework (and for this document) is the interoperability with *EOSC-Core*, which is Type A.

3 Analysis of the current EOSC Architecture and Interoperability Framework

A full analysis of the Architecture as a whole would be premature at this point in time as significant development is ongoing. The result of the Science Projects will provide a good insight to identify gaps and determine steps to fill them. Some of these aspects more relevant to requirements have been addressed in Deliverable 3.1 '*Science Cases for Development of EOSC Architecture and Frameworks*', particularly in light of interoperability.

As already mentioned, the approach taken for WP3 is to collect existing knowledge, requirements and artifacts available at the start of the EOSC Future project, understand the current landscape, assess existing results and further develop them as needed. In line with this approach, WP3 produced D3.1, which collected science cases emerging in the clusters and Science Projects (under development in WP6) and validated them with the communities in which they were generated.

D3.1 offers an accessible summary of common requirements across the science clusters, with the aim to identify requirements not yet addressed and prioritise the work in WP3 concerning the Interoperability Framework, namely:

a) provide a common EOSC AAI for all researchers,
b) define a common standard for FAIR[13] data, services and products across communities,
c) provide a powerful search engine for data and services,
d) provide access to high performance storage, computing, archiving, simulation and analysis services,
e) define common standards for data and metadata to federate different catalogue of services,
f) make cluster community services available to the scientific community via EOSC and across clusters.

Although the current EOSC Architecture already supports some of the requirements above (the AAI being the most advanced example), more work is needed to seamlessly enable them across research communities and clusters.

The output of D3.1 has led to the creation of Working Groups (WGs) under WP3 whose aim is to define the required EOSC Interoperability Guidelines (i.e., guidelines, APIs) to enable some of the requirements listed above and to populate the *EOSC Interoperability Framework*.

The existing WGs are:

- **Compute Continuum** Working Group, that aims to define a metadata schema as an extension of the *EOSC Profile* in order to describe better the compute resources in the EOSC resource catalogue - addresses d), f).
- **Science Projects** Working Group, that aims to use the results of the science projects to steer the overall project technical roadmap and the future enhancement of EOSC architecture – addresses a), b), c) and f).
- **Research Product Publishing Framework** Working Group, that aims to define a research publishing framework to simplify the adoption of that practice, by enabling services of research infrastructures to seamlessly integrate repository deposition workflows in the context of the EOSC - addresses b) and c).
- **Metadata** Working Group - This WG (still in the planning phase) aims to improve the 'FAIRness' of community asset metadata in general and especially interoperability and availability of community metadata schema - it addresses b) and e).

In addition to this WP3 liaises also with the Task Forces operated under the EOSC Association, namely the AAI Task Force[14], the Semantic Interoperability Task Force[15] and the Technical Interoperability of Data and Services[16].

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[13] FAIR metrics recommendations: https://op.europa.eu/en/publication-detail/-/publication/ced147c9-53c0-11eb-b59f-01aa75ed71a1
[14] https://www.eosc.eu/advisory-groups/aai-architecture
[15] https://www.eosc.eu/advisory-groups/semantic-interoperability
[16] https://www.eosc.eu/advisory-groups/technical-interoperability-data-and-services

A more detailed gap analysis is planned for the EOSC architecture and interoperability framework is planned in mid-2022, which will include the outcome of the Working Groups in EOSC Future, the progresses of the Science Projects, any interim result of the EOSC Association Task Forces, and any requirements emerging from deployments taking places in other EOSC Future work packages.

4 EOSC IF for *EOSC-Core*

The EOSC Future is working on the EOSC IF to support interoperability of the various elements of EOSC, across the interoperability and composability models described in previous sections. In this section we focus on Type A from the diagrams above, integration with *EOSC-Core*. This interoperability and composability is twofold: internal to *EOSC-Core* in order to make it operational and to allow communication between components in the Core, and external to the *EOSC-Core* to set clear *Rules of Participation* to EOSC providers so that they can:(i) onboard resources in the *EOSC-Exchange* (EOSC resource catalogue) and (ii) integrate resources with the *EOSC-Core* added-value services (Order Management, Execution Framework, Monitor, Accounting, Helpdesk).

For the first purpose, the internal functioning of *EOSC-Core*, we consider the different technical components whose functionality are described in Deliverable *D2.5a Inventory of Core Functions and Inclusion Criteria*. This defines capabilities for EOSC which are then implemented through a set of technical services delivered through WP4 and WP5 and a set of core coordination activities. The connection between these components is summarised in the diagram in Figure 4.1, from the EOSC Future proposal.
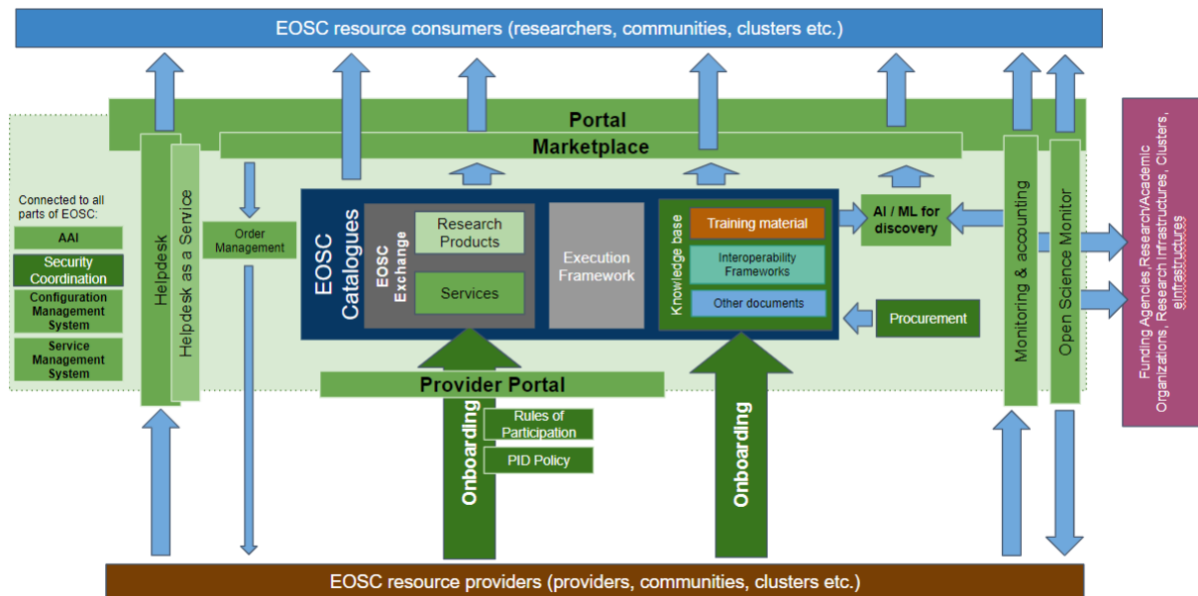

Figure 4.1: High-level connections between components

A number of specific connections are shown in this diagram where interoperability plays an important role. On the left of the diagram there are several pervasive functions which touch on all others, such as AAI, Service management and Security Coordination, which mix both technical components of the core and coordination activities. This scopes the challenge to ensuring that all core components and coordination functions can interact in an open environment where they may not be offered by the same or related organisations, through using agreed upon standards, formats, approaches and practises defined in the EOSC IF.

Once these elements of the EOSC IF are used internally by the core, the same can be used to support integration of the core with the outside, such as the integration of a provider with a service in the exchange with the EOSC monitoring capabilities. In the same way the Monitoring and Accounting need to use an element of the EOSC IF in order to talk to the registry of EOSC providers and resources to check its availability and usage, it can use the same to talk to the systems of a thematic provider who wishes to expose their availability and usage to EOSC, for instance to support virtual access funding.

In this way the EOSC IF both allows the core to operate effectively and supports the Core in interacting with the outside world, such as providers in *EOSC-Exchange*.

Task 3.2 of EOSC Future WP3 is working to define a set of interoperability guidelines for the *EOSC-Core* services providing detailed information on how a service in the *EOSC-Exchange* can be integrated with the Core capabilities. In particular, the EOSC Future effort in this area is focused on evolving the guidelines for federation

services developed in EOSC-hub[17] to satisfy the requirements that emerged from relevant research communities and to align them with the latest enhancement of the EOSC architecture.

These guidelines define high-level architecture and interfaces for integration of each core service, enabling the interoperation of services and resources with the EOSC. These guidelines also specify a set of integration options from which a Provider joining EOSC can select the option that best fits their needs. As an example, a Provider onboarding resources in EOSC can decide to be integrated with the EOSC central helpdesk choosing an option between: (a) full integration - the provider decides to use the EOSC central helpdesk as its own helpdesk, (b) integration through the helpdesk API - the provider programmatically connects its helpdesk to the EOSC central helpdesk so that a ticket created in the central helpdesk is automatically forwarded to its own helpdesk, (c) integration through e-mail - the provider is notified by the helpdesk via e-mail when a ticket for its resources is created in the central helpdesk, (d) no integration - the provider decides to not integrate its resources with the EOSC helpdesk. This approach leaves each provider free to benefit from the added value functions delivered by *EOSC-Core* at the level it prefers without raising the cost of the basic integration with EOSC and, without creating a barrier that may hinder some providers to onboard their resources.

Details about the interoperability guidelines for the *EOSC-Core* will be provided in *D3.3a Architecture and Interoperability Guidelines for Operational Services of the EOSC-Core* that will be delivered in January 2020. The following sub-section describes an interoperability guideline for the *EOSC-Core*, the Resource Description Framework and its implementation through the *EOSC Profile*s as an evolution of the work delivered by the EOSC-Enhance and EOSC-hub projects.

4.1 EOSC Interoperability Example: *EOSC Profiles*[18]

Perhaps the best initial example of this is what is described in the description of work as the 'Resource Description Framework'. In practice, this has been implemented through the *EOSC Profile*s, which represent a specific metadata model which is used to describe the providers and resources which are made available through EOSC. The same EOSC Interoperability Guideline is used internally to pull the resource information from the registry behind *EOSC Portal* into the EOSC Marketplace[19], which is the user-facing component. Hence the *EOSC Profile*s of the EOSC IF support the internal connection between the two technical core elements.

Beyond the use of the profiles within the Core, the EOSC registry of providers and resources is foreseen as one of many catalogues within the network of EOSC approved catalogues. The vision of the network of EOSC approved catalogues is depicted in Figure 4.2. The network of catalogues consists of thematic and regional based resource catalogues provided through the Scientific Clusters and Regional projects. It is envisioned that services and resources which are onboarded within a thematic and/or regional catalogue populate the EOSC resource catalogue and vice versa. The exchange of provider and resource descriptions between catalogues will be based on the *EOSC Profile*s. The *EOSC-Core* resource catalogue will act as a sort of enterprise bus to mediate movement of records between different catalogues and with the core itself. It would also allow users to build new layers on top of the *EOSC-Core* which could provide horizontal or added value resources to support specific communities and/or other kind of use cases.

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[17] https://wiki.eosc-hub.eu/display/EOSCDOC/Federation+services
[18] https://eosc-portal.eu/sites/default/files/EOSC-Profiles-v3.00.pdf
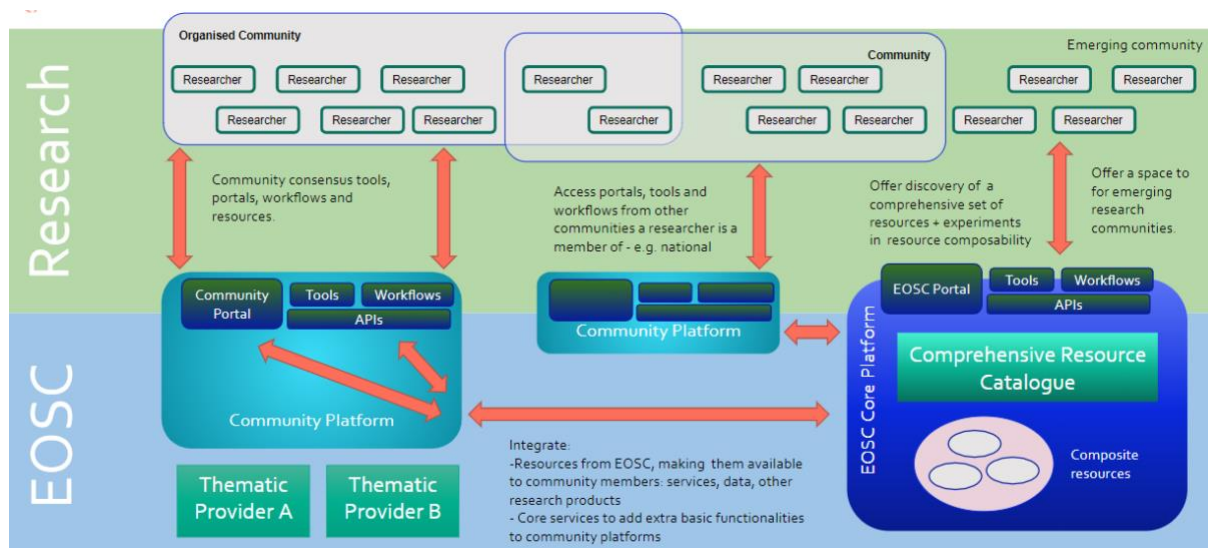[19] See https://marketplace.eosc-portal.eu/

Figure 4.2: Connections between core and exchange components including EOSC catalogues using the EOSC Profiles format in a system of systems.

In detail, the *EOSC Profile*s are specifications that define common data models for EOSC entities (Providers, Resources, etc) and related taxonomies. They contribute to the unified framework for describing and offering EOSC Resources to end-users in a harmonised way, supporting the exchange of resources metadata via open APIs. This allows automated management of the EOSC resource information and their accompanying data without human intervention.

The *EOSC Profile*s are evolving specifications, which will incorporate new features from the European research communities in the EOSC ecosystem. The *EOSC Profile*s provide definition of their attributes, their format/type (if any) and multiplicity, as well as whether the attribute is mandatory or optional. They also provide rules for validation of input data. The *EOSC Profile*s also include Provider and Resource Code lists, Taxonomies, Classifications that have been developed to provide a structured classification of Resources and a harmonized way for the description of various attributes. They also constitute the basis to structure the filtering within the EOSC Catalogue. **Error! Reference source not found.** lists example elements of the *EOSC Profile*s released by EOSC Enhance.

Table 4-1: Elements of the EOSC Profiles[20]

Profile name	Description
EOSC Provider Profile	An EOSC Provider is an EOSC System User responsible for the provisioning of one or more Resources to the EOSC. The Provider Profile describes the information requested to onboard Providers into The EOSC Provider Portal.
EOSC Resource Profile	An EOSC Resource is an asset made available by means of the EOSC system and according to the EOSC *Rules of Participation* to EOSC End-Users to perform a process useful to deliver value in the context of the EOSC. EOSC Resources include Services, Data Sources, Research Products, and any other asset. A Resource Profile describes the information requested to onboard Resources into the EOSC Provider Portal.
EOSC Research Product Profile	Research products are EOSC Resources resulting from a scientific process, any physical or digital asset produced and shared by users/services for users/services, such as research literature, research data(sets), research software, and others. Research Products are characterized/described by metadata to be used for citation, attribution, re-use, reproducibility, semantic linking, and findability, made available via EOSC Data Sources, which also host the digital assets when the product is digital.

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[20] https://eosc-portal.eu/providers-documentation

EOSC Data Source Profile	Data sources are EOSC Resources and a subclass of EOSC Services whose specific purpose is to offer deposition, preservation, curation, discovery, access, and usage statistics functionalities to collections of EOSC Research Product Scientific Products from a thematic or cross-discipline perspective.
EOSC Multi-Provider Catalogue Profile	An EOSC Provider is an EOSC System User responsible for the provisioning of one or more Resources to the EOSC. EOSC Providers are organisations, a part of an organisation or a federation that manages and delivers Resources to End-Users. EOSC Providers can be Resource Providers, Service Providers, Data (Source) Providers, Service Developers, Research Infrastructures, Distributed Research Infrastructures, Resource Aggregators, Thematic Clouds, Regional Clouds, etc. More definitions here.

EOSC Future takes over the ownership and development of the *EOSC Profiles* from December 2021 (after EOSC Enhance, where they were firstly developed, concluded at the end of November). This will involve not only planning for the next version of the profiles, but also their governance and engaging with stakeholders such as the owners of the thematic and regional catalogues in the EOSC landscape. EOSC Future will also align the profiles with the rules and compliance criteria resulting from the EOSC Association *Rules of Participation* and Compliance Monitoring task forces.

5 EOSC IF for interoperability between research infrastructures and/or between research infrastructures and e-Infrastructures

The EOSC is not a single monolithic organisation or resource provider but is rather a federation built out of many independent organisations and resource providers as in a System of Systems approach. As such, it ensures independence and autonomy of resource providers. Resource providers are widely distributed across Europe, have the mandate to serve one or more research disciplines and have to comply with different national and European legislations. The vision of EOSC to serve a wide variety of users and stakeholders (e.g. Researchers, research infrastructures, service providers, service developers, funders, organizations, project managers, SMEs, citizens etc.). It is to create a virtual environment that provides easy access to already existing resources and to allow the EOSC users to build complex solutions out of a variety of resources.

As the EOSC is recognized as a System of Systems, it means that it should be inclusive rather than selective, i.e. all metadata standards from communities are acceptable, all service framework standards (service pipe-lining and workflows, e.g. Galaxy, KNIME, Taverna, etc.) adopted by the communities are acceptable, etc. This said, a system of systems approach to work properly and to ensure interoperability has to define some boundaries and therefore a choice has to be made (based on rough consensus) to select standards, best practices, tools and APIs that are mostly adopted.

In the past, thematic cluster-type EU projects and research topic specific EU projects have striven towards better interoperability between their constituent RIs (type D, ref section 2.3.2) and with e-Infrastructure services considered useful by them (type B and C, ref section 2.3.2). The cross-RI interoperability solutions ranged from working out common infrastructure reference models, ontologies and recommendations to practical matters such as use of common services, metadata discovery etc. However, some of such initiatives were only partially successful and were not sustained beyond the end of the projects concerned. However, most *have* had a lasting impact by providing relevant standardization documentation and software and aligning terminology and practices. Some of these results have been taken-up as (part of) RDA recommendations or been otherwise incorporated as a standard. For others impact remained limited to the directly involved communities and did not get broad visibility.

Nevertheless, all community interoperability solutions can become essential for the functioning of research infrastructures and must in principle be able to find a place in any *EOSC Interoperability Framework*, and the main criteria for their inclusion in the EOSC IF must be for them sufficient clear and unambiguous, promoting FAIR and having communities taking responsibility for their maintenance.

Furthermore, the Research Infrastructures have been adopting, to a limited extent, common services provided by e-Infrastructures. Because of the nature of how RI and e-Infrastructures services have been developed to bespoke solutions some level of composability between RI and e-Infrastructure services exist, for example between community workflows, HPC and/or Cloud computing and data services.

To increase the value of previously invested funding and efforts in developing technologies the reuse of services and technologies is encouraged as widely as possible, and the approach is to adapt what is available to the requirements of a user or community. The flipside to this is that, from experience, adapting existing infrastructures developed for one community to be used by another community is non-trivial due to the underlying assumptions that are typically made to facilitate composability of resources. In general, the devil is in the details: Services are composed with a community focus, therefore, adapting services to another community is challenging. Due to community particularities, semantic differences, defined standards, use of APIs, use of different tools and services such adaptations may be sometimes impossible. Hence, the development of bespoke solutions steered the proliferation of the standards and APIs in use across resource providers limiting the interoperability and reusability of resources from EOSC perspective.

Due to the lack of an all-encompassing interoperability framework, or having to choose from too many options, the evolution of resources and technologies has been based on the choices made by research-, e-Infrastructure and resource providers that intend to address specific requirements.

The EOSC pilot, EOSC-hub and the EOSC Architecture working group (e.g. AAI and *PID* policy task forces) initiatives began the harmonisation process, producing interoperability guidelines for *EOSC-Core* services (e.g. accounting, monitoring, helpdesk, and so on) and in the areas of an EOSC AAI and EOSC *PID* policy. These initiatives must be considered the very beginning of a process that must be extended and evolve overtime to an *EOSC Interoperability Framework* consisting of a rich set of guidelines to be adopted by resource providers across EOSC overtime.

Through WP3, EOSC Future will progress these initiatives to build the rich set of guidelines and will establish a governance structure and processes to populate the *EOSC Interoperability Framework*.

6   Governance of the *EOSC Interoperability Framework*

6.1   Introduction

The *EOSC Interoperability Framework* governance seeks to ensure that interoperability is built, encouraged and maintained with structure, fairness and transparency.

EOSC Future does not propose to re-invent or create its own best practices or standards, unless gaps are identified that cannot be filled by existing practices and standards, neither does EOSC Future propose that EOSC attempts to create its own (or indeed attempt to duplicate) an 'ISO-style' certification model; instead the proposed best practices and standards would be evaluated on the basis of their maturity and suitability of existing interoperability solutions.

The global research community has for a long time sought to define interoperability best practices and has successfully produced a number of well-known and widely adopted bodies to that end, from which inspiration can be taken as regards to the governance that each body has established. The following bodies have been considered (Appendix F shows the assessment done on a subset of the list), with their selection primarily driven by the intent to show the diversity in governance models and processes that are prevalent in the research community:

- W3C (World Wide Web Consortium)[21],
- The RDA Output recommendation submission and endorsement process[22],
- AEGIS[23] - AARC Guidelines[24] to enable interoperability across research and e-Infrastructures that implement the AARC Blueprint Architecture,
- IETF Internet Standards Process[25],
- REFEDS[26] - community best practices and consultation process,
- IGTF[27] - best practices in authentication and trust management for providers of e-Infrastructures, identity providers, and global relying parties.

It is agreed that the EOSC IF governance needs to support a process of proposal, consultation and ratification that will demonstrate and confirm the readiness of each interoperability artifact component to be used as an accepted EOSC Interoperability artifact, prior to being announced as such to the research community at large via the EOSC channels. This process will also support the identification of gaps in relation to the research community's problems and needs. A draft process has been proposed and is included in Appendix A for consultation.

6.2   Proposed EOSC IF Governance Model

The proposed governance model takes a pragmatic approach with the aim to build on the existing structure of the EOSC Future project. The key aspects that have been taken into consideration are:

1. the need to define an independent group (similar to an editorial board) that can assess that, requests for inclusion into the EOSC IF are compliant with a minimum set of requirements (see Appendix A for more information), namely maturity, community uptake, the existence of a group that maintains the item that has been proposed for inclusions and some governing model that allows for its evolution. This group needs to have a variety of expertise, as the *EOSC Interoperability Framework* consists of a wide range of topics, organised in different areas, for example Metadata, *PIDs*, Data, AAI, Semantics, and so on, to the *EOSC-Core* components. This body makes recommendations for inclusion or exclusion.

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[21] https://www.w3.org/standards/
[22] https://www.rd-alliance.org/groups/creating-and-managing-rda-groups/rda-outputs.html
[23] https://aarc-community.org/wp-content/uploads/2019/12/AEGIS-Charter-v1.0.pdf
[24] https://aarc-project.eu/guidelines and https://wiki.geant.org/display/AARC/Guidelines+Process
[25] https://datatracker.ietf.org/doc/rfc2026/, section 6.
[26] https://refeds.org/specifications
[27] https://www.igtf.net/about/charter

2. the need to have an overarching body that has the oversight and the responsibility for the EOSC IF, is formally responsible for endorsing new and/or deprecating guidelines into the EOSC IF. This body would also offer an escalation point.

In addition, a third group is also proposed to ensure that the EOSC IF guidelines for the *EOSC-Core* can be well supported; this is also defined in the table below. These bodies, alongside their proposed responsibilities are listed in the table below:

Table 6-1: Proposed EOSC IF Governance Model

Body	Responsibility	Interim body for duration of EOSC Future project
EOSC Interoperability Advisory Board (EIAB)	Responsible for overseeing the EOSC IF; it endorses new/deprecates guidelines, based on the recommendations of the EIAC.	EOSC Future Technical Coordination Board
EOSC Interoperability Area Chairs (EIAC)	Responsible to perform the initial assessment of the proposed standards and guidelines and to make recommendations for inclusion/exclusion to the EIAB.	EOSC Future WP3 task leads - they will call in experts to help with the review process as needed. The review process will consider impact, maturity, global interoperability, update, and any cross-thematic nature of the guideline and its impact
EOSC Interoperability Core Guidelines Owners	Responsible for contributing Interoperability Guidelines relating to the *EOSC-Core*, and providing input to impact analysis of proposed EOSC Interoperability Guidelines	Service owners for core components

The *EOSC Interoperability Framework* governance defines:
- A process for submitting, consulting and accepting guidelines/other frameworks (Appendix A).
- A structured proposal template providing information about the EOSC Interoperability Guideline (Appendix B).
- Community consultation to achieve ratification.
- A registry for accepted guidelines and frameworks, where artefacts will be curated using an agreed *EOSC Profile* extension for EOSC Interoperability Guidelines; discussions have commenced to determine the most appropriate attributes required for inclusion.
- A body to oversee the overall process (both in terms of operation and its fitness for purpose).
- If appropriate publicity, documentation, training,

This document proposes a short- to medium-term, initial set up that will be maintained for the life of the EOSC Future project, handing over to the final governing body (which is expected to be the EOSC Association), which will be defined in Deliverable 3.2b.

The early-stage, initial governance is necessary at this stage in order to progress with the ratification of the significant volume of relevant prior works (see Appendix D).

It will be necessary to ratify the use of an appropriate Creative Commons 4.0 license, or any other open-source license as needed for all in-scope works.

6.3   *EOSC Interoperability Framework*: Interoperability Registry

The initial scope of the Interoperability Registry is the output of the EOSC Hub, EOSC Enhance, AARC and OpenAIRE projects and will be populated using the *'Main Standards and Interfaces as a Starting Point for EOSC*

Future' (Appendix D), thereby fast-tracking the adoption and ratification of these standards and interfaces to the EOSC and enabling formal communications and dissemination activities to progress.

A registry is necessary to create a supporting structure that will allow the governing body to record each identified or proposed EOSC Interoperability Guideline, based on an agreed profile of attributes, that will:

- become a library of accepted artifacts, and
- allow the governance forum to acknowledge a policy, standard, interface, framework, etc, that is presented to become a formally recognised EOSC Interoperability Guideline and monitor each Guideline through the proposal and consultation process.

This Registry will become a de facto EOSC Knowledge Base.

The Interoperability Registry going forward can be structured in terms of:

- how each EOSC Interoperability Guideline can be categorised in terms of the Layer of Interoperability that it supports, and to which architectural building block it relates;
- to which problem/need/recommendation articulated by the EAWG document and SRIA final report the guideline relates;
- to which EOSC Future Working Group or EOSC Association Task Force it relates;
- its status in relation to the community consultation and ratification process;

This process will support the identification of gaps in the interoperability landscape, with a view to finding solutions to fill those gaps over the course of the project.

The resulting registry will be published at the EOSC Future Wiki as a living document, and it will be possible to track and monitor the progress and evolution of a proposed interoperability guidelines from proposed prior work to a ratified artifact of the *EOSC Interoperability Framework*, as well as to identify the gaps that need to be the subject of targeted analysis and activity.

The proposed process to propose/consult/ratify an interoperability component is outlined in Appendix A.

7 Conclusions and next steps

This document should be considered as a starting point to establish the *EOSC Interoperability Framework* and propose a light-weight governance to further evolve this framework. In addition to the governance, the document has focused on the requirements and the ongoing work to enable interoperability with the *EOSC-Core*. A wider consultation is planned in Q1 2022; the inputs will be included in the next update of this document.

In addition, work will continue to define a 'library' (the Interoperability Registry) of standards, best practices and APIs that are commonly used by the clusters, e-Infrastructures and service providers that will be included in the *EOSC Interoperability Framework*. The proposed governance supports a process to enable proposals for inclusion into the *EOSC Interoperability Framework*.

It is important to stress once more that there is no 'one-size-fits-all' approach that can be applied to integration, interoperability, and composability of resources across disciplines. The reasons are many: legacy (historical adoption of different frameworks which are problematic to migrate from), requirements (different frameworks support different scenarios), cost (switching from one framework to another implies rather expensive refactoring of code and services).

As mentioned above, the *EOSC Interoperability Framework* will not impose a top-down model to be universally adopted. In line with the vision of a System of Systems, coexistence of different resource interoperability frameworks is possible and the *EOSC Interoperability Framework* will be an enabler to mediate, bridge, and interoperate between different domains.

By working with the clusters, the other work packages and the 07 projects and by addressing their requirements, WP3 aims to create the conditions to converge towards a reduced set of frameworks and standards selected through a natural process of rough consensus that will reward those adopted by more communities and that will satisfy the highest number of common requirements.

To ensure a sustainable, long-term approach to governing the *EOSC Interoperability Framework*, the governance and its outputs will be handed over to the permanent governing body, that will align to other activities that are looking beyond the end of the Project, as well as towards community governance (e.g., RDA, IETF, Science Clusters, etc), to ensure that a lasting governance framework is adopted that collaborates with overlapping bodies.

8   Appendix A – Draft Process for Inclusion in Interoperability Registry

EOSC Interoperability Guidelines are the accepted frameworks, guidelines, best practices and standards that are collectively agreed via a process of consultation and ratification as an accepted and necessary aspect to achieve the goal of interoperability within and amongst research communities. The EOSC Interoperability Guidelines arise either from related EOSC Projects or from community best practices or from activities inside the EOSC Future project, and the *EOSC Interoperability Framework* governance body seeks to ensure that relevant and prior works are formally recognised as supporting interoperability for the EOSC.

At the time of writing this document the administrative role that will manage this activity was still to be confirmed. This draft is to facilitate the consultation process in determining the correct process and acceptance criteria.

Table 8-1: Process for Inclusion in the EOSC Interoperability Framework

Step	Name	Notes and instructions
0	Proposal submission	A proposer completes the EOSC IF Proposal Form (see Appendix B) and sends it to [EIAC]
1	Confirm receipt	The **[EIAC]** assesses the proposal for completeness, and enters it in the Interoperability Registry, assigning the 'Proposed' status. Acknowledges receipt to the proposer and provides the related registration reference number. The **[EIAC]** posts the proposal on the EOSC Public Wiki and initiates the review, consultation and ratification process.
2	Commence internal review	The following steps will be undertaken prior to the community consultation and ratification process: • **Impact analysis**: Upon receipt of a submission, an impact analysis is performed to establish whether any overlapping components exist, what the value is, its proposed impact on the current landscape and how it could support interoperability generally. • **Maturity assessment:** performed to determine whether it is ready to be utilised by working researchers, etc • **Interoperability assessment**: whether the proposed guideline either aligns with or strengthens interoperation in the related research ecosystem, and, if it deviates from related standards, whether such divergence should be mended or be accepted. • **Uptake assessment**: performed to determine if there is already a community using it and a governance model to further maintain and enhance it • **Identify the need for additional community consultation**: this might be in the case where, although thematic consultation has concluded and the practice has been ratified by that community, if the practice is proposed to cover a broader scope, it might be necessary to consult additional communities prior to its ratification; it should be made clear by the proposer at the point of submission which communities the proposed EOSC Interoperability Guideline would apply to. Acceptance criteria: • Prior consultation must be described and evidenced.

		• Relevant community consultation and consensus must have concluded with 'acceptance' prior to submission to this process. • Evidence of maturity must be provided such as breadth and diversity of uptake, date of initial implementation, scope of community utilising the guideline. • The proposed guideline must have a guardian and governing body that actively maintains it.
3	Resolve outstanding queries	The **[EIAC]** works with the proposer to complete/clarify any gaps in the proposal,
4a	Conclude internal review and provide feedback	Outcomes at the conclusion of this stage are: consultation, rejected, on hold, withdrawn, abandoned. In the event that the proposal does not achieve 'Consultation' status, relevant feedback will be given to the proposer by [role].
4b	Conclude internal review and make ready for community consultation	The EIAC will work with [Comms WP] to launch a community consultation; the **[EIAC]** will work with the proposer to ensure it is expressly clear to those consulted what the intent is, and exactly what they are being asked to review (e.g. if the subject of the consultation is a well-established thematic practice, the consultation is not intended to be an opportunity to highlight issues with the practice itself, but instead it is to assess whether the practice can be made applicable to the identified communities). The consultation is launched, feedback is collected, and a recommendation is then made by the **[EIAC]** to the EOSC Interoperability Advisory Board for a final decision. Outcomes at the conclusion of this stage are: accepted, rejected, on hold, withdrawn, abandoned.
5	Ratification	The final decision is communicated to the proposer. For accepted proposals: • An EOSC IF Profile shall be captured, in order for the relating metadata describing the new Guideline is made available as appropriate in the EOSC Resource Catalogue and the EOSC Interoperability Registry. • The relevant documentation shall be stored [location/repository] • The Interoperability Registry will be updated to reflect the outcome of the final decision. • This denotes that the guideline has been published as an EOSC Approved approach/standard, referred to as an EOSC Interoperability Guideline. • Promotion/dissemination/training will start to ensure that the research community know that it has been adopted by the EOSC and is available to be used by the intended communities. Once the proposals have been accepted, the [role] will be responsible for announcing them to members and non-members via the following channels as appropriate: • Press releases

		• Website announcements • EOSC newsletter • Social media • Email campaigns • Webinars • Other Outcomes at the conclusion of this stage are: accepted, rejected, on hold, withdrawn, abandoned.

6	Post-ratification	Subsequent to ratification, there will be a requirement for regular touch points to ensure that the EOSC Interoperability Guideline continues to be relevant:
		• [annual] review process
		• Deprecation process, to ensure that it is clear which are no longer operational or that have been superseded by new practices or standards.
		• It will be required to have a method to record and recognise when:
		   - EOSC IF entry is deployed as far as supports *EOSC-Core* components
		   - EOSC IF Entry is deployed in a significant portion of relevant community
		   - EOSC IF entry is (near) globally deployed)
		
		Outcomes at the conclusion of this stage are: operating, rejected, on hold, withdrawn, abandoned, deprecated.

9 Appendix B – Draft 'EOSC Interoperability Guideline Proposal' Form:

The Proposer should provide the proposal to the [role] in a non-proprietary, open-file and electronic format, together with the following information.

This draft is to facilitate the consultation process in determining the correct process and acceptance criteria.

Table 9-1: EOSC IF Guideline Proposal Form

Field name	Intended content
Proposer:	Name, role, and affiliation in context of the proposed practice/standard/guideline.
Peer reviewer:	Name, role and affiliation of the peer reviewer prior to submission of the proposal.
Guardian/Operator:	Organisation and community that owns/operates the proposed guideline; must have a named representative (assumed to be the Proposer). Orphaned guidelines will not be considered via this process, and an exception will need to be raised with the [EIAC]
Name:	Official name of the proposed practice/standard/guideline, as it is intended to be known operationally.
Version:	Version of the guideline
Publication Date:	Publication date of the guideline
Abstract:	A short description of the guideline
Proposed scope of the component and impact statement:	How far reaching is the practice/standard/guideline expected to be applied, which communities have already ratified it and which communities are asked to adopt it as part of this consultation?
Technical scope:	The list of functions we need an interoperability standard for/list of technical areas to be covered by interop guidelines
Category Tags:	To assist in identifying future overlap To assist in categorisation and cataloguing.
Prior community consultation:	Confirmation of the communities that have been consulted as regards the proposed practice/standard/guideline, including those who have already ratified the proposed practice/standard/guideline
Numbering standard/*PID*:	*PID* where one exists already; where no *PID* exists, this will be assigned during the proposal process.
Response to community needs/problems	A description of how the proposal supports the various levels of interoperability and the problems and needs represented by the [user communities].

Nature of proposed practice/standard/guideline	Propose should identify the type of proposed practice/standard/guideline, such as:
	Standard (i.e. IETF, IEEE, RDA, etc..)
	Community best practice
	Interoperability Guideline
	API
	Other: please indicate what
Licensing information	e.g. Creative Commons Attribution Only 4.0 license (CC-BY) or the Creative Commons CC0 1.0 Public Domain Waiver (CC0).

- Proposals must be submitted using the 'EOSC Interoperability Guideline Proposal Form'.
- Proposals must have been peer reviewed prior to submission.
- Proposed EOSC Interoperability Guidelines must have a guardian/operator in order to be considered.
- Proposed guidelines/standards/best practices must have already concluded their thematic/community consultation prior to submitting for EOSC ratification.

10 Appendix C – DRAFT EOSC Interoperability Guideline Lifecycle Stages

This draft is to facilitate the consultation process in determining the correct process and acceptance criteria.

Each Artifact is assigned with an appropriate lifecycle status in the Interoperability Registry:

Table 10-1: EOSC Interoperability Guideline Lifecycle stages

Status	Description	Next state/s
Candidate	Identified and registered, but no proposal has been submitted.	Proposed, on hold, abandoned, withdrawn, rejected
Proposed		Consultation, on hold, abandoned, withdrawn, rejected
Consultation	This would operate as a 'Pending Approval' status (like 'patent pending').	Accepted, rejected, on hold, withdrawn, abandoned
On Hold	To be used in the event that further information is required.	Consultation, abandoned, withdrawn, rejected
Accepted	To identify Artifacts that have been accepted by the EOSC Interoperability Advisory Board but have not yet been announced as operational.	Operating, deprecated, withdrawn
Operating	To identify Artifacts that have been accepted by the EOSC Interoperability Advisory Board and have been announced as operational.	Deprecated, withdrawn
Deprecated	Artifacts that have been superseded or replaced by new versions but are to be retained in the Registry.	n/a
Abandoned	An artifact that was proposed but its Guardian is unresponsive to requests from the [role]	n/a
Withdrawn	An artifact that has been withdrawn from the proposal process by its Guardian	n/a
Rejected	An artifact that was rejected at the proposal stage by the EOSC Interoperability Advisory Board	n/a

11 Appendix D – Main Standards and Interfaces as a Starting Point for EOSC Future

This table describes the standards and interfaces already recognised as a starting point for the EOSC Future project and will be built upon to form the EOSC Interoperability Registry.

Table 11-1: Standards and Interfaces described in the EOSC Future DoW

EOSC IF Area	Current Standards and Approaches	Goal	Possible Outputs and Impact
Resource Description Framework	EOSC Provider and resource profiles 3.0 and 4.00 developed in EOSC Enhance (recently handed over to EOSC Future), RDF, XML, UML, OpenAIRE guidelines for publication, data and software repositories, OpenAIRE Guidelines for CRIS systems, OpenAIRE-ELIXIR guidelines for bioschema.org (in the making), Scholix.org	Agreed way to describe resources and providers that is shared by the EOSC ecosystem (03, 04, 05, 07) projects	Ensure that EOSC Provider and Resource Profiles 4.0 is adopted by all stakeholders. Records for providers and resources are shared between catalogues Users can search for providers and resources across multiple catalogues to more easily find valuable resources
Identifiers	FAIR Principles, EOSC *PID* Policy and report on the *PID* Architecture, mature Persistent Identifier Frameworks (Datacite, ORCID, DONA, ePIC, EUDAT), initial FREYA *PID* Graph technology, OpenAIRE Research Graph (*PID* graph across all sciences, org registries, author registries, funder registries)	Develop guidelines for providers to select *PID* types, for new *PID* types (e.g. instruments, services, software, organisations), to connect to *PID* Graphs and to implement minimum *PID* Kernel Type Information	EOSC *PID* policy defining how different *PID* approaches can be deployed
AAI	SAML2, OAuth2, OpenID Connect, REFEDS Framework (Sirtfi, R&S, RAF), AARC Blueprint architecture and guidelines, EAWG TF-AAI output on Architecture and Authentication, WISE SCI Trust Framework and AUP which are endorsed by the major Research Infrastructure and e-Infrastructures	Agree on the EOSC AAI Interoperability Guidelines and EOSC Federation Membership requirements	EOSC AAI Federation policy, EOSC AAI Interoperability Guidelines adopted by the Research Infrastructure and *EOSC-Exchange* services
Metadata and Ontologies	Many thematic and community-based metadata schemas and ontologies are	EOSC guidelines for data discovery	Interoperability framework on data discovery and exchange

	available, guidelines for data discovery and metadata harvesting from OpenAIRE and EUDAT, DataCite guidelines for registering DOIs. EOSC-hub interoperability guidelines on Metadata Management and Data Discovery: https://wiki.eosc-hub.eu/display/EOSCDOC/Metadata+Management+and+Data+Discovery	Exchange and cross-walks on basis of existing guidelines	
Accounting for services	Cloud VM Usage Record, OGF StAR record, Grid job usage record, Grid summary job record, ARGO Messaging Service EOSC-hub Interoperability guidelines: https://wiki.eosc-hub.eu/display/EOSCDOC/Accounting .	Agreed usage records to track consumption of EOSC resources Agreed interfaces to collect accounting records from EOSC providers	Interoperability framework for service providers for automated reporting of accounting and usage metrics
Monitoring	Nagios Plugin API, ARGO API, Apache Avro, REST and JSON API, ARGO Messaging Service EOSC-hub Interoperability guidelines: https://wiki.eosc-hub.eu/display/EOSCDOC/Monitoring	Agreed definition of service availability and reliability in EOSC Agreed interfaces to collect monitoring information from EOSC providers	Interoperability framework for monitoring service availability and reliability of services in the EOSC Catalogue
Order Management	API for providers to define service offers and related parameters v1 from EOSC-hub API for EOSC order handling v1 from EOSC-hub	Agreed interfaces to manage service offers and orders	Interoperability framework for order management and for automatic exchange of the orders with service providers
Accounting for research products	COUNTER Code of Practice, OpenAIRE Guidelines and APIs, MakeDataCount Guidelines and APIs	Agreed protocol and exchange format for pull/push exchange of usage data	Interoperability Framework enabling the collection of research data usage statistics across EOSC data repositories
Helpdesk	X-GUS protocol implemented over SOAP	Agreed paths to integrate a helpdesk in the Federated EOSC Helpdesk	Federated EOSC Helpdesk framework for EOSC providers

	EOSC-hub interoperability guidelines: https://wiki.eosc-hub.eu/display/EOSCDOC/Helpdesk	Agreed interfaces between helpdesks	
Data platforms for processing	POSIX, WebDAV, CDMI, S3, OneData	Agreed interfaces for transparent data ingesting, movement, and processing in distributed and hybrid cloud environments, including containers and notebooks	Interoperability framework for transparent data ingesting, movement, and processing in distributed computing resources
Data Publishing and Open Data	SWORD, DOIP, FedoraCommons, DSpace, B2SHARE, Zenodo, DataCite, OpenAIRE guidelines for Data Archives, OpenAIRE PROVIDE, B2FIND guidelines, EDMI, Schema,org, OAI-PMH, RO-Crate	Agreed macro-features and interfaces for a digital repository, an infrastructure component that is able to store, manage, and curate Digital Objects and return their bitstreams when a request is being issued	Interoperability framework for digital repositories in EOSC
Cloud Compute Containerisation and Orchestration	OpenStack API, Open Virtualisation Format (OVF), Paas orchestrators, Kubernetes, Docker Swarm, Mesos, TOSCA EOSC-hub interoperability guidelines: https://wiki.eosc-hub.eu/pages/viewpage.action?pageId=68224522 https://wiki.eosc-hub.eu/display/EOSCDOC/PaaS+Solutions	Agreed interfaces and orchestrators to create VMs and containers into cloud resources	Interoperability framework to federate cloud resources in EOSC
HTC-HPC Compute	TOSCA, OpenStack API, Kubernetes, Distributed Resource Management Application API, QCG (DRMAA) EOSC-hub interoperability guidelines: https://wiki.eosc-hub.eu/pages/viewpage.action?pageId=63438908	Agreed interfaces and orchestrators to deploy and manage clusters on HPC and HTC resources	Interoperability framework to deploy and orchestrate clusters on demand on HPC and HTC resources and manage batch job processing

12 Appendix E – Layers of Interoperability

As described in the *EOSC Interoperability Framework* report[28] from the EOSC FAIR and Architecture Working Group of the previous EOSC Governance, the structure of *EOSC Interoperability Framework* (EOSC IF) has been inspired by the Interoperability model of the European Interoperability Framework for European Public services[29]. The Interoperability model is structured in four layers as depicted in the Figure 12.1.

Figure 12.1. European Interoperability model

In the EOSC IF report the following definitions have been provided for the interoperability layers:

- **Legal interoperability**[30] is about ensuring that organisations operating under different legal frameworks, policies and strategies are able to work together. This might require that legislation does not block the establishment of European public services within and between Member States and that there are clear agreements about how to deal with differences in legislation across borders, including the option of putting in place new legislation.

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[28] https://dx.doi.org/10.2777/620649
[29] https://dx.doi.org/10.2799/78681
[30] Legal interoperability: https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework- observatory/glossary/term/legal-interoperability

- **Organisational interoperability** refers to the way in which organisations align their business processes, responsibilities and expectations to achieve commonly agreed and mutually beneficial goals (source: European Interoperability Framework).
- **Semantic Interoperability**[31] It ensures that the precise format and meaning of exchanged data and information is preserved and understood throughout exchanges between parties, in other words 'what is sent is what is understood'.
- **Technical interoperability** A characteristic of an Information Technology (IT) system, whose interfaces are completely understood, to work with other IT systems, at present or in the future, in either implementation or access, without any restrictions or with a controlled access (source: Interoperability - Wikipedia).

In the context of the EOSC Architecture and Interoperability Framework work in EOSC Future the focus will be on the Technical and Semantic interoperability layers.

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[31] Semantic interoperability: https://joinup.ec.europa.eu/collection/nifo-national-interoperability-framework- observatory/glossary/term/semantic-interoperability

13 Appendix F – Analysis of Related Governance Frameworks and Proposed *EOSC Interoperability Framework* Governance

Table 13-1: Analysis of some governance frameworks and proposed EOSC IF Governance Structure

	IETF	RDA	AARC	IGTF	Proposed EOSC IF Governance Structure
Scope	The mission of the IETF is to make the Internet work better by producing high quality, relevant technical documents that influence the way people design, use, and manage the Internet.	The Research Data Alliance (RDA) was launched as a community-driven initiative in 2013 by the European Commission, the United States Government's National Science Foundation and National Institute of Standards and Technology, and the Australian Government's Department of Innovation with the goal of building the social and technical infrastructure to enable open sharing and re-use of data.	The AARC Engagement Group for Infrastructures (AEGIS) brings together representatives from research and e-Infrastructures, operators of AAI services to bridge communication gaps and make the most of common synergies. AEGIS ultimately enhances the wider and more effective uptake of AAI recommendations by infrastructures in their federated access solutions, so that they can focus on providing other support for research activities.	The IGTF is a body to establish common policies and guidelines that help establish interoperable, global trust relations between providers of e-Infrastructures and cyber-infrastructures, identity providers, and other qualified relying parties.	The *EOSC Interoperability Framework* aims to provide a set of recommendations on the components that need to be provided in the ecosystem and on the principles guiding digital object producers and/or consumers on their use, in order for the framework to set a foundation for an efficient machine-enabled exchange of digital objects within EOSC and between EOSC and the outside world[32].

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[32] (EFWG/EAWG EOSC Interoperability Framework report - p7 2nd paragraph)

Objectives	The Internet Engineering Task Force (IETF) is the premier Internet standards body, developing open standards through open processes. The IETF is a large open international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet.	**The RDA Vision**: Researchers and innovators openly share and re-use data across technologies, disciplines, and countries to address the grand challenges of society. **The RDA Mission**: RDA builds the social and technical bridges that enable open sharing and re-use of data.	• Consult the expertise of participants for feedback on AAI activities; • showcase ongoing implementation efforts of the AARC Blueprint Architecture; • promote a consistent vision for federated access; • facilitate activities for the adoption of harmonised solutions and avoid 'reinventing' the wheel; • report on the adoption of and provide guidance on the AARC guidelines; • provide a home for the adoption and further development of the AARC Blueprint Architecture; • maintain, develop, and organisationally support the AARC community;	The IGTF develops guidance, coordinates requirements, and harmonizes assurance levels, for the purpose for supporting trust between distributed IT infrastructures for research. It coordinates providers of trust information (authorities) and consumers thereof (relying parties) and by agreement to sets of common standards, baselines, and best practices for policy, technical security, and operational trust. For the purpose of establishing and maintaining an identity federation service, the IGTF maintains a set of authentication profiles (APs) that specify the policy and technical requirements for a class of identity assertions and assertion providers.	Maintain and promote a set of standards and guidelines to support interoperability and composability between resources (e.g. services and research artifacts) within EOSC. Offer a platform for communities and RIs to promote their standards and guidelines within EOSC.

			• liaise with other entities in the AAI ecosystem.		

Principles	Open process Any interested person can participate in the work, know what is being decided, and make his or her voice heard on the issue. Part of this principle is our commitment to making our documents, our WG mailing lists, our attendance lists, and our meeting minutes publicly available on the Internet. **Technical competence** The issues on which the IETF produces its documents are issues where the IETF has the competence needed to speak to them, and that the IETF is willing to listen to technically competent input from any source. Technical competence also means that we expect IETF output to be designed to sound network engineering principles - this is also often referred to as 'engineering quality'. **Volunteer Core** Our	**Openness** – Membership is open to all interested individuals who subscribe to the RDA's Guiding Principles. RDA community meetings and processes are open, and the deliverables of RDA Working Groups will be publicly disseminated. **Consensus** – The RDA moves forward by achieving consensus among its membership. RDA processes and procedures include appropriate mechanisms to resolve conflicts. **Inclusive** – The RDA seeks to promote broad, balanced and inclusive representation of its membership and stakeholder communities. **Harmonization** – The RDA works to achieve harmonization across data standards, policies, technologies, infrastructure, and communities. **Community-driven** – The RDA is a public, community-driven body constituted of volunteer members and	Following the Community First approach and driven by the use cases. AEGIS follows a consensus-based model.	The IGT follows a peer review model and consensus driven process.	• EOSC IF standards and guidelines are based on existing mature standards and guidelines (do not reinvent the wheel) • EOSC IF standards and guidelines are widely adopted standards within the research community • EOSC IF standards and guidelines are selected on basis of the consensus principle • EOSC IF standards and guidelines should be based on open standards.

	participants and our leadership are people who come to the IETF because they want to do work that furthers the IETF's mission of 'making the Internet work better.' **Rough consensus and running code** We make standards based on the combined engineering judgement of our participants and our real-world experience in implementing and deploying our specifications. **Protocol ownership** When the IETF takes ownership of a protocol or function, it accepts the responsibility for all aspects of the protocol, even though some aspects may rarely or never be seen on the Internet. Conversely, when the IETF is not responsible for a protocol or function, it does not attempt to exert control over it, even though it may at times	organizations, supported by the RDA Secretariat. **Non-profit and technology-neutral** - RDA does not promote, endorse, or sell commercial products, technologies, or services and the development of open and re-usable recommendations and outputs within the RDA is mandatory.			

	touch or affect the Internet.				
Types of Standards	**Technical Specification** is any description of a protocol, service, procedure, convention, or format. It may completely describe all of the relevant aspects of its subject, or it may leave one or more	**RDA Recommendations** - produced by RDA WGs **Supporting Outputs** - produced by any RDA group **Other Outputs** - produced by any RDA group	AARC Guideline (AARC-Gxxx) AARC Informational white paper (AARC-Ixxx)	IGTF Authentication Profiles covering Authentication Assurance Profiles and Technical Guidance documents	**EOSC IF Core guidelines**: Interoperability guidelines and best practices to make use of and/or integrate with *EOSC-Core* provided services and capabilities **EOSC IF Interoperability guidelines**: Generic

					Interoperability guidelines and best practices. These guidelines are organised in Interoperability Areas. **EOSC IF Community guidelines**: Community defined and maintained guidelines. EOSC provides a platform via which Communities can promote their guidelines and best practices.
	parameters or options unspecified. **Applicability Statement** specifies how, and under what circumstances, one or more TSs may be applied to support a particular Internet capability. **Best current practice** subseries of the RFC series is designed to be a way to standardize practices and the results of community deliberations.				
Procedure	1. Initiation of Action - specification to enter the standards track is posted as Internet-Draft 2. Internet Engineering Steering Group (IESG) Review and Approval - determine whether or not the technical quality and clarity of the specification is consistent with that expected for the maturity level to which the specification is recommended 3. Publication - Specification is published	1. Community review - The Secretariat opens the Recommendation for review by the RDA community by placing it in the RFC box on the home page. 2. Organisational Assembly review - to provide an expert commentary on the adoptability of the Recommendation, and whether this Recommendation furthers the RDA mission. 3. Adoption report - Secretariat will ask the	New AARC guidelines and policies are being developed within the AARC Working groups (i.e. Architecture and Policy Harmonisation). New guidelines and policies are accepted by the AEGIS representatives	New Guidelines are adopted through the regional (continental) policy management authorities	1. Proposal submission- Proposer requests inclusion of new standard and/or guidelines to be included in the EOSC IF 2. Review process - New requests are being reviewed on technical quality and clarity and is consistent with that expectation of EOSC IF standards and guidelines 3. Endorsement process - New standards and guidelines are being discussed within the EIAB and if approved submitted to the EIC for endorsement 4. Publication process - New

	as an RFC, specification is removed from the Internet-Drafts directory	group chairs to provide contact details for two adopters of the Recommendation. 4. Council review - Council reviews the OA commentary (if any), adoption report, and community responses, and detects the presence or absence of consensus.			standards and guidelines are being published in the EOSC Knowledge Hub and Announced via the EOSC channels
Maturity levels	Proposed standard, Draft standard, Standard, Retired, Experimental, Informational	Draft, endorsed RDA output	Concept, Abandoned, In Progress, On Hold, Consultation, Final Call, Final, Endorsed by	Draft, accepted by a regional policy authority, globally endorsed by IGTF	Proposed, Accepted, Deprecated
Submission requirements		• Short description • Impact statement • Authorship information • Licensing information • Further metadata (version, publication date) • Maintenance and retirement plan • Two adopters			• EOSC Interoperability Area • Short description • Impact statement • Authorship information • Licensing information • Further metadata (version, publication date) • Maintenance and retirement plan • Endorsement

Governance structure	Internet Architecture Board: The Internet Architecture Board provides long-range technical direction for Internet standards, ensuring the Internet continues to grow and evolve as a platform for global communication and innovation. Internet Engineering Steering Group (IESG): administers the process according to the rules and procedures that have been ratified by the Internet Society trustees [RFC 2026]. It is directly responsible for the actions associated with entry into and movement along the Internet 'standards track,' including final approval of specifications as Internet Standards. The IESG consists of the Area Directors (AD) Areas: The area structure is defined by the IESG, and the IESG can add areas, redefine areas,	Council: maintains the vision of RDA, ensuring the guiding principles of the organisation are maintained, and formally endorses RDA Working and Interest Groups and Recommendations. Technical Advisory Board: provides technical expertise and advice to the Council, and assists in development, review and promotion of RDA Working & Interest Groups. Working Groups: are short-term (18 months) and come together to develop and implement data infrastructure, which could be tools, policy, practices and products that are adopted and used by projects, organizations, and communities. Embedded within these groups are individuals who will use the infrastructure and help in making it broadly available to the public. Any RDA member can join or initiate a WG.	There are two ways to participate in AEGIS: ● Members - Research and e-Infrastructures and other organizations responsible for the operation of AAIs for international research collaborations following the AARC guidelines relevant to their interoperability with AEGIS peers. Each member can appoint up to two individuals to represent the organization in AEGIS. ● Observers - AEGIS welcomes parties that may have an interest in using AARC guidelines or that are in the process of implementing an AAI that follows the AARC BPA. Observers should be invited by an AEGIS member and endorsed by the AEGIS membership. Observers do not vote nor endorse documents.	The International Grid Trust Federation consists of the Asia Pacific Grid Policy Management Authority, the European Policy Management Authority for Grid Auth-entication in e-Science, and The Americas Grid Policy Management Authority. Each PMA is represented in the IGTF via its chair. By virtue of its membership of a PMA, each member of a PMA is subject to the IGTF Federation document and is thus a member of the Federation.	EOSC Interoperability Advisory Board (EIAB): Responsible for overseeing the EOSC IF; it endorses new/deprecates guidelines, based on the recommendations of the EIAC. EOSC Interoperability Area Chairs (EIAC): The *EOSC Interoperability Framework* consists of wide range of topics. These are organised in different areas, for example Metadata, *PID*s, Data, AAI, Semantics, etc. in line with the *EOSC-Core* components. The EIAC is responsible to perform the initial assessment of the proposed standards and guidelines and to make recommendations for inclusion/exclusion to the EIAB.

	merge areas, change the number of Area Directors (ADs) assigned to an area, or close down areas. **Working Groups**: are the primary mechanism for development of IETF specifications and guidelines, many of which are intended to be standards or recommendations.	**Interest Groups**: are open-ended in terms of longevity. They focus on solving a specific data sharing problem and identifying what kind of infrastructure needs to be built. These groups identify specific pieces of work and can start up a WG to tackle those projects. Any RDA member can join or initiate an IG.			
Conflict resolution	1. Find consensus within WG 2. If disagreement cannot be resolved escalate to AD 3. If disagreement cannot be resolved escalate to IESG 4. If disagreement cannot be resolved escalate to IAB		Decision is achieved either by rough consensus or by a vote. A voting process should only be started if it has proven impossible to reach rough consensus within a reasonable period of time. In such cases, voting can be requested by at least two AEGIS members,	IGTF – the International Grid Trust Federation – http://www.gridpma.org / International Grid Trust Federation page 6/7 version 1.1 Dated: 27 Jan 2009 12 Federation Administration 12.1 Change procedures for this federation document	1. Find consensus between submitter and EIAC 2. If disagreement cannot be resolved escalate to EIAB

				and voting will be called by the AEGIS chair. Each member organisation will have one vote. Only items on the agenda can be voted on.	This document can be changed by consensus of all participating regional and continental PMAs. In this decision the Chair represents each PMA. Each PMA must define the criterion to reach a decision on such consensus. Unless stated otherwise, this federation document will have the same status as a Charter in a regional or continental PMA. 12.2 Federation management The federation management consists of the chairs of each of the participating regional or continental PMAs. The chairs will meet when necessary, possibly by electronic means, to ensure continued operation of the federation. The IGTF itself will have a chair. The role of chair	

				of the IGTF will be filled by one of the regional PMA chairs. This role will last for one year, and rotate to the other PMA chairs on the anniversary of the founding of the IGTF, from Europe to the Asia-Pacific, to the Americas and then to Europe again. The first chair will be selected by unanimous consent of the voting members and announced after the founding vote has occurred. Each member PMA must operate a forum in which its members convene periodically. Such a meeting will also be opened to chairs and members of any of the other PMAs. Minutes of the PMA meetings will be distributed across all members of all PMAs	

				within the federation. The IGTF can develop other controlling documents as needed. 12.3 Membership applications Each member PMA must define guidelines on membership application and on the accreditation of issuing authorities. These guidelines must contain: - which groups and organizations can join a PMA, - how issuing authorities are grouped by accreditation profile, - how issuing authorities are accredited according to that profile. The accreditation shall be based on a sound review process in which the compliance of the authority with respect to this federation document and the selected authentication profile is assessed.	

				All accredited authorities will be members of the accrediting PMA. Each PMA must allow representation of relying parties, and document how relying parties are represented. 12.4 Dispute resolution Disputes may be brought to the attention of the IGTF or to any of the member PMAs by sending an electronic mail message to the 'concerns' address of the relevant body. Whenever possible, disputes will be resolved by the PMA whom the issue concerns. The PMA chairs will resolve IGTF-related disputes via unanimous decision.	
Documentation	Procedure described in RFC 2026 - https://datatracker.ietf.org/doc/html/rfc2026	https://www.rd-alliance.org/groups/creating-and-managing-rda-groups/rda-outputs.html	https://aarc-project.eu/guidelines https://wiki.geant.org/display/AARC/Guidelines+Process https://aarc-	https://www.igtf.net/doc/IGTF-Federation.pdf	The documentation is being created

			community.org/wp-content/uploads/2019/12/AEGIS-Charter-v1.0.pdf		