D2.5Final Governance and Sustainability Roadmap

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Deliverable Abstract
This deliverable presents a final governance and sustainability roadmap for EOSC-hub which takes account of the current and expected future shape of the EOSC landscape. It presents recommended actions to address identified issues of relevance to the governance and sustainability of the EOSC-hub services.

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TERMINOLOGY

https://wiki.eosc-hub.eu/display/EOSC/EOSC-hub+Glossary

Terminology/Acronym	Definition
AAI	Authentication and Authorisation Infrastructure
Cluster Projects	Collaborative projects between ESFRI research infrastructures in similar disciplines, providing a gathering point for connecting to the EOSC
Common Services	
Compliance Framework	Part of the EOSC-Core. The Rules of Participation, the Interoperability Framework, the Service Management System and other policies and processes for the demand side and the supply side to engage with EOSC. The Compliance Framework constitutes the EOSC "regulatory tier"
Depletable Resources	Resources which can support only a limited number of user requests, for example services such as HPC, HTC or cloud computing
DICE	Horizon 2020 project Data Infrastructure Capacity for EOSC, to enable a European storage and data management infrastructure for EOSC, providing generic services and building blocks to store, find, access and process data in a consistent and persistent way
EGI-ACE	Horizon 2020 project to deliver the EOSC Compute Platform and contribute to the EOSC Data Commons through a federation of cloud compute and storage facilities, PaaS services and data spaces with analytics tools and federated access services
EGI Federation	A federation of computing and storage resource providers united by a mission to support research and innovation with advanced computing services. The federation is governed by the participants represented in the EGI Council and coordinated by the EGI Foundation
EGI Foundation	Coordinates the EGI infrastructure on behalf of the participants of the EGI Council
EOSC	The European Open Science Cloud promoted by the European Commission to provide all researchers, innovators, companies and citizens with seamless access to an open-by-default, efficient and cross-disciplinary environment for storing, accessing, reusing data, tools, publications and any EOSC Resource for research, innovation and educational purposes
EOSC Association	Legal entity created to progress the EOSC Partnership with the European Commission to co-design and deploy a European research data common where data are findable, accessible, interoperable and reusable (FAIR), and as open as possible
EOSC-Core	Set of services providing the means to discover, share, access and re-use data and services
EOSC-Exchange	Set of services storing and exploiting FAIR data and encouraging its reuse
EOSC Partnership	Proposed co-programmed European Partnership under Horizon Europe
EOSC Portal	The EOSC Service providing online access to and use of the EOSC Resources
ERA	European Research Area

ESFRI	European Strategy Forum on Research Infrastructures
EU	European Union
EUDAT CDI	EUDAT Collaborative Data Infrastructure; European e-infrastructure of integrated data services and resources to support research
EUDAT Ltd	Non-profit organisation operating as the voice of European organisations working together as part of the EUDAT CDI
FAIR	Guiding principles to make data Findable, Accessible, Interoperable, and Reusable
Federating Core	The activities, policies and resources required to facilitate, monitor and regulate as appropriate day-to-day transactions across the EOSC. The Federating Core is made up of the Hub Portfolio, the Compliance Framework and the Shared Resources
HPC	High-performance computing
HTC	High-throughput computing
Horizon 2020	The European Union Framework Programme for Research and Innovation
Hub Portfolio	Functions which implement the federating tier of the EOSC: the activities and tools that are necessary to provide coordinated access to and management of resources (services and scientific products) provided in the EOSC Shared Resources or the Service Portfolio. EOSC resources are expected to be delivered at national and European level, together with the support and expertise necessary to address complex digital needs of the EOSC user communities. The Hub portfolio delivers the EOSC "federating tier"
INDIGO-DataCloud	Integrating Distributed data Infrastructures for Global ExplOitation, Horizon 2020 project. After the project ended in 2017, this indicates a collaboration agreement among the main participants aimed at supporting the products developed by the INDIGO-DataCloud project and its follow-on projects, DEEP HybridDataCloud and eXtreme DataCloud (XDC)
KPI	Key Performance Indicator
MS	(EU) Member State
MVE	Minimal Viable EOSC
NASA	National Aeronautics and Space Administration
OECD	Organisation for Economic Cooperation and Development
OpenAIRE-Advance	Project supporting Open Access/Open Data mandates in Europe
PID	Persistent Identifier
Research support	Provision of expert technical support and consultancy for performing research
RSP	Research Support Provider. Providers of expert technical support and consultancy, for example, support staff at Research Infrastructures, e-Infrastructures or universities
Science Europe	Association representing major public organisations that fund or perform excellent, ground-breaking research in Europe
Shared Resources	Resources including scientific outputs (local copies of data; applications, software, pipelines etc.) and the storage and compute hosting platforms needed to deposit, share and process them. The shared resources realise the EOSC "resource tier"
SRIA	Strategic Research and Innovation Agenda

Virtual Access	Financial instrument defined in the "European Research Infrastructures (including e-Infrastructures)" EC Work Programme, which is part of the Horizon 2020 framework programme. The goal of the instrument is to reimburse the costs of service providers (also called "access providers"), as beneficiaries of a Horizon 2020 grant, for provisioning (via the internet) services to researchers

Contents

Executive summary

This deliverable discusses issues relating to the EOSC which are of relevance to the sustainability of EOSC-hub services for the period from 2023 onwards and presents recommendations for further actions which could be undertaken to investigate them further and address them. It draws on the previous work of Task 2.3 (Governance and Sustainability), which presented proposals defining the structure and composition of the EOSC and, jointly with WP12 (Business Models and Procurement), examined issues associated with the provision of storage and compute services across borders. It also draws on other work of WP12, particularly relating to procurement.

A mapping shows that many of the functions of the EOSC-Core are provided by EOSC-hub services, whose consolidation in the EOSC-Core is expected over the next 2 years as part of the project funded by the INFRAEOSC-03 call. Numerous EOSC-hub services are also expected to contribute to the EOSC-Exchange, particularly to the Shared Resources[1] which were identified as important to the value proposition of the EOSC and proposed by Task 2.3 to be sustained in future by the EOSC along with the EOSC-Core.

The issues discussed include

- The lack of coordination at both the national and European levels between research and e-Infrastructure funding policies and investment plans, and the lack of European-level coordination between national e-Infrastructure strategies
- The need to define coordinated access policies and funding streams to compensate for data and service provisioning by EOSC stakeholders across national and organisational boundaries
- The ability and commitment of EGI and EUDAT to provide components of services to the EOSC-Core which, although they would constitute only one instance of the services, could also relate to their more general perceived relevance and value, and hence sustainability
- The issues and risks entailed by use of public procurement for purchasing services in the EOSC-Core and EOSC-Exchange from 2023
- The importance of research support provision to the success of the EOSC by enabling use of data and services, commonly provided by the e-Infrastructures and other stakeholders.

The recommendations proposed to address these issues have the following objectives, desired impacts and suggested actions

1. Objective: Achieve greater efficiency in allocation of EC and member state funding for e-Infrastructures
   Desired impacts:
   - Demonstrated funding requirements of research better met, including required e-infrastructure
   - Demonstrated and recognised value of e-infrastructures in relation to research needs including those arising from the EOSC

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[1] A subset of the EOSC-Exchange proposed and defined by Task 2.3 as "resources including scientific outputs (local copies of data; applications, software, pipelines etc) and the storage and compute hosting platforms needed to deposit, share and process them"

- Smoother interoperation of EC and member state funding streams

Suggested actions:

- o Improve co-ordination of e-Infrastructures' engagement with research communities at MS and EU levels
- o Develop, through dialogue, cohesive views within Member States across:
    - o Provision of Shared Resources (storage and compute services for research) in the EOSC
    - o Representation in the EOSC Partnership
    - o Broader EU research strategy
- o Gather and represent requirements to the EOSC Partnership Board from the perspective of EOSC Association members
- o Align research and e-infrastructure strategy within Member States and at European level
- o Ensure appropriate coordination and synchronisation of different funding streams (e.g., from Member States, EC, research performing organisations and projects etc) to balance national and international interests and sustain the whole EOSC ecosystem including the Shared Resources
- o Simplify resource allocation procedures/mechanisms to achieve an appropriate balance between the effort and timescale involved in applying for resources and the size/value of the resources required.

2. Objective: Define and implement a solution for funding the expected additional marginal costs of consumption of resources arising in the EOSC
   Desired impacts:
   - International, interdisciplinary research has access to the Shared Resources (including compute and storage services) it requires
   - The additional consumption of depletable resources arising in the EOSC is sustainable

Suggested actions:

- o Agree and articulate the EOSC value proposition for all EOSC stakeholder groups, including funders
- o Carry out further studies to obtain empirical evidence of the macroeconomic and societal benefits of cross-border research funding
- o Run pilots involving support of cross-border research collaborations to help assess the potential value of data and other resources for new use cases
- o Analyse Covid-19 research interdisciplinary and cross-border collaboration and resource consumption, for examples of how they were organised, and for any use of depletable resources
- o Experiment with providing supplementary demand-side funding for use of national e-Infrastructures, including their cross-border use, to complement or top-up national supply-side funding

o Develop guidelines and structures which facilitate cross-border public-to-public service collaboration with cost reimbursement, for example public-to-public cooperation exemption from public procurement rules.

3. Objective: Ensure due consideration is given to the wider and longer-term consequences of the choices made when selecting suppliers for the EOSC-Core

Desired impacts:

- The criteria for selecting suppliers for EOSC-Core services from 2024 onwards include full and due consideration of all aspects, including the wider and longer-term consequences of the choices made

Suggested action:

o Carry out a study into the pros and cons of publicly funded versus commercial services in the EOSC-Core, including wider and longer-term implications for future research e-Infrastructure use and development such as quality, wider capacity expansion, support provision, driving out public providers, vendor lock-in, trust in long-term sustainability of services, deriving full benefit from public investment to date, fragmentation of investment and erosion of funding.

4. Objective: Identification and understanding of the likely or possible consequences of use of public procurement, to inform decision-making and specification of future actions
   Desired impacts:
   - Well-informed decision-making and clear specification of future actions

Suggested actions:

o Publicly funded e-Infrastructure providers should reconsider and re-evaluate their ability to respond to public tenders
o Consider the wider and longer-term consequences for large-scale infrastructures of a move to use of public procurement, covering such aspects as deriving full benefit from public investment to date, and risks such as fragmentation of investment and erosion of funding
o Determine the role of the EOSC Association in public procurement for EOSC-Core and -Exchange services.

5. Objective: Assess the cost of research support activity to e-Infrastructures, likely demand and take-up of research support as a service, and identify potential funding sources

Desired impacts:

- Clear understanding of the role research support should play in the EOSC and its importance to the success of the EOSC
- Consider research support as a fundamental element when specifying tenders for resource procurement

- Assessment of the viability of research support as a service which might be provided through the EOSC Portal as a value-added service enriching the resource and service provision

Suggested actions:

- o Unbundle research support costs in e-Infrastructure service provision
- o Carry out studies to assess the likely demand and uptake of e-Infrastructures' research support services, including demand in the context of the EOSC, and potential funding sources
- o Identify concrete actions to make research support available to prospective users, complementing resources provision
- o Consider widening the scope of competence centres or centres of excellence to include research support activities
- o Consider including research support services when specifying tenders for resource procurement.

The actions proposed above mostly involve activity in the EOSC Association or the EOSC Partnership governance, in the projects funded by the INFRAEOSC-03 or -07 calls, or within member states. The majority are recommended to be implemented during 2021 and 2022, with a few later or longer-term activities.

The role of the EOSC-hub services in the EOSC beyond 2022 is unclear currently but may lie in harnessing their deep expertise and knowledge of the research community, and their contribution of innovative services developments which build the value of the EOSC.

1 Introduction

1.1 Purpose

This deliverable presents a final roadmap for sustaining the provision of EOSC-hub services to European researchers in the context of EOSC. The roadmap is presented in the form of recommendations for further actions which should be undertaken to address issues of relevance to the sustainability of the EOSC-hub services.

The EOSC landscape, architecture and strategy has evolved significantly during the course of the EOSC-hub project. The Horizon 2020 INFRAEOSC-03 and -07 calls already provide means for the short-term sustainability of various EOSC-hub services. Task 2.3 has, therefore, taken a longer-term view and puts forward recommendations for further actions which could be undertaken in the next few years to address some of the issues which have been identified relating to sustainability.

1.2 Scope

Sustainability, for the purposes of this report, is about how to continue to provide the services in question, involving consideration of their governance, organisation and funding. Governance is about oversight and includes consideration of services' ownership and control; organisation considers services' operation, delivery and technological development, and includes consideration of user demand for services; funding includes consideration of investment and payment for consumption. Sustainability is not just about financial considerations, but about their wider effects, including equality of access, balancing payment contributions against usage, incentives for sharing resources, and influence of minority funding contributors.

The scope of services considered is those included in EOSC-hub, primarily the EGI and EUDAT services, but also those involved in the EOSC-hub activities on thematic services, competence centres and the digital innovation hub (Work Packages 5, 6, 7, 8 and 9 respectively) involving research communities.

While EGI and EUDAT continue contributing to various projects under the coordination of their legal entities (EGI Foundation and EUDAT CDI respectively), the INDIGO-DataCloud services offered in the EOSC-hub portfolio have continued to be developed and supported in projects like eXtreme-DataCloud and DEEP-Hybrid DataCloud. The most important INDIGO-DataCloud and INDIGO-DataCloud-derived services, such as INDIGO-IAM, the PaaS Orchestrator, Onedata, the Infrastructure Manager and DODAS, are now supported by the EGI Federation, multiple international projects such as ESCAPE, EGI-ACE, IoTwins, by international collaborations such as WLCG and by national or regional initiatives. The sustainability of INDIGO-DataCloud services is thus no longer a direct concern of EOSC-hub, but several of the services are candidates for the EOSC-Core or EOSC-Exchange to which the considerations and recommendations made in this document are relevant.

Given the overall objectives of the EOSC-hub project, the sustainability-related issues considered in this deliverable are naturally those which relate to or are affected by the EOSC, rather than forming

a complete consideration of all issues which may affect the services' sustainability, which takes place in the governing bodies of the respective services.

As will be seen in chapter 3, the EOSC-hub services are expected to contribute significantly to the Minimum Viable EOSC (see later for definition/discussion), making their sustainability of direct relevance to the value-add of the EOSC. It is therefore important to identify challenges likely to be faced in future and implement actions to address them.

The full set of EOSC-hub Key Exploitable Results (KERs), and the protection and exploitation of the Intellectual Property created in the EOSC-hub project, are considered by Task 3.1 and will be reported in deliverable D3.4.

This deliverable builds on the previous work of T2.3, which is summarised in the following section.

1.3 Background

The purpose of Task 2.3 (Governance and Sustainability) has been to investigate and prepare the means for sustaining collaboration between the e-Infrastructure service providers and the associated communities in EOSC-hub (the thematic services, competence centres and digital innovation hub) beyond the end of the EOSC-hub project.

During the course of the project, T2.3 elaborated proposals to define the structure and composition of the EOSC, a necessary step towards determining the potential future involvement of the e-Infrastructures' and communities' services in the EOSC, and hence the possible means for sustaining them. The work was published in two briefing papers, in July 2019[2] and February 2020[3]. The proposed structure included an EOSC "resource tier" called the Shared Resources, defined as "resources including scientific outputs (local copies of data; applications, software, pipelines etc) and the storage and compute hosting platforms needed to deposit, share and process them".

It was proposed that to add value, the EOSC should provide the framework to guarantee opening access to research outputs (datasets, software, publications) for a wider community. This should include providing generic storage for common user needs, and processing facilities for data management and analysis (such as high-performance and high-throughput distributed compute capabilities), for researchers to manipulate resources to which they have been afforded access via the EOSC.

It was further proposed that the additional usage of services such as storage and compute required for this mission, extending the current scope of exploitation of research data, should be governed and sustained by the EOSC, making their sustainability synonymous with that of the EOSC itself.

This proposal was reflected in a draft community position paper on the Federating Core[4] in February 2020, which observed that "the EOSC needs to sustain the costs of providing the benefits of open data policies to a wider community of users. It needs to create the financial vehicle to cover the costs of the Hub Portfolio and Compliance Framework, and of provision and consumption of the

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[2] https://www.eosc-hub.eu/publications/briefing-paper-%E2%80%93-eosc-federating-core
[3] https://www.eosc-hub.eu/publications/briefing-paper-%E2%80%93-eosc-federating-core-v20-0
[4] https://www.eosc-hub.eu/publications/eosc-federating-core-community-position-paper-v11

Shared Resources beyond their originating communities. Coordinated provisioning and funding of the Federating Core is expected to bring economies of scale by aligning investments from member states with the compensation of marginal costs associated with cross-border usage of depletable resources and services".

Driven in part by the identification of the importance of the Shared Resources to the value proposition of the EOSC, work then took place jointly with WP12 to examine issues associated with the provision of storage and compute services across borders. The insights gained illustrated the fundamental importance of the Shared Resources for effective third-party open data and software sharing, as was further recognised by the ESFRI clusters and e-Infrastructures joint position paper published in November 2020[5].

The work allowed the formulation of recommendations for developing the EOSC to address the identified opportunities and requirements, which were published in a further briefing paper, on Provision of Cross-Border Services, in October 2020[6]. Recognising the need to align investments from member states with the compensation of marginal costs associated with cross-border usage of depletable resources and services, with reference to the Shared Resources the paper recommended that the EOSC legal entity should "ensure appropriate coordination and synchronisation of different funding streams (e.g. from member state, EC, research performing organisations and projects etc) to sustain the whole EOSC ecosystem including the Shared Resources. To underpin this policy, dialogues should take place within member states between ministries, research funders and Research Service Providers to allow for a cohesive input and contribution across the operational support of pan-European research, representation in the EOSC Partnership, and the broader EU research policy".

In parallel to T2.3, WP12 (Business Models and Procurement) of EOSC-hub has been examining how different ways of organising procurement activity are used in the European research community currently and assessing their potential use in the context of the EOSC.

The issues identified by these activities, relating to the sustainability of EOSC-hub services, are discussed further in the following chapters.

1.4 Methodology and Structure

This deliverable assesses the EOSC landscape as it stands at the start of 2021 and, building on the previous work of T2.3, describes the main issues known to be present in terms of the sustainability of EOSC-hub services and presents recommended actions for addressing them, in the form of a roadmap.

Chapter 2 describes the EOSC landscape at the start of 2021; chapter 3 describes the expected future contribution of EOSC-hub services to the EOSC-Core and EOSC-Exchange, forming an initial implementation action report in its description of the mapping of the EOSC-hub services to follow-on projects and the onboarding status of the relevant services in to the EOSC catalogue which is also a requirement of this deliverable; chapter 4 discusses issues relating to sustainability of EOSC-hub

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[5] https://zenodo.org/record/4044010#.YFmqeeYo-KU
[6] https://www.eosc-hub.eu/publications/briefing-paper-provision-cross-border-services

services and presents recommendations for further work to address them; chapter 5 contains some brief conclusions. Appendix 1 contains an update on the implementation of the roadmap which was presented in deliverable D2.4. Appendices 2, 3 and 4 present various mappings between the EOSC-hub services and the EOSC-Core and EOSC-Exchange, which are discussed in chapter 3.

2 Current EOSC Landscape and Context

This chapter describes the elements of the EOSC Landscape at the start of 2021 which are of most relevance to the sustainability of EOSC-hub services. The overall vision of EOSC which has been developed and clarified in recent years is that it is a multidisciplinary endeavour which should foster open, FAIR data, stimulate the release of open, high-quality, efficient and production-ready services, and provide seamless environments linked to e-Infrastructures. As discussed in this chapter and the following one, the EOSC-hub services and other key project results are fundamental to achieving this[7].

2.1 EOSC Preparation Phase Governance Outputs

The Preparation Phase of the EOSC was completed at the end of 2020. The outputs of the EOSC Executive Board and its working groups are all publicly available[8].

Of most direct relevance for the work of T2.3 during 2019 and 2020 were the activities of the Sustainability and Architecture Working Groups. The Federating Core and Cross-Border Services Briefing Papers were referenced in different iterations of the Sustainability Working Group's report "Solutions for a Sustainable EOSC"[9] which proposed a definition and high-level description of the structure and composition of the EOSC in what it called the EOSC-Core and the EOSC-Exchange, shown in the schematic on the left in Figure 1 below. The EOSC-hub (T2.3) proposals and the Sustainability Working Group proposals showed a significant amount of agreement, as can be seen from the mapping shown in Figure 1. Note that the Shared Resources form part of the EOSC-Exchange.

The vocabulary and definitions used by the Sustainability Working Group have generally been adopted in this Deliverable, although the term "Shared Resources" defined in section 2.3 continues to be used here, and the "Hub Portfolio" services of EOSC-hub are also referred to in places.

The EOSC-hub Briefing Papers' proposals and recommendations relating to the sustainability of the EOSC and the business models which may apply to the different elements of the EOSC also helped to inform the Working Group's report.

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[7] See Deliverable D3.4 for further information https://documents.egi.eu/public/ShowDocument?docid=3710
[8] https://www.eoscsecretariat.eu/eosc-governance/eosc-executive-board-outputs
[9] the different versions are listed at https://www.eoscsecretariat.eu/eosc-governance/eosc-executive-board-outputs
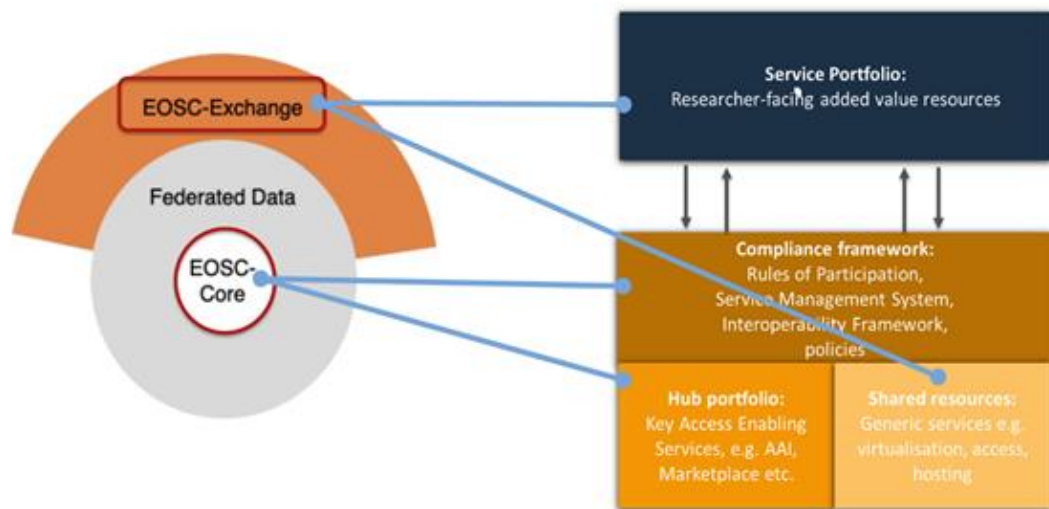
Figure 1: Key Elements of the Minimum Viable EOSC Compared with the EOSC Federating Core Proposals[10]

The Architecture Working Group's View On The Minimum Viable EOSC (MVE)[11] was developed by consensus from a basis which drew on proposals from EOSC-hub, OpenAIRE and the Sustainability Working Group's Tinman document. The document defines the MVE as a dynamic set of EOSC resources which will evolve over time, consisting of

- The subset of EOSC resources necessary for forming the added-value and opportunities considered essential to be provided by the EOSC 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, which could not be otherwise;
- The subset of EOSC-Core components/services required to operate and deliver such resources.

The View shows broad agreement with the EOSC-hub proposals on the Federating Core and confirms that many of the functions of the MVE, and of the EOSC-Core in particular, will be provided by EOSC-hub services. It can also be seen from the MVE definition above that the Shared Resources form part of the MVE.

Figure 2 below illustrates the Architecture Working Group's view of the MVE.

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[10] Sources: EOSC Sustainability Working Group Strawman document and
 https://www.eosc-hub.eu/publications/briefing-paper-%E2%80%93-eosc-federating-core
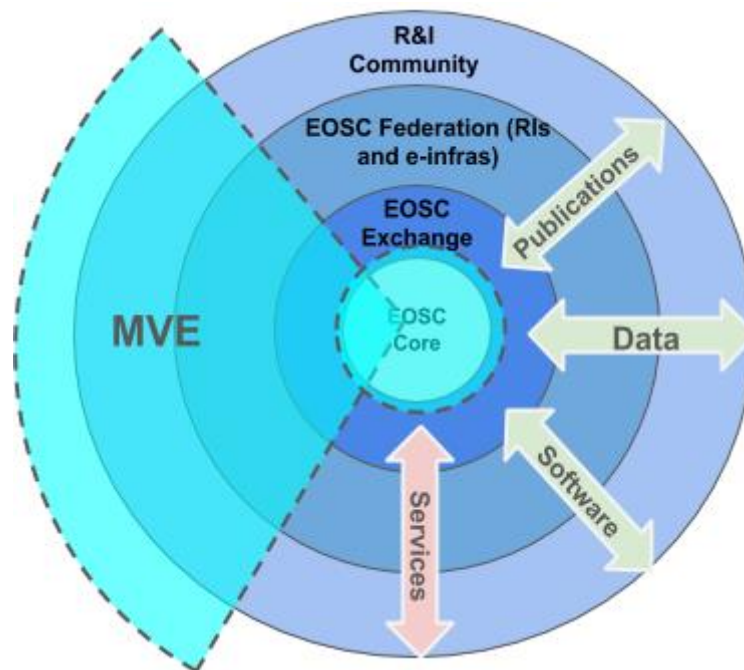[11] http://dx.doi.org/10.2777/492370

Figure 2: Architecture Working Group's High-level Diagram of the EOSC Depicting the Relationship Between EOSC-Core, EOSC-Exchange, EOSC-Federation and the MVE

The Working Groups' proposals are reference documents which will help to inform further development of the EOSC-Core and the Minimum Viable EOSC.

A further important output of the EOSC Governance and its Working Groups during 2020 was the draft Strategic Research and Innovation Agenda (SRIA)[12], which indicates a roadmap for realising the EOSC vision and objectives. The SRIA document is built on feedback received from the community via an open consultation over summer 2020. It will be annexed to the Memorandum of Understanding between the EOSC Association and the European Union for the EOSC European Partnership (see section 3.2). In particular, it describes how the EOSC will help deliver the goal of Findable, Accessible, Interoperable and Reusable (FAIR) data and the specific objectives of the Horizon Europe framework programme. It is foreseen that the SRIA and the associated Multi-Annual Roadmap (MAR) will be further developed by the EOSC Association.

The Final Progress Report of the EOSC Executive Board[13] notes several lessons learned and recommendations to the EC and the EOSC Association, namely:

- the need for a strong action by the EOSC Association to ensure that the engagement of the main stakeholders be strengthened and the divergence of objectives, priorities and interests across and within stakeholder groups concerning the benefits and costs of EOSC be reconciled
- ensure that the disruption that EOSC may cause to existing structures, decision making processes and funding models of the stakeholders are properly addressed
- ensure that the EOSC governance has authority to act, looking at ESFRI as a possible model

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[12] SRIA v1.0: https://www.eosc.eu/eosc-sria-v10-15-february-2021
[13] available from https://www.eoscsecretariat.eu/eosc-governance/eosc-executive-board-outputs

- ensure that the EOSC Association has clearer links and an ability to steer EC-funded projects to avoid them having diverging objectives and thus increasing fragmentation. To achieve this the EOSC Association should have a clear role within key investments
- To avoid loss of reputation, establish a single point of information for the wider EOSC community to retrieve information and as a way for the EOSC Association and the Partnership as a whole to send out a coherent, aligned message on EOSC.

These important points all have potential influence over future directions and decisions relating to EOSC and are all of relevance to the sustainability of EOSC-hub services.

2.2 EOSC Implementation Phase Governance

The EOSC entered its first implementation phase as of 1 January 2021, with a new governance structure which will support the European Open Science Cloud Partnership Agreement and oversee the continued development of the EOSC. European Partnerships are collaborations between the European Commission and private and/or public partners, which are being used as part of Horizon Europe to achieve research and innovation initiatives. The EOSC Partnership Agreement is expected to be concluded shortly with the signature of a Memorandum of Understanding between the EC and the EOSC Association, to which the SRIA (see section 2.1) will be annexed.

The EOSC Association, providing the Stakeholder Forum component of the EOSC governance structure, was established as a legal entity during 2020 and held its first General Assembly, admitting 142 members and 49 observers, on 17 December 2020. The Association provides an important vehicle for expressing and discussing the views of EOSC stakeholders.

The EOSC governance will also include a Steering Board of EU Member State and Associated Country representatives which will liaise with and advise the EOSC Association, the EC and the Partnership Board. The new governance structure is shown in Figure 3.

Figure 3: Schematic of EOSC Implementation Phase Governance

These entities will all influence the future direction and shape of EOSC, including the sustainability of EOSC-hub services.

2.3 EOSC-hub Outputs

EOSC-hub Deliverable D2.7[14], Final Service Roadmap, Service Portfolio and Service Catalogue, published at the end of 2020, maps the EOSC-hub service portfolios to the EOSC-Core and the EOSC-Exchange and helps to define the sustainability of EOSC-hub services. This mapping is discussed further in chapter 4.

Deliverable D12.3[15] builds on previous work in WP12 and the joint work with T2.3 on the Cross-Border Services Briefing Paper. D12.3 evaluates numerous business models which may be applied to the EOSC and proposes related recommendations for EOSC stakeholders. These include the recommendation that public providers should identify potential obstacles and risks associated with participation in public tenders and try to overcome them to be able to continue to provide services to the research community as part of the EOSC. This recommendation significantly influences the discussion in the current deliverable and the recommendations formulated in chapter 4.

2.4 EC-funded EOSC Implementation Projects

The EOSC-hub project will be succeeded by projects funded by the calls for proposals INFRAEOSC-03 and -07 which were part of the final Work Programme of Horizon 2020. In very simple terms, the project funded by the INFRAEOSC-03 call is expected to implement the EOSC-Core until mid- to-late 2023 by integrating the services it should contain, whereas the projects funded by the INFRAEOSC-07 call will provide services to the EOSC-Exchange. The -07 projects include EGI-ACE, which will be coordinated by EGI and in which most EGI partners also contribute, and the DICE project coordinated by CINECA and in which most EUDAT partners contribute. The -03 and -07 projects are complemented by other EOSC-related projects, including the EOSC regional projects funded by the INFRAEOSC-05b call, which support the connection of national thematic services to EOSC[16], and the EOSC cluster projects[17].

The services proposed by the Architecture Working Group View On The Minimum Viable EOSC as part of Phase 1 of the MVE are envisaged to be supported in the -03 project. Relevant contributions from EOSC-hub to the EOSC-Core and EOSC-Exchange, and how these map to the projects funded under these two calls, are discussed further in chapter 3.

2.5 Draft Horizon Europe Work Programme 2021-22

The first work programme of the Horizon Europe programme is not due to be officially published until April, but a draft version[18] shows that the EC envisages continuing to provide grant funding to support the implementation of the EOSC – in line with the EOSC Partnership Agreement – for a period following on from the projects funded by the INFRAEOSC-03 and -07 calls discussed in the

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[14] https://documents.egi.eu/document/3639
[15] https://documents.egi.eu/document/3633
[16] EOSC-Nordic, EOSC-Pillar, EOSC-Synergy, NI4OS-Europe, ExPaNDS, FAIRsFAIR - see
https://www.eoscsecretariat.eu/communities/eosc-regional-projects
[17] EOSC-Life, ENVRI-FAIR, ESCAPE, SSHOC, PaNOSC - see
https://www.eoscsecretariat.eu/communities/EOSC-ESFRI
[18] Circulating in early March 2021

previous section. From the draft Work Programme, it can be seen that the EOSC Partnership will be supported, among other things, to:

- Further develop the Strategic Research and Innovation agenda (SRIA), which should include the development of the EOSC-Core, the Minimum Viable EOSC and the future widening of the EOSC to the public and private sectors as well as supporting the alignment of contributions to the EOSC at the national, regional, institutional and scientific community levels
- Monitor investments related to EOSC
- Develop and test cost models and future business models for a lasting long-term sustainability framework, building on the work performed by the EOSC Sustainability Working Group and the studies already conducted as well as on the findings in this area of EOSC-related projects.

The draft Work Programme also contains specific calls aimed at supporting the development of new innovative services, the deployment of EOSC components for FAIR, and the discovery and interoperability of research objects across scientific domains.

The Work Programme recognises the importance of professional research support: there will be a specific call to fund a distributed pan-European user support network, supporting the collaboration of existing networks of competence and data curation centres in addition to more canonical actions targeted at the development of new curricula and the recognition of digital career profiles specifically related to Open Science. However, it could be worth considering an improvement of this action, specifically the relationship of research support to the other services provided through the EOSC Portal.

The possibility is also being considered by the EC, of using public procurement for purchasing the EOSC-Core services and possibly also some services in the EOSC-Exchange. The novel approach here is that support for those EOSC-Core and -Exchange services would no longer depend on grant funding through calls for project proposals, as it did in Horizon 2020. This is in line with the motivation of the European Commission first expressed in the directions of the 2016-18 Work Programme of Horizon 2020 and continued thereafter, that grants, and project lifecycle funding were not the appropriate way to fund mature operational infrastructures. The implications of this are discussed further in chapter 4.

3   EOSC-hub Services in the EOSC-Core and EOSC-Exchange

One of the concrete elements to be considered to deal with sustainability, is the evolution of the services which were selected to be part of EOSC-hub project beyond the end of the project at the end of March 2021. Although the target of this document is what will happen after 2023, we think an important piece of information is what is foreseen within the projects funded in the last calls of H2020, specifically INFRAEOSC-03 and INFRAEOSC-07.

The EOSC-hub services may be grouped in the following four categories:

- Hub Portfolio services
- Common services
- Thematic services
- Compliance Framework services

These categories were defined within the scope of EOSC-hub before the Preparation Phase EOSC Governance structure and its working groups were established. Although several EOSC-hub participants were involved in the mentioned working groups and specifically in the Architecture Working group, the Working Groups' outcomes are the result of contributions by different stakeholders and therefore reflect many points of view relevant to the EOSC ecosystem.

The main outcome of the EOSC Governance working groups related to the EOSC architecture and its main components has been described in the Fair Lady report and the Architecture Working Group View on the MVE. Mapping the EOSC-hub services into the services described in those documents gives a useful view of the contribution the EOSC-hub activities can make to creating the EOSC. Information on how and where these services are supported after the end of the project is also important for paving the way to what may happen in the frame of the new Horizon Europe programme. This information is summarised in tables in Appendices 2, 3 and 4, which are discussed below.

The content of EOSC-Core (and the functionalities included) is defined at a theoretical level in the Fair Lady report and the Architecture Working Group View on the MVE, but its concrete implementation and its boundaries in terms of real services have not yet been derived. Appendix 2 maps the EOSC-hub services to the EOSC-Core and EOSC-Exchange and shows which Horizon 2020 projects will sustain them until 2023. It shows that EOSC-hub is already providing a number of services which can fit into the EOSC-core category (and this is also true of some other EC-funded projects), and their consolidation in the EOSC-Core is expected to happen in the next couple of years in the context of the EOSC Association and the last H2020 EOSC-related projects, although the role the EOSC Association will play in this has yet to be defined. As can be seen, the Hub Portfolio and Compliance Framework services all map to the EOSC-Core and will be sustained in the INRAEOSC-03 project; the Digital Innovation Hub[19], although not part of EOSC-Core, will also be supported in the INFRAEOSC-03 project, and may be extended to strengthen relations with innovative Small and

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[19] See https://eosc-dih.eu/

Medium Enterprises; and the common and thematic services all map to the EOSC-Exchange and will be sustained in one or other of the INFRAEOSC-07 projects, with the exception of a few technical components which will be phased out[20].

Some of the Hub Portfolio services are also supported in the EGI-ACE or DICE projects even though these two projects, whose main goals are to provide capacity (and services) to a vast number of different user communities, would be the natural place for the EOSC-Exchange services. This is because, to be effective, the EOSC-Exchange services (and the capacity delivered to users) may require integration with the EOSC-Core services. This is one of the important synergies among the three projects.

The EOSC ecosystem, as shown in figure 2, is composed of different elements (EOSC-core, EOSC-Exchange, EOSC Federation, RI communities) which all contribute to the Minimum Viable EOSC (MVE). The outermost layers in the figure rely on the innermost ones, and the MVE cannot exist if any of these components are missing. Specifically, the EOSC-Exchange services should rely on the EOSC-core components.

In Work Package 13 (Access Provisioning) of EOSC-hub, a number of providers within the consortium delivered live instances of the services maintained in WP5 and WP7 (i.e., services expected to contribute to the EOSC-Core and -Exchange respectively) for the benefit of many different user communities. The providers supported users to access and use the services and this activity was reimbursed through the Virtual Access mechanism. The experience showed that providing support for using the services was key to fostering a larger uptake of services by prospective users and to lowering the barrier to entry (i.e., making the services less daunting for users). We therefore recommend that research support be considered when defining service procurement or provisioning activities.

Starting from the Fair Lady document and the EOSC-hub and OpenAIRE position papers, the Architecture Working Group made an effort to reconcile the different views on the EOSC-Core by describing it in terms of functions and defining a phase when each of them should be implemented. This resulted in the already mentioned document "EOSC Architecture Working Group View on the Minimum Viable EOSC", which was delivered in February 2021. An additional important information is the relation of the EOSC-core functions with the action areas of the SRIA document where they are considered. This information, which is summarised in a table reported in Appendix 3, shows that most of the EOSC-core functions should be implemented in the first phase and as already pointed out in the table in Appendix 2, the Hub portfolio services provide functions which are paramount for the EOSC-core. Of course, there are additional functions important for the EOSC-core which are not part of the Hub portfolio, such as PID and Open Science services, and more services could be added along with the evolution of the SRIA document.

Appendix 4 contains a table extracted from the EOSC-hub deliverable D2.7 (Final Service roadmap, service portfolio and service catalogue) where this information is presented from a different perspective: the EOSC-core areas, components and capabilities (from the Architecture WG documents) are mapped to the EOSC-hub components.

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[20] See Appendix 2 for details

Although the definition of EOSC-Exchange is quite broad[21], it has been assumed that the EOSC-hub services belonging to the "Common services" and "Thematic services" categories fit with this definition. However, it is expected that EOSC-Exchange will contain more and more services along with the increasing uptake of EOSC.

From the sustainability perspective, although general consensus has not been achieved so far, various actors think that the EOSC-Exchange services in general should have their own sustainability plans for ongoing operation and development independently of the EOSC. Therefore, they should not require EOSC-related support and funding by the EC in the long term, although some of them may be supported by EC-funded projects in the short term (e.g., within the Cluster projects[22] as well as in the INFRAEOSC-03 and -07 projects). As discussed in section 1.3, Shared Resources, which are included in EOSC-Exchange (see figure 1), deserve special consideration by the EOSC Association although to date this recommendation does not appear to have been followed.

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[21] From the Fair Lady Report: "EOSC-Exchange is a digital marketplace that builds on the EOSC-Core to offer a progressively growing set of services exploiting FAIR data and encouraging its reuse by publicly funded researchers. It is expected that services, such as those that store, preserve or transfer research data as well as those that compute against it, will be made available via EOSC-Exchange"

[22] Projects funded in the INFRAEOSC-04-2018 call: Connecting ESFRI infrastructures through Cluster projects

4 Sustainability of EOSC-hub Services

This chapter discusses the main issues pertaining to the governance and sustainability of the EOSC-hub services identified by the work of T2.3, and recommends actions to address them.

4.1 Current Directions and Issues

4.1.1 Coordination of Research and e-Infrastructure Funding Policies and Investment Plans

The Cross-Border Services Briefing Paper demonstrated some of the challenges involved in the reuse of data. Data can be considered as a product from research investments, but the Briefing Paper observed that long-term strategies on science and infrastructure are not formulated in a coordinated manner on a pan-European basis, leading to suboptimal use of EC and member state public funding and inefficient interoperation of EC and member state funding. It also observed, as was reflected in the FAIR Lady report, that the majority of e-Infrastructure investment is still funded nationally. On a European scale, this is one of the factors leading to fragmentation, and one of the drivers of the EOSC is to reduce fragmentation. The Briefing Paper demonstrated that it is challenging to coordinate funding to meet the needs of an international research collaboration. Further, it remarked that the complexity and fragmentation of funding rules for cross-border research activities is a recognised issue highlighted by the EOSC, which needs to be addressed, but it has received limited attention during the implementation of the EOSC to date.

In general, research strategy has a strong influence on demand for e-Infrastructure services and capacity, but research and e-Infrastructures are often funded by separate streams, leading to a mismatch or high coordination costs between research and e-Infrastructure requirements. Too often, research is funded without considering related e-Infrastructure needs, and too often, the necessity of e-Infrastructure funding is questioned while its relationship to the research it supports is not made explicit, leading to a lack of political support. Stronger alignment between research and e-Infrastructure funding policies and investment plans, both within member states and also at the European level - including, but not limited to, European regional development/structural funds[23], the European Fund for Strategic Investments[24] and Startup Europe[25] - would help e-Infrastructure requirements to be better informed by, and matched to, research needs, leading to more efficient investment. In addition, stronger coordination of national e-Infrastructure funding policies and investment plans at the European level would help to reduce the fragmentation highlighted by the Cross-Border Services Briefing Paper. EU-level action may act as a catalyst for member state-level action. There is still room for diversity, and the principle of subsidiarity should be applied, but greater harmonisation is required so the different strategies work better together than at present.

These issues need to be addressed if the EOSC is to fulfil its objectives, and to add value in addition to the capabilities currently available from Europe's research supporting infrastructures and

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[23] https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls_en#esif
[24] https://www.eib.org/en/efsi/index.htm#
[25] https://digital-strategy.ec.europa.eu/en/policies/startup-europe

services. Actions to do so are required primarily at the strategic level within and between member states. The EOSC Partnership, including the mandated members, and its governance bodies provide structures within which the outcomes of the necessary dialogues can be focussed and, ideally, concluded.

The European Research Area (ERA)[26] is currently in the process of being relaunched with the publication of the EC Communication "A new ERA for Research and Innovation"[27] in September 2020. The Communication's ambition to strengthen the ERA includes the objectives of prioritising investments and reforms in research and innovation, improving access to excellent facilities and infrastructures for researchers across the EU, and strengthening the free flow of knowledge and technology. The document recognises the success to date in setting up the EOSC, and what has been achieved so far through collaboration in the context of the EOSC is a good example of what the ERA can achieve, but the EOSC also highlights the need for further progress towards a single European research area and increases the urgency of doing so.

The systemic issues in how European digital research is funded remain and addressing them is a precondition to the success of the EOSC. The EOSC Partnership provides the opportunity to address the fragmentation and lack of appropriate investment which have prevailed until now.

4.1.2   Governance and Funding of Shared Resources in the EOSC-Exchange

As explained in section 1.3, the EOSC-hub Briefing Papers on the Federating Core proposed that the additional usage of services such as storage and compute required for the EOSC to provide the framework for effective exploitation of open access to research outputs by a wider community, should be governed and sustained by the EOSC.

EGI, EUDAT and several of the other providers of EOSC-hub services wish to provide their services in future as part of the EOSC Shared Resources to sustain this EOSC value proposition. The EOSC provides a potentially very significant opportunity to increase demand for their data, software and services from across the research community, widening their user base. The draft Horizon Europe 2021-22 Work Programme is ambiguous but appears to suggest that Shared Resources may be purchased using public procurement[28]. The implications of the use of public procurement are discussed further in section 4.1.4; the present section discusses the Shared Resources' governance and sustainability more generally.

As explained in section 2.1, the Shared Resources form part of the EOSC MVE. The FAIR Lady report observes that realising the added value of the EOSC requires bringing together all the elements of the MVE, so failing to provide sustainability for all of those elements would be a missed opportunity which runs the risk of the EOSC failing to rapidly increase its impact.

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[26] https://ec.europa.eu/info/research-and-innovation/strategy/era_en
[27] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0628&from=EN
[28] See the Procurement section of the draft circulating in early March 2021, "Delivering the EOSC core infrastructure and services", which expects to achieve "a fully operational, secure cloud-based EOSC infrastructure, including a federated core platform and the EOSC Exchange".

The Canadian experience[29] in addressing the organisation and sustainability of research data infrastructures is instructive. Canada has a federal government model in which the national federal government pays for e-Infrastructure resources and the provinces fund the universities and provincial-level systems. It had a landscape of unintegrated compute activities in 2002, since when it has moved through several iterations to a national integrated platform implemented in 2018 which shares some characteristics of EOSC in that a not-for-profit body has been created to govern the platform. The body puts direct responsibility for (i.e., governance of) the platform back into the hands of the Canadian universities (the users, and also providers of some of the systems). Funding is provided by a combination of federal and provincial funds, but the federal government has placed governance responsibility with the universities. The current structure addresses imbalances experienced with previous structures, such as inequalities in access, inequalities in payment contributions compared to usage, lack of incentive of some providers to share resources, and lack of influence for those who did not contribute the majority of the funding. The model appears to be working well so far.

In Germany, the German National Research Data Infrastructure (NFDI)[30] forms the backbone for research data management, addressing the need for long-term storage and access to data with a distributed model which delegates as much responsibility as possible to the regional (Länder) level and ensures close linkages between research data providers and users. This model also appears to be working to the satisfaction of its stakeholders.

These examples demonstrate that whilst the federal level plays an important role in providing funding for research data infrastructures, it is important to delegate and empower users and providers in the governance of the infrastructures. In essence, a compromise is made at the federal government level (the equivalent for the EOSC is the EC, on behalf of the EU, and national governments) by providing funding but being prepared to delegate control of its usage. In Europe, the basis for such a compromise for research data infrastructure and e-Infrastructure exists in the form of the EOSC Association, a not-for-profit body in which users and providers are represented, but the role it might play in future in the governance and funding of the Shared Resources is not clear. The EC currently demonstrates its commitment to the EOSC by providing grant funding for the provision of Shared Resources in the EOSC in the projects funded by the INFRAEOSC-07 call, and after this is expected to purchase the services through public tenders. Observations relating to this in sections 4.1.3 and 4.1.4 below are also relevant to the Shared Resources. The member states' commitment to providing funding – specifically, funding and access conditions for the cross-border use of nationally funded resources – also currently remains unclear. The continued need to define coordinated access policies and funding streams to compensate for data and service provisioning by EOSC stakeholders across national and organisational boundaries causes continued uncertainty about the EOSC's sustainability. This is of direct relevance to the sustainability of the EOSC-hub services - particularly those of EGI and EUDAT - which include storage and compute services which form part of the Shared Resources - which require dedicated investments at national and European level to address the demand from EOSC users, complementing the existing capacity already allocated to other established international research communities. The FAIR Lady report

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[29] See keynote address in Session 1 of the e-IRG workshop at http://e-irg.eu/workshop-2020-12-programme
[30] See presentation as part of session 1 of e-IRG workshop at http://e-irg.eu/workshop-2020-12-programme

recommended that the EOSC should develop a funding model that combines in-kind and in-cash contributions based on agreements that align national research funding policies and leverage European-level funding schemes to ensure cross-border and cross-discipline research can flourish.

In June 2020, the OECD and Science Europe presented a framework for national research infrastructure portfolio management[31], identifying factors which should be considered for optimising national Research Infrastructures' user bases. The recommendations recognised the need for funders to strike a balance between national benefits and international cooperation, and for communities to be realistic and triage what must be kept so as to manage preservation costs. This provides some hints for the possible roles to be played by the EOSC Partnership governance and the EOSC Association in funding and governing the Shared Resources. The basis for this is contained in the final draft of the EOSC partnership Memorandum of Understanding[32].

The EOSC governance structures described in section 2.2 are new bodies whose members still have to form relationships and establish their ways of working within and between each body. Particularly as concerns relations between the Steering Board and the Partnership Board, and between the Steering Board and the EOSC Association, trust will need to be established, as the basis upon which to address the different interests and perspectives involved and to achieve commitment to the difficult decisions which will be required. This aspect of the EOSC is a test case for the creation of a true single European research area, and crucial to the success of the EOSC.

The OECD's 2017 report "Business Models for Sustainable Research Data Repositories"[33], despite being focussed more specifically on research data repositories than on e-Infrastructures, is nonetheless informative. It recommends that all stakeholders should recognise that research data repositories are an essential part of the infrastructure for open science, whose sustainability depends amongst other things on a clearly articulated value proposition and the development of a "business model". It considers that repository managers and operators should clearly understand and articulate their value proposition for all stakeholders, and that the value proposition is likely to be different for different public sector stakeholders (including funders), which will affect thinking on how public funding is most effectively provided. These recommendations could also apply to Shared Resources in the EOSC. EOSC-hub and the Sustainability Working Group have both made proposals around the value proposition of the EOSC, which is key to incentivising funders to provide the support required for the Shared Resources. The EOSC Association could assist with developing greater understanding and articulation of the value proposition of Shared Resources from different stakeholder groups' points of view.

The Cross-Border Services Briefing Paper recognised that Shared Resources such as storage and compute are a fundamental part of the value-add of the EOSC and stated that a means needs to be

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[31] https://www.oecd-ilibrary.org/science-and-technology/optimising-the-operation-and-use-of-national-research-infrastructures_7cc876f7-en
[32] https://www.eosc.eu/sites/default/files/20210215_EOSC_MoU_FinalDraft.pdf
[33] http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=DSTI/STP/GSF(2017)1/FINAL&docLanguage=En

found to fund their cross-border use in support of international research collaboration. Several actions were recommended in the Briefing Paper, which are reflected and added to in section 4.2.

4.1.3 Governance and Funding of EOSC-Core Services

The functions which will constitute the EOSC-Core will require to interoperate and form a seamless suite of backend services for the EOSC. Their performance will be important to users' and providers' overall experience of the EOSC. For a set of functions which is so integral to the functioning and performance of the EOSC, a uniform solution to their governance and funding is required – unlike for the Shared Resources, where it is possible and desirable to maintain diversity. The EOSC-hub Federating Core Briefing Paper proposed that the services in the core should be governed and sustained by the EOSC. The FAIR Lady report[34] observes that the EOSC is likely to require subsidy in its early years, for which financial risk for stakeholders is shared with the EC via the EOSC Partnership, although the partnership is time-limited[35] and in the longer-term EOSC participants should provide the required funding. It is to be expected, then, that in the coming years the EOSC Association will play a role in the governance of the EOSC-Core.

As demonstrated in chapter 3, EOSC-hub services – including several provided by EGI and EUDAT in particular - can fulfil many of the requirements of the EOSC-Core. For 2021-2023, they will continue to be funded to do so by the project funded by the Horizon 2020 INFRAEOSC-03 call. Thereafter, as already mentioned above, the draft 2021-22 Horizon Europe Research Infrastructures Work Programme indicates that public procurement may be used to select and purchase the EOSC-Core services after 2023, with procurement conducted by the EC on behalf of the EOSC in the first instance at least, although it is a possibility that the EOSC Association may perform the procurement in the longer-term[36].

The importance to the EGI Federation and EUDAT CDI of the "backend" services of the sort required for the EOSC-Core should not be underestimated. These services provide the "glue" which supports the EGI and EUDAT federations, despite the fact that the more "visible" value to researchers is provided by the storage and compute services provided by the federation members. Similarly, as discussed in chapter 3, the EOSC-Core services will support the composition and federation of services in the EOSC-Exchange and support the increased uptake of common and thematic services. This can feed a virtuous circle in which the value of the EOSC-Core increases as a result of the increased use of services in the EOSC-Exchange, in line with the view of the EOSC as a platform, discussed in the Cross-Border Services Briefing Paper, in D12.2 and in the FAIR Lady report.

The involvement of EGI and EUDAT "backend" services or components in the EOSC-Core does, therefore, relate to their more general perceived relevance and value, and hence sustainability. Nonetheless, provision of "backend" services to the EOSC-Core by EGI and EUDAT constitutes one instance of these services, forming only a part of their overall business activity. Whilst it is perhaps

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[34] in section 1.4.4, about the MVE

[35] the final draft EOSC Partnership MoU envisages a duration until 2030 – see
https://www.eosc.eu/sites/default/files/20210215_EOSC_MoU_FinalDraft.pdf

[36] See draft EOSC Partnership proposal, p51
https://ec.europa.eu/info/sites/info/files/research_and_innovation/funding/documents/ec_rtd_he-partnership-open-science-cloud-eosc.pdf

too early to reach any firm conclusions, at present it does not appear that provision of services or components to the EOSC-Core is essential to the sustainability of either EGI or EUDAT, and the issue of their longer-term sustainability can perhaps be considered separately from the EOSC-Core. It has to be noted also, that both the EGI Federation and EUDAT CDI are federations with existing and functioning governance to oversee long-term sustainability issues, independent from any of the governance structures set up as part of the EOSC Association or implementation projects.

It is worth considering, though, that the EGI and EUDAT infrastructures have been built up over years through public funding, and provide established, high quality services to their users who have greater trust in them than in potential alternative commercial offerings. More than investments in technology and infrastructure, these investments include capacity building and established quality systems for federated service operation and provisioning, elements which are not easily copied or sourced elsewhere. In the interest of leveraging existing public investment, the use of these services as part of the EOSC-Core should be considered, including possible further capacity expansion which could result. This philosophy is supported by the OECD's recently updated Recommendation concerning Access to Research Data from Public Funding[37] which recommends developing strategies to ensure sustainable infrastructures from public funding, to ensure an appropriate match between funding instruments, review criteria regarding the need for long term preservation of digital research objects, and the expected longevity of needed infrastructure. In considering use of commercial suppliers for the EOSC-Core, the threat of driving out public providers, and the long-term sustainability of commercial services and customer dependency on, or lock-in to them, should be considered.

In arguing for the power of the state to shape markets, Professor Marianna Mazzucato[38] cites an example of NASA retaining sufficient in-house capability to ensure it had the ability to specify procurement bids and assess tenders, to avoid capture by commercial suppliers. This consideration may also be worth bearing in mind in the case of the EOSC.

4.1.4 Public Procurement and Allocation of Resources

As described in chapter 3, most of the EOSC-hub services will be funded until 2023 in the projects funded by the Horizon 2020 INFRAEOSC-03 and -07 calls. The draft 2021-22 Work Programme of Horizon Europe shows that the European Commission is considering a shift of the funding instrument, from grants to procurement, for purchasing services for the EOSC-Core and possibly for some parts of the EOSC-Exchange starting from 2023. This adds additional complexity at a time when business models are being sought for funding the additional usage of resources required for the EOSC to open access to research outputs to a wider community. It is unclear to what extent member state governments support a move away from supply-driven funding allocation for research infrastructure, but elements of supply-driven and demand-driven resource allocation currently appear to be under consideration simultaneously.

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[37] OECD, Recommendation of the Council concerning Access to Research Data from Public Funding, OECD/LEGAL/0347. Available from http://legalinstruments.oecd.org

[38] Mazzucato, M 2021, Mission Economy: A Moonshot Guide to Changing Capitalism, Penguin Random House, Dublin

As analysed in D12.3, the identified reasons for the move to procurement are: the ability to better ensure professionalisation of the services; the ability to impose reciprocal obligations on both sides; the Commission monitors the delivery of the purchase; the possibility to exercise control of the Intellectual Property Rights needed to operate the services (in procurements, the IP normally stays with the contractor, but more recently the EC has been pushing for a change[39]); the possibility to open up to industry and catalyse the European market, promoting innovation. This may be perceived as a way of achieving a more efficient allocation of resources, supporting the EOSC as a platform, with resources allocated in response to demand.

On the other hand, the majority of the EOSC-hub services - many of which, as already discussed, will provide services in the EOSC-Core and EOSC-Exchange from 2021 to 2023 - are provided by publicly funded organisations, many of which do not currently respond to public calls for tender. The shift to the procurement instrument from 2023 therefore threatens the continued provision of the EOSC-Core services, and some of the EOSC-Exchange services. The reservations of publicly funded organisations to participate in public tenders are discussed in the Cross-Border Services Briefing Paper, in the FAIR Lady report, and in D12.3, and there was discussion in the EOSC Governing Board during 2020 of the risks posed to publicly funded providers to the EOSC, of a move to public procurement.

Public procurement entails financial and legal risks for those involved. Other approaches, such as supportive grants, public to public cooperation and virtual access, are discussed in D12.3 and should be further studied in the context of the EOSC. Further consideration needs to be given to how publicly funded organisations may be able to participate in public tenders, including any governance alterations which may be required. At present, some organisations are unable even to raise invoices, whilst others strictly observe the rules of in-house status[40]. As observed in the previous section, it is important to continue to benefit from and build on public investment already made in infrastructures and other research resources. Repositioning government intervention from the current system of partnerships and trust to a demand-led approach carries the risk of fragmentation of investments and erosion of the funding for large-scale infrastructure. The wider and longer-term consequences of the move to use of procurement should also, therefore, be carefully considered.

Public procurement conducted for the EOSC by the European Commission should also respect the subsidiarity principle by ensuring that actions are backed at the member state level and by research performing organisations, to help ensure efficiency of resource allocation. The role of the EOSC Association in this needs to be determined, however it is not just a user forum but also includes providers - including EGI, EUDAT and other potential providers of EOSC-Core and -Exchange services - who would potentially wish to respond to calls for tender.

If public procurement is indeed used for purchasing EOSC-Core and -Exchange services, whether or not it is desired that publicly funded organisations are able to respond to tenders, the specification of tenders will be very important. Quality and performance specifications are the most obvious

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[39] https://ec.europa.eu/digital-single-market/en/news/eu-recommends-member-states-leave-ipr-ownership-public-procurements-contractors
[40] See Cross-Border Services Briefing Paper https://www.eosc-hub.eu/publications/briefing-paper-provision-cross-border-services and D12.2 https://documents.egi.eu/document/3627 for further discussion

criteria, but relating to costs, aspects to consider are not only direct operation costs but also the cost of wider administrative support functions involved in delivering services, and costs for capacity expansion. The latter point includes recognising that the marginal cost of increasing capacity is not zero. The use of the virtual access mechanism in the INFRAEOSC-07 projects will help service providers to identify their costs at a more granular level than previously but it is currently still unclear which cost categories should be included in service pricing for tenders, and also to what extent the EGI-ACE and DICE projects will be able to determine marginal costs of capacity increases. The values of EOSC Association members should also be reflected in the specification of services, which could be achieved by referencing the EOSC KPIs[41]. The inclusion of research support - support to researchers to actually select and use services - is of great importance and is discussed in a separate section below.

Operational services are also in a constant state of evolution, developing in response to changing technology capabilities and user requirements. This is an important source of European innovation which requires funding streams to support it - for example in the Horizon Europe Work Programme - and should not be overlooked or assumed to be the same as development of new services.

Evidence of the demand for and usage of resources in the EOSC-Exchange will help future decision-making, whether for demand-driven or supply-driven provision. It will therefore be important for the EOSC Association to develop and implement metrics, measurement and reporting in a timely manner. Development of the EOSC as a platform, as discussed in the Cross-Border Services Briefing Paper, may also contribute towards this with the development of user reviews along the lines commonly seen on many e-commerce sites.

4.1.5   Research Support Provision

The availability of research support in national and European e-Infrastructure providers distinguishes these organisations from commercial service providers with whom they may be in competition. Research support takes the form of specialised, experienced experts able to support researchers in finding, selecting and using research services. It is mainly available in publicly funded organisations such as universities, research infrastructures or e-Infrastructures. The Cross-Border Services Briefing paper discussed and demonstrated the importance of the role of research support providers (RSPs) to the success of the EOSC. The work showed RSPs to be key for researchers to derive maximum benefit from it, and likely "super-users" of the EOSC.

In terms of the effectiveness of resource provision, it should be noted that qualified research support is almost always associated with the e-Infrastructures' and research infrastructures' service provision because of the way research performing organisations are used to operating. This greatly reduces both the skills required of the final users and their learning curve. This element is therefore key to achieving an effective use of resources. On the contrary, commercial resource procurement typically does not include qualified support, which has to be found elsewhere. So, this element should be considered when planning procurement actions, in addition to the evaluation of costs.

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[41] As specified in the SRIA, section 8.6
https://www.eosc.eu/sites/default/files/EOSC-SRIA-V1.0_15Feb2021.pdf

There is clear evidence the research support function is necessary; the question is how to organise it. The Cross-Border Services Briefing Paper recommended creating an EOSC Coordination Point providing a federated European network of distributed expert teams. The inclusion in the draft 2021-22 Work Programme is noted, of a call to fund a distributed pan-European user support network. A further important element to be considered is the recognition of the importance of the expertise and training activities delivered by research support, which is complementary to the training skills typically provided in academia or through the various structures of competence centres, but training is distinct from research support and the two should not be confused. Consideration should be given to widening the scope of competence centres or centres of excellence to include research support activities as one of their important pillars.

Research support is a benefit provided by e-Infrastructures and other publicly funded organisations which is undervalued currently. Its (significant) cost is largely hidden, bundled with the overall cost of e-Infrastructures' service provision, but it adds to the overall running costs of the e-Infrastructures and needs to be considered as part of the consideration of the e-Infrastructures' sustainability. It may be beneficial to unbundle the costs of research support and to "productise" this activity and assess potential demand and likely take-up of research support services. This unbundling of costs is taking place already as part of the use of the Virtual Access instrument in the EGI-ACE and DICE projects. More needs to be done, however, to raise appreciation of the importance of research support to researchers, and to the success of the EOSC. Some research support activities should perhaps be considered for inclusion in a future iteration of the EOSC-Core.

4.2 Recommendations for Further Action

The tables below contain recommendations for actions which could be undertaken to address the issues discussed in section 5.1, identifying the outcomes and impacts sought.

Recommendation Area/Topic	Coordination of Research and e-Infrastructure Strategies and Funding Policies and Investment Plans	
Problem Description	Long-term funding policies and investment plans for research and e-Infrastructure are not formulated in a coordinated manner on a national or European basis, leading to inefficient interoperation of both EC and Member State funding for e-Infrastructure services which will contribute to the EOSC Shared Resources for pan-European research	
Objective(s) of Proposed Actions	Achieve greater efficiency in allocation of EC and Member State funding for e-Infrastructures	
Desired Outcomes and Impact	Demonstrated funding requirements of research better met, including required e-infrastructure Demonstrated and recognised value of e-infrastructures in relation to research needs including those arising from the EOSC Smoother interoperation of EC and Member State funding streams	
Recommended Actions	**Who/Where (Resources)**	**Timing**
Improve co-ordination of e-Infrastructures' engagement with research communities at MS and EU levels	MS level: national e-Infrastructures to liaise with research communities in their countries EU level: European e-Infrastructures, in co-ordination with their national members	2021-22, in preparation for EOSC second phase from 2023
Develop, through dialogue, cohesive views within Member States across: -Provision of Shared Resources (storage and compute services for research) in the EOSC -Representation in the EOSC Partnership -broader EU research strategy	Within Member States: between ministries, research funders, research communities and research infrastructures, making use of the mandated members in the EOSC Association and Member State representatives in the EOSC Steering Board Across communities: from ESFRI clusters to the underpinning national research infrastructures	2021-22, in preparation for the second phase of EOSC from 2023

Gather and represent requirements to the EOSC Partnership Board from the perspective of EOSC Association members	EOSC Association	2021-22, in preparation for EOSC second phase from 2023
Align research and e-infrastructure strategy within Member States and at European level	In Member States: relevant/appropriate bodies European: EC, making use of the EOSC mandated members, Partnership Board and Steering Board and the ERA governance structures	2021-22 and beyond
Ensure appropriate coordination and synchronisation of different funding streams (e.g., from Member States, EC, research performing organisations and projects etc) to balance national and international interests and sustain the whole EOSC ecosystem including the Shared Resources	EOSC mandated members, Partnership Board and Steering Committee; ERA Board	2021-22, in preparation for EOSC second phase from 2023
Simplify resource allocation procedures/mechanisms to achieve an appropriate balance between the effort and timescale involved in applying for resources and the size/value of the resources required	National and European e-Infrastructure providers, national funders, EC	2021-22 and beyond

Recommendation Area/Topic	Business Model for EOSC Shared Resources	
Problem Description	The EOSC lacks a solution for providing dedicated investments at national and European level to address the demand from EOSC users, complementing the existing capacity already allocated to other established international research communities	
Objective(s) of Proposed Actions	Define and implement a solution for funding the expected additional marginal costs of consumption of resources arising in the EOSC	
Desired Outcomes and Impact	International, interdisciplinary research has access to the Shared Resources (including compute and storage services) it requires The additional consumption of depletable resources arising in the EOSC is sustainable	
Recommended Actions	**Who/Where (Resources)**	**Timing**
Agree and articulate the EOSC value proposition for all EOSC stakeholder groups, including funders	EOSC Association	2021-22
Carry out further studies to obtain empirical evidence of the macroeconomic and societal benefits of cross-border research funding	INFRAEOSC-03 project (e.g., in stakeholder engagement task) or Funded in the Horizon Europe 2021-22 Work Programme (for example the INFRA-2021-EOSC-01-02 call)	2021-22
Run pilots involving support of cross-border research collaborations to help assess the potential value of data and other resources for new use cases	INFRAEOSC-03 project or Funded in the Horizon Europe 2021-22 Work Programme (for example the INRA-2021-EOSC-01-02 call)	2021-22
Analyse Covid-19 research interdisciplinary and cross-border collaboration and resource consumption, for examples of how they were organised, and for any use of depletable resources	INFRAEOSC-03 project or Funded in the Horizon Europe 2021-22 Work Programme (for example the INRA-2021-EOSC-01-02 call)	Phase 1 or 2 of EOSC: by 2024

Experiment with providing supplementary demand-side funding for use of national e-Infrastructures, including their cross-border use, to complement or top-up national supply-side funding	EU member states and associated countries, co-ordinated action from EOSC Partnership Steering Board of Member State representatives	Phase 1 or 2 of EOSC: by 2024
Develop guidelines and structures which facilitate cross-border public-to-public service collaboration with cost reimbursement, for example public-to-public cooperation exemption from public procurement rules	EOSC-Future project (procurement activity)	2021-22

Recommendation Area/Topic	Selection criteria and choice of suppliers for EOSC-Core and -Exchange services from 2024 onwards	
Problem Description	The selection criteria and choice of suppliers for the EOSC-Core and -Exchange may be made without full consideration of the value gained from public investment in e-Infrastructures and the potential issues inherent in choosing commercial suppliers	
Objective(s) of Proposed Actions	Ensure due consideration is given to the wider and longer-term consequences of the choices made when selecting suppliers for the EOSC-Core	
Desired Outcomes and Impact	The criteria for selecting suppliers for EOSC-Core services from 2024 onwards include full and due consideration of all aspects, including the wider and longer-term consequences of the choices made	
Recommended Actions	**Who/Where (Resources)**	**Timing**
Carry out a study into the pros and cons of publicly funded versus commercial services in the EOSC-Core, including wider and longer-term implications for future research e-Infrastructure use and development such as quality, wider capacity expansion, support provision, driving out public providers, vendor lock-in, trust in long-term sustainability of services, deriving full benefit from public investment to date, fragmentation of investment and erosion of funding	EOSC Association and EOSC-Future or early Horizon Europe projects	2021-22

Recommendation Area/Topic	Procurement	
Problem Description	The proposed use of public procurement for purchasing services in the EOSC-Core and, possibly, EOSC-Exchange potentially carries consequences for the future landscape which should be further explored	
Objective(s) of Proposed Actions	Identification and understanding of the likely or possible consequences of use of public procurement, to inform decision-making and specification of future actions	
Desired Outcomes and Impact	Well-informed decision-making and clear specification of future actions	
Recommended Actions	**Who/Where (Resources)**	**Timing**
Publicly funded e-Infrastructure providers should reconsider and re-evaluate their ability to respond to public tenders	EGI Foundation, EGI Federation, EUDAT Ltd, EUDAT CDI	2021-22
Consider the wider and longer-term consequences for large-scale infrastructures of a move to use of public procurement, covering such aspects as deriving full benefit from public investment to date, and risks such as fragmentation of investment and erosion of funding	EOSC Association or INFRAEOSC-03 project	2021-22
Determine the role of the EOSC Association in public procurement for EOSC-Core and -Exchange services	EOSC Association	2021-22

Recommendation Area/Topic	Research Support Provision	
Problem Description	Research support providers contribute to the effectiveness of e-Infrastructures by assisting use of data and services, and are key to the success of the EOSC, but are costly and under-recognised and under-valued currently	
Objective(s) of Proposed Actions	Assess the cost of research support activity to e-Infrastructures, likely demand and take-up of research support as a service, and identify potential funding sources	
Desired Outcomes and Impact	Clear understanding of the role research support should play in the EOSC and its importance to the success of the EOSC Consider research support as a fundamental element when specifying tenders for resource procurement Assessment of the viability of research support as a service which might be provided through the EOSC Portal as a value-added service enriching the resource and service provision	
Recommended Actions	**Who/Where (Resources)**	**Timing**
Unbundle research support costs in e-Infrastructure service provision	EGI-ACE and DICE projects	2021-23, duration of EGI-ACE and DICE projects
Carry out studies to assess the likely demand and uptake of e-Infrastructures' research support services, including demand in the context of the EOSC, and potential funding sources	EGI Foundation, EUDAT Ltd, EOSC Association (e.g., through advisory groups relating to user engagement and training and skills)	2021-23
Identify concrete actions to make research support available to prospective users, complementing resources provision	EOSC Association	2021-23
Consider widening the scope of competence centres or centres of	Funded in the INFRA-2021-EOSC call of the Horizon Europe 2021-22 Work Programme	2022-24

excellence to include research support activities		
Consider including research support services when specifying tenders for resource procurement	EC for Horizon Europe calls definition, EC-funded projects for tenders' implementation	2021-27

5 Conclusions

The current and future landscape of the EOSC has altered significantly during the lifetime of the EOSC-hub project, particularly due to the definition of the INFRAEOSC-03 and -07 call texts and the potential future use of public procurement for services in the EOSC-Core and EOSC-Exchange, as indicated in the draft Horizon Europe 2021-22 Work Programme.

The work performed by T2.3 has clearly demonstrated the importance of the EOSC-hub services to the EOSC and therefore the close relationship between their sustainability and that of the value-add and sustainability of the EOSC itself. The outputs of the EOSC Working Groups highlight that much work remains to be done to fully realise the EOSC, and the issues discussed here have also identified areas where further work is required to bring greater understanding and clarity to some of the complex issues which are involved in creating the EOSC, and their consequences for the EOSC-hub services.

The EOSC raises threats and opportunities for the EOSC-hub services relating to future development of services and to broadening of their user base. Their role in the EOSC beyond 2022 is currently unclear but may in fact lie in harnessing their deep expertise and knowledge of the research community, and their contribution of innovative service developments which build the value of the EOSC.

Appendix I.   D2.4 Roadmap Progress Report

Deliverable D2.4, published in February 2020, contained an updated roadmap in the form of a table of proposed milestones, with target timings. The table covered the period from January 2020 to December 2020, when EOSC-hub was originally scheduled to end. By way of a report on the progress of the activities proposed in that roadmap, its milestones and proposed outputs with their original intended timings are replicated below, together with an explanation for each milestone of how the proposed activities evolved in practice.

Overall, the objectives of the roadmap were achieved although the activities involved were different, in practice, to those envisaged when D2.4 was written. This was due to the way the landscape developed over the course of 2020, as has been described in this deliverable.

Timeline	Milestone (M) and Proposed Output (O)	Outcome
Jan-Feb 2020	M: Planning for detailed examination of business models and procurement for Shared Resources, building on the work of D12.1 O: Detailed plan for how to examine and identify ways of compensating for cross-border consumption of depletable/contestable resources in the Shared Resources	Done. Addressed in Cross-Border Services Briefing Paper and D12.2
Jan-Mar 2020	M: Input to and discussion with Architecture Working Group on definition of the EOSC minimal core O: Presentation of EOSC-hub Federating Core proposals; compilation of possible core functions from EOSC-hub, Sust WG Tinman, and OpenAIRE-Advance	Done. EOSC-hub Federating Core proposals presented Jan 2020; compiled view with OpenAIRE and including Tinman prepared Jan-April and presented to Arch WG
February 2020	M: Response to Sustainability Working Group Tinman document O: EOSC-hub response to the Tinman report	Done. EOSC-hub response was compiled and submitted Feb 2020
February 2020	M: Response to Sustainability Working Group MVE (Minimum Viable EOSC) Study proposal including use cases to examine specific benefits the EOSC could deliver	Not done. The study scope was reduced to focus on the Core and felt to no longer be aligned with the required focus of work in T2.3. Work was pursued independently,

Timeline	Milestone (M) and Proposed Output (O)	Outcome
	O: Bid to conduct the work specified in the Sustainability Working Group's Proposal for Studies S1 and S2	described in Cross-Border Services Briefing Paper
Feb-Mar 2020	M: Joint EOSC-hub-OpenAIRE-Advance Position Paper O: Position Paper published	Not completed. Joint position paper was drafted awaiting formulation of Arch WG view on the EOSC Core/MVE, which was not published until Feb 2021
Mar-Jun 2020	M: (Assuming bid is successful) Conduct Minimum Viable EOSC Study O: Minimum Viable EOSC Study including clarification of business models of Shared Resources	Not done. Cross-Border Services work undertaken instead
Apr-Aug 2020	M: Discuss EOSC-hub-OpenAIRE-Advance joint paper and draft EOSC Federating Core Community Position Paper in Federating Core Interest Group O: Final EOSC Federating Core Community Position Paper	Not done. Joint position paper delayed by delay in Arch WG
May 2020	M: (Fulfilment of EOSC-hub Milestone M2.4: "Sustainability Roadmap Implementation Kick-off Summit") EOSC Business Models session at EOSC-hub week O: Input to business models work	Delayed due to Covid-19 but done. Sustainability session held at Realising the EOSC event, Nov 2020, which contributed to D2.5 and D12.3
August 2020	M: Updated EOSC-hub Briefing Paper on the EOSC Federating Core O: Draft update, for consultation, to EOSC-hub Briefing Paper on the Federating Core, incorporating proposals drawn from the Business Modelling work	Done. An update to the Jul 2019 Federating Core Briefing Paper was published in Feb 2020; a separate Briefing Paper, focussed on Provision of Cross-Border Services, was circulated for consultation in Sep 2020
Sep-Oct 2020	M: Finalised EOSC-hub Briefing Paper on the EOSC Federating Core – following consultation O: Final EOSC-hub Briefing Paper on the Federating Core	Done. Final version of Cross-Border Services Briefing Paper published in Oct 2020 following consultation

Timeline	Milestone (M) and Proposed Output (O)	Outcome
Oct-Nov 2020	M: EOSC-hub business plan: Federating Core composition, cost model and process for selecting providers – identifying business opportunities for EGI, EUDAT, INDIGO-DataCloud O: EOSC-hub Federating Core Business plan	Partially achieved. D2.5 describes landscape developments and mapping of EOSC-hub services to EOSC-Core and EOSC-Exchange in INRAEOSC-03 and -07 projects and discussed issues with longer-term sustainability
Nov 2020	M: Develop EOSC-hub Service Proposition based on business plans and Community Position Paper O: EOSC-hub Service Proposition	Partially achieved. Service proposition is discussed as part of D2.5
Dec 2020	M: Drafting and publication of EOSC-hub deliverable D2.5 Final Governance and Sustainability Roadmap O: D2.5 Final Governance and Sustainability Roadmap	Done. Rescheduled to Mar 2021 as part of project extension due to Covid-19

Appendix II. EOSC-hub Services in the EOSC-Core and EOSC-Exchange

The following table shows how the services in scope of the EOSC-Hub project are expected to become part of the EOSC-Core and EOSC-Exchange[42] services, and whether they are supported in upcoming H2020 projects.

EOSC-hub service	EOSC-hub Work Package[43]	Included in EOSC-Core capability – Iron/FAIR Lady (yes/no)	Included in EOSC-Exchange (yes/no)	Continuing in an EC-funded project[44] (F=EOSC Future, A=EGI-ACE, D=DICE, O=Other)
Hub Portfolio Services				
EOSC Portal (Including web content, Marketplace, Provider portal, portal metrics)	WP5	Yes		F
EOSC Order Handling System (SOMBO)	WP5	Yes		F
AAI (EGI Checkin, EUDAT B2ACCESS, INDIGO-IAM, eduTEAMS, rCAUTH, PERUN)	WP5	Yes		F, A (EGI Checkin, INDIGO-IAM, PERUN, rCAUTH), D (B2ACCESS), O (INDIGO-IAM)
Helpdesk (GGUS, EUDAT RT)	WP5	Yes		F, A, D
Monitoring (ARGO)	WP5	Yes		F, A, D

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[42] the attribution to this category has been derived by the definition of EOSC-Exchange in the Fair Lady Report: "EOSC-Exchange is a digital marketplace that builds on the EOSC-Core to offer a progressively growing set of services exploiting FAIR data and encouraging its reuse by publicly funded researchers. It is expected that services, such as those that store, preserve or transfer research data as well as those that compute against it, will be made available via EOSC-Exchange".

[43] WP4: Federated Service Management; WP5: Federation and Collaboration Services; WP6: Common Services; WP7: Thematic Services; WP9: Joint Digital Innovation Hub; WP10: Technical coordination

[44] the services continuing in a follow-on project are not totally maintained by these projects, they are typically also sustained by other actors/funding

Accounting (APEL, portal, repository, message broker)	WP5	Yes		F, A
Configuration Management System (GOCDB, DPMT, SVMON)	WP4, WP5	Yes		F, A (GOCDB), D (for DPMT)
EOSC Portal Metrics Dashboard	WP5	Yes		F
Common Services[45]				
EGI DataHub	WP6	No	Yes	A
B2FIND	WP6	No	Yes	D
B2STAGE	WP6	No	Yes	
B2DROP	WP6	No	Yes	D
EGI Cloud compute	WP6	No	Yes	A
EGI cloud container	WP6	No	Yes	A
EGI Workload management (DIRAC)	WP6	No	Yes	A
EGI Online Storage	WP6	No	Yes	A
EGI High Throughput Compute (CREAM)	WP6	No	No (this service has been phased out)	[46]
TOSCA for Heat	WP6	No	Yes	[47]
Infrastructure Manager	WP6	No	Yes	A
PaaS Orchestration System	WP6	No	Yes	A, O

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[45] See D6.3: https://documents.egi.eu/document/3558

[46] CREAM has been phasing out during the last part of the EOSC-hub project, due to a strategy change of its main developer

[47] TOSCA for Heat will continue to be supported by a community

Future Gateway	WP6	No	Yes	[48]
B2HANDLE	WP6	No	Yes	D
B2SAFE	WP6	No	Yes	D
B2SHARE	WP6	No	Yes	D
B2NOTE	WP6	No	Yes	
eTDR	WP6	No	Yes	
TSD	WP6	No	Yes	D
ePOUTA	WP6	No	Yes	O (ELIXIR and health area)
Thematic Services				
CLARIN	WP7	No	Yes	F, O
DODAS	WP7	No	Yes	A, O
ECAS	WP7	No	Yes	A
GEOSS	WP7	No	Yes	O
OPENCOASTS	WP7	No	Yes	A, O
WeNMR	WP7	No	Yes	A
EO Pillar	WP7	No	Yes	A, O
DARIAH	WP7	No	Yes	F, O
LIFEWATCH	WP7	No	Yes	A
Compliance Framework and Other Services				
Security Vulnerability Group, Information Security Management process in EOSC SMS	WP4	Yes		F
EOSC Security Coordination	WP4	Yes		F
EOSC Digital Innovation Hub	WP9	No		F
SMS	WP4	Yes		F
Interoperability guidelines (project	WP10	Yes		F, A

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[48] Future Gateway will be supported in future by one of its partners

documentation not formatted as a service)				

Appendix III. Minimal Viable EOSC

The following table, which is reproduced from the Architecture Working Group's View on the Minimum Viable EOSC[49], shows how the various functions of the Minimum Viable EOSC map to the related sections in the FAIR Lady report and to the SRIA action areas. It also reports the phase when they should be implemented, defined through consensus gained from discussions within the regular EOSC Architecture Working Group meetings. Phase 1 corresponds to the initial MVE and EOSC-Core functions assigned to phases 2 or 3 can be implemented later and may become part of a later version of the MVE.

Area	Function in the MVE	ESWG FAIR Lady	EAWG Proposal	Phase (1-3)	Functional description	Reference to SRIA action area
PID Services	PID for EOSC services	1.1 EOSC-Core: PID	EOSC needs to select and run a service (part of the EOSC-core) for providing PIDs for EOSC services	2	A way to mint/resolve PIDs for services in the EOSC landscape (core services plus onboarded ones) to allow for unique identification, citing, avoiding duplication and tracking of impact. This may be a service to generate, resolve and validate persistent identifiers (PID) or a service to connect existing PID systems.	Action Area (AA)1 Identifiers
	PIDs for research entities in EOSC	1.1 EOSC-Core: PID	Policy framework for PIDs to be defined by EOSC	1	Policy framework for PIDs for research entities, (data, sw, publications, organisations, researchers, funders, etc) TBD by WG-Arch PID task force.	AA1 Identifiers
Portal, Catalogues & Orders	EOSC portal (website)	1.1 EOSC-Core: Web-portal	Part of EOSC-Core	1	Website with basic information about EOSC, embeds the catalogue(s) in it. Features basic user management functions.	AA5 User Environnements, AA6 Resource provider Environnements
	EOSC Portal Service Catalogue and federated portfolio	1.1 EOSC-Core: Web-portal	Part of EOSC-Core	1	User facing frontend of the portal which exposes services to the customers. Allows searching, discovering and ordering of services. Backend to collect list for services, allow them to be published as a catalogue, and to allow data on services to flow between	AA2 Metadata and Ontologies, AA5 User Environment (frontend), AA6 Resource Provider Environment

49 http://dx.doi.org/10.2777/492370

Area	Function in the MVE	ESWG FAIR Lady	EAWG Proposal	Phase (1-3)	Functional description	Reference to SRIA action area
					thematic, regional and national catalogues. Includes onboarding.	s (backend), BC1 RoP
	EOSC Data source portfolio / catalogue and onboarding of data sources (registering, validating, discovering)	1.1 EOSC-Core: Web-portal	Part of EOSC-Core	1	User facing frontend of the portal which exposes data sources to the customers. Allows registration/onboarding, searching, discovering, validation/certification of data sources. Backend to collect data source information for registration, support onboarding/validation/certification against guidelines (expected quality of the metadata describing the scientific products within the data source), and to allow information on data sources to flow between thematic, regional and national catalogues of data sources.	AA2 Metadata and Ontologies, AA5 User Environment (frontend), AA6 Resource Provider Environments (backend), BC1 RoP
	EOSC Portal scientific product portfolio/catalogue	1.1 EOSC-Core: Web-portal	Part of EOSC-Core	2	Backend to collect list of research products, allow them to be published as a catalogue, and to allow data on research products to flow between thematic, regional and national catalogues. Includes onboarding.	AA2 Metadata and Ontologies, AA5 User Environment (frontend), AA6 Resource Provider Environments (backend), BC1 RoP
	EOSC Order Management Tool	1.1 EOSC-Core: Service management and access framework, 1.2 EOSC-Exchange	Not part of MVE		Software platform to manage orders for services made through central EOSC catalogue (directly from researcher-facing portal or potentially passed from other catalogues which display services pulled from central catalogue). Collect customer/user requests with relevant data, pass to providers via API, email or other means. Support collection of order metrics.	AA5 User Environment

Area	Function in the MVE	ESWG FAIR Lady	EAWG Proposal	Phase (1-3)	Functional description	Reference to SRIA action area
Data Services	EOSC Data Transfer Services	1.1 EOSC-Core: Data Access Framework	Not part of MVE		Data Transfer services enable the movement of data files asynchronously between source and destination storage endpoints, including mechanisms to ensure automatic retry in case of failure and for optimisation of performance for large files or large numbers of files.	
	Research Data as a Service	1.1 EOSC-Core: Data Access Framework	Part of MVE	3	Data access framework, whose primary role is to offer data as a service, enabling open interfaces where data consumers are able to discover and retrieve best-fit data to meet their needs. Of particular interest is the architectural model conceived in industry from the International Data Spaces Association which details the different roles and addresses data sovereignty, parts of which may apply in sharing (open) research data.	AA7 EOSC Interoperability Framework
AAI & Security	EOSC AAI in support of EOSC Service portfolio	1.1 EOSC-Core: AAI	Part of EOSC-Core	1	Providing a distributed federated AAI infrastructure which allows for sharing of login and access to services and data across EOSC.	AA4 AAI
	EOSC AAI for EOSC core services	1.1 EOSC-Core: AAI	Part of EOSC-Core	1	Providing an AAI infrastructure to provide a SSO environment on basis of Federated Identities across the EOSC (Federated) Core services.	
	EOSC Security Policies and Security Coordination Functions	1.1 EOSC-Core: Security policies and procedures	Part of EOSC-Core	1	Central coordination of security activities ensures that Trust and Identity policies, operational security, and maintenance are compatible amongst all partners, providing monitoring services to check for security vulnerabilities and other security-related problems in the infrastructure: it guarantees that incidents are promptly and efficiently handled, that common policies are followed by providing services such as security monitoring, and by training	AA4 AAI

Area	Function in the MVE	ESWG FAIR Lady	EAWG Proposal	Phase (1-3)	Functional description	Reference to SRIA action area
					and dissemination with the goal of improving the response to incidents.	
Helpdesk	EOSC portal/core Helpdesk	1.1 EOSC-Core: Operational support services	Part of EOSC-Core	1	Basic helpdesk to cover incidents for the portal and for the core services.	
	EOSC Helpdesk as a service		Not part of MVE		A. Framework for connecting existing help desks so that they can move tickets between them.	
	EOSC Helpdesk as a service		Not part of MVE		B. Offer helpdesk to those communities without one, or that don't want to deploy one themselves.	
Support Services	EOSC Core Collaboration Software	1.1 EOSC-Core: Service management and access framework	Part of EOSC-Core (exactly which of its services and tools are required for the EOSC-Core must be assessed)	1	Software platform to track documentation, tasks, communication of the operations of the core of EOSC.

Wikis, ticketing systems, mailing lists, video calling systems etc. | |
| | EOSC Support Services | 1.1 EOSC-Core: Operational support services | Part of EOSC-Core (exactly which of its services and tools are required for the EOSC-Core must be assessed) | 1 | Consultancy and training on how to use and benefit from EOSC core services | Boundary Condition (BC)4 Skills and training |
| | EOSC Open Science training and support | 1.1 EOSC-Core: supports the Shared open science policy framework | Part of EOSC-Core only if not adequately addressed elsewhere (e.g., provided by ESFRIs) | 1 | Organise and operate a distributed human-driven and hierarchical structure with the countries and disciplines in the centre, addressing the technical-organisational and legal aspects of data and service Interoperability. Topics include FAIRness of scientific products, FAIRness of services, IPRs, RDM, DMP, Open Access to publications, reproducibility of science, etc. | BC4 Skills and training |

Area	Function in the MVE	ESWG FAIR Lady	EAWG Proposal	Phase (1-3)	Functional description	Reference to SRIA action area
	EOSC Open Science Help Desk and Collaborative tools	1.1 EOSC-Core: Operational support services	Part of EOSC-Core only if not adequately addressed elsewhere (e.g., provided by ESFRIs)	1	Open Science helpdesk, a Collaborative Dashboard for a network of OS experts to be in contact with EOSC users/providers; Learning Material Registry, federating country/thematic registries, to aggregate European training/support OS material.	BC4 Skills and training
	EOSC Service monitoring	1.1 EOSC-Core: Open metrics framework	Part of EOSC-Core: Passive service monitoring is mandatory. Active service monitoring is optional	Passive: 1 Active: 2	Monitoring of service use for services, to report on their availability in various ways. Includes a CMDB database of entities that contribute to delivery of the core services to support: support, change management, monitoring and accounting. The service can be used to integrate EOSC portfolio services for compositionality.	BC1 RoP, BC3 Funding Models
Monitoring, metrics and accounting	EOSC Open Science metrics	1.1 EOSC-Core: Open metrics framework, Shared open science policy framework	Framework is part of EOSC-Core. Delivery of accounting data by services is optional (not part of MVE)	1	For Open Science to gain traction, EOSC must embed an infrastructure for scientific reward which gathers all types of usage data for all types of resources (citations, usage events for data, services, software) and offer Analytics Services to support reproducible/transparent calculation of indicators and provide measures of assessment and evaluation at the community level	AA6 Resource Provider Environments, BC1 RoP, BC3 Funding Models
	EOSC Accounting	1.1 EOSC-Core: Open metrics framework	Framework is part of EOSC-Core. Delivery of accounting data by services is optional (not part of the MVE)	1	Usage statistics on services in the EOSC-Exchange to support billing and accounting of services through e.g., Virtual Access. When the EOSC Accounting service is offered to service providers then the EOSC CMDB is required as a component.	BC1 RoP, BC3 Funding Models
	Core Services CMDB	1.1 EOSC-Core: Operational support services	Part of EOSC-Core	1	Database of entities that contribute to delivery of the core services to support: support, change management, monitoring and accounting.	

Area	Function in the MVE	ESWG FAIR Lady	EAWG Proposal	Phase (1-3)	Functional description	Reference to SRIA action area
	Shared open science policy framework	1.1 EOSC-Core: Shared open science policy framework	Part of EOSC-Core	1	for ensuring openness and interoperability, privacy and security (copyright status, disclosure limitations, patents pending, other IPR on the datasets or workflows, the existence of personal data, designation of data as PSI, etc.)	4.5.2 EOSC-Core
	Interoperable metadata framework	1.1 EOSC-Core: Interoperable metadata framework	Part of EOSC-Core	1	Minimum and common understanding of metadata schemas, mapping between schemas, registering schemas, ontologies. Profiles for metadata schemas, ontologies, crosswalks, and also tools for metadata management. This profiling should drive the development of registries and recommendation systems in this domain.	4.5.2 EOSC-Core
EOSC Interoperability Framework	Compliance framework: Rules of Participation, including a Resource Description Framework	1.1 EOSC-Core, but it defines the guidelines for resources to be included in the EOSC-Exchange	Part of EOSC-Core	1	Not a technical service, Initial Rules of Participation defined by the RoP WG. Resources included within the EOSC-Exchange are required to conform to the predefined Rules of Participation and need to be described according to the EOSC Resource Description Framework, for example with Resource Profiles for Services, Data Sources, Research Products.	4.5.2 EOSC-Core, AA5 Resource provider environments, AA7 EOSC Interoperability Framework: Organisational, BC1 Rules of Participation
	Service management and access framework	1.1 EOSC-Core: Service management and access framework	Part of EOSC-Core	1	Not a technical service, but a management framework that allows services and operational roles in delivering core services and supporting external services to be delivered. Includes a set of roles, responsibilities, documents, policies and other documentation and tooling to support management of services.	4.5.2 EOSC-Core
	Compliance Framework: Interoperability policies	1.1 EOSC-Core, but it defines the guidelines for resources to be included in the EOSC-Exchange	Part of EOSC-Core	1	Not a technical service, but a set of policies, recommendations and de facto standards on how EOSC services can be built and interact, so has a strong impact on technical services.	4.5.2 EOSC-Core

Area	Function in the MVE	ESWG FAIR Lady	EAWG Proposal	Phase (1-3)	Functional description	Reference to SRIA action area
	Compliance Framework: Policies	1.1 EOSC-Core: Service management and access framework	Part of EOSC-Core	1	Not a technical service, a collection of policies that need to be applied in the EOSC domain to ensure the coherence and value generation of EOSC.	4.5.2 EOSC-Core
Industry and business ecosystem	EOSC Digital Innovation Hub	2.5 Digital Innovation Hubs	DIH platform potentially part of the MVE, but resources provided through DIH are outside the MVE	1	An ecosystem of start-ups, SMEs, large industries, researchers, accelerators and investors that fosters the creation of partnerships to stimulate innovation.	2.3 The European strategy for data: Future action to initiate collaboration with Digital Innovation Hubs network
	Procurement framework	5 Recommendations Pre-commercial Procurement	Procurement Framework potentially part of the MVE, the procurements themselves are performed outside of the scope of the MVE	1	Framework to support aggregated procurements activities for commodity commercial resources for publicly funded research communities via for example Public Private Partnerships (PPP) and/or Pre-Commercial Procurements (PCP)	7.2 Development of innovative services and products

Notes:

- Phases as defined in the SRIA document: Phase 1: 2021 - 2023; Phase 2: 2024 - 2025; Phase 3: 2026 - 2027
- AA: Areas of Action as described in section 5 of the SRIA[50]
- BC: Boundary Conditions as described in section 6 of the SRIA

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[50] https://www.eoscsecretariat.eu/sites/default/files/eosc-sria-v09.pdf

Appendix IV. EOSC-hub/EOSC-Core Mapping

The following table, which focuses on the EOSC-Core, has been extracted from deliverable D2.7[51], and presents the EOSC-hub services from a different angle, i.e., maps them and their functions above to the EOSC Architecture Working Group view on the MVE and to the EOSC-Core capabilities presented in the FAIR Lady.

EOSC-Core area (from WG Architecture)	EOSC-Core component (from WG Architecture)	EOSC-Core capability (From WG Sustainability / FAIR lady)	EOSC-hub component(s)	EOSC-hub level service (Hub Portfolio)
EOSC Demand Portal	Added Value resource access	A Web Portal		EOSC Portal
	Website	A Web Portal	EOSC Portal web component	
	Discovery	A Service Management and Access Framework, A Web Portal	EOSC marketplace	
	Ordering	A Service Management and Access Framework, A Web Portal	EOSC Marketplace	
	Impact, Credit, Open Science	A Web Portal		
	Support / Training	Operational support services, A Web Portal	*Provided through training work packages and competence centres rather than as a service.*	

EOSC-Core area (from WG Architecture)	EOSC-Core component (from WG Architecture)	EOSC-Core capability (From WG Sustainability / FAIR lady)	EOSC-hub component(s)	EOSC-hub level service (Hub Portfolio)
EOSC Resource Catalogues	Service Catalogue (Services, Data sources, other service types)	An Interoperable Metadata Framework, A Web Portal	Resource Database (provided by EOSC-hub and EOSC Enhance) attached to Provider Portal and populating Marketplace	EOSC Portal
	Research Product Catalogue (Publications, Software, Research Data, Other research product types)	An Interoperable Metadata Framework, A Web Portal	Resource Database (provided by EOSC-hub and EOSC Enhance) attached to Provider Portal and populating Marketplace	EOSC Portal
Information and Dissemination	About EOSC	A Web Portal	EOSC Portal web component	EOSC Portal
	Training modules	A Web Portal	*Provided through training work packages and competence centres rather than as a service*	
	Architecture guidelines / specifications	An Interoperable Metadata Framework, A Web Portal	*Provided through EOSC-hub deliverables*	
Support	Helpdesk	A Service Management and Access Framework, Operational support services	XGUS (connected to GGUS, EUDAT helpdesk)	EOSC-hub Helpdesk
	Open science support	A shared open science policy framework		

EOSC-Core area (from WG Architecture)	EOSC-Core component (from WG Architecture)	EOSC-Core capability (From WG Sustainability / FAIR lady)	EOSC-hub component(s)	EOSC-hub level service (Hub Portfolio)
	Portfolio and core service support	A Service Management and Access Framework, Operational support services	*Provided as EOSC-hub Service Management System, a management framework rather than a typical IT service.*	EOSC-hub SMS
Common benefit Horizontal Services	Research Data transfer	A Data Access Framework		
	Research Data as a service	A Data Access Framework		
	PID Services	Persistent Identifier System		
	Digital Innovation Hub	NA	EOSC Digital Innovation Hub	EOSC Digital Innovation Hub
	Procurement management	A Service Management and Access Framework		
	Other added-value services	NA		
Core AAI	Core AAI	Authentication and Authorization Infrastructure (AAI) Interoperability framework, A Service Management and Access Framework	IAM, Check-In, B2Access	EOSC AAI

EOSC-Core area (from WG Architecture)	EOSC-Core component (from WG Architecture)	EOSC-Core capability (From WG Sustainability / FAIR lady)	EOSC-hub component(s)	EOSC-hub level service (Hub Portfolio)
Core Configuration management system / database	Core Configuration management system / database	An Interoperable Metadata Framework, A Service Management and Access Framework	GOCDB, EOSC SMS CMDB	EOSC Configuration Management System
EOSC Supply Portal	PIDs for services	Persistent Identifier System		
	Security coordination	A Service Management and Access Framework	Security Vulnerability Group, Information Security Management process in EOSC SMS	EOSC Security Coordination
	Onboarding	An Interoperable Metadata Framework, A Service Management and Access Framework		
	Order Management	An Open Metrics Framework, A Service Management and Access Framework	SOMBO	EOSC Order Handling System
	Accounting	An Open Metrics Framework, A Service Management and Access Framework	APEL	EOSC-hub Accounting
	Monitoring / Analytics	An Open Metrics Framework, A Service Management and Access Framework	ARGO	EOSC-hub Monitoring

EOSC-Core area (from WG Architecture)	EOSC-Core component (from WG Architecture)	EOSC-Core capability (From WG Sustainability / FAIR lady)	EOSC-hub component(s)	EOSC-hub level service (Hub Portfolio)
	Open Science Metrics	A shared open science policy framework		
	Helpdesk as a Service	A Service Management and Access Framework, Operational support services	GGUS. XGUS, EUDAT RT	EOSC-hub Helpdesk
EOSC Interoperability Framework		An Interoperable Metadata Framework		*Interoperability guidelines (project documentation not formatted as a service)*