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Resourcing models

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Deliverable Abstract

This deliverable contains a summary of the activities in Work Package 5 of EOSC Focus related to the sustainability of EOSC, from the organisational perspective as well as from the point of view of the sustainability of the services that will be provided and consumed through it. The current state in the respective areas and next steps are described to help in the decision making process to set up a workable and sustainable EOSC in the coming months.

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TERMINOLOGY

| Terminology/Acronym | Definition |
|---------------------|--|
| AAI | Authorisation and Authentication Infrastructure |
| AP | Access Policies |
| AUP | Acceptable Use Policies |
| EC | European Commission |
| EDIC | European Digital Infrastructure Consortium |
| EOSC | European Open Science Cloud |
| EOSC EB WG | EOSC Executive Board Working Group |
| EOSC SB | EOSC Steering Board |
| EOSC-A | EOSC Association |
| EOSC-A MO | EOSC-A Mandated Organisation |
| ERIC | European Research Infrastructure Consortium |
| FAIR | Findable, Accessible, Interoperable and Reusable |
| FinSust | Financial Sustainability |
| MS/AC | (European Union) Member State / Associated Country |
| NREN | National Research and Education Network |
| PID | Persistent Identifier |
| RoP | Rules of Participation |
| SP | Service Provider |
| TF | (EOSC-A) Task Force |

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Executive Summary

EOSC, the European initiative to create a web of FAIR data and services for the establishment of Open Science as the “new normal”, is advancing towards its realisation, and is approaching the time in which decisions that will establish its structure and shape are to be taken. The EOSC Focus project, as one of the main tools of the EOSC Association in the framework of the Co-Programmed Partnership agreed with the European Commission, is contributing to EOSC’s progress by collecting and analysing the information available from EOSC-related projects, initiatives and countries, with the goal of providing additional insights and support to the Partnership members.

Under the broad title of “Resourcing models”, Work Package 5 of EOSC Focus has collected in the first half of the project the status of several topics that are key to ensure that EOSC can become a sustainable endeavour. These include:

- the organisation of EOSC as a federation of nodes;
- the “Rules of Participation” that entities that want to become members of the “EOSC Federation” need to comply with;
- the costing and pricing of services that underpin the business models that may be adopted by providers to offer their services, and the business models themselves;
- and the contributions of Member States and Associated Countries to the sustainability of EOSC.

In deliverable 5.1, we summarise these findings and analyse options for their future directions, which may be developed by the EOSC Association with the support of the EOSC Focus consortium:

- According to the latest proposals of the European Commission, EOSC will be established as a federation of nodes. This federated structure has implications in how entities have to organise themselves to enable a seamless access to FAIR research data and services.
- A federation can only be set up if an appropriate set of “rules of participation” that determines without ambiguities how the different actors can interact with one another is in place.
- The provision and consumption of FAIR data and services through EOSC needs to be economically viable and become financially sustainable. This sets constraints on how funding from public sources (national budgets, European Commission) flows into the EOSC ecosystem, both to develop the tools for data sharing and analysis, and to use (and pay for) those resources, and demands the creation of suitable business models for entities practising Open Science. Sustainability needs to be considered together with the strategies developed at country level and within existing research ecosystems like that of Research Infrastructures.

D5.1 discusses the current understanding of (a) how to develop and implement suitable rules of participation and (b) which funding models can facilitate the long-term sustainability of service and data providers in EOSC in the context of the EOSC Federation of nodes. The basis for this was formed by the knowledge gathered from available documents, desk-based research, and specific activities. In addition, D5.1 contains pointers to ongoing project work envisaged to advance these matters and for which the results will be covered by D5.2 (due in M34). D5.1 can be used as a reference for future communication action lines to indicate the direction in which rules of participation and funding and business models may be further developed.

1. Introduction

Work Package 5 (WP5) of EOSC Focus, “Sustainability of EOSC”, looks into several aspects related to the long-term sustainability of EOSC, which is based on three pillars: uptake, financial resourcing, and interoperability. D5.1 considers mainly the first two, and addresses interoperability only very briefly in relation to the EOSC Federation (chapter 2).

Chapter 2 discusses essential characteristics of federations, and translates these characteristics into possible steps required to establish EOSC as a federation, including the elaboration of the necessary components of its governance framework. With this background, the proposal to organise EOSC as a “federation of nodes”, as recently proposed by the European Commission (EC)¹ is considered, along with the input collected during the summer and early autumn of 2023 on the EOSC nodes in the workshops and meetings organised for this purpose.

Chapter 3 summarises the current status of proposals for the components of the governance framework of a future EOSC Federation. It then explores recent development of three of these components, namely the Rules of Participation, Access Policies and Acceptable Use Policies.

In Chapter 4 the focus is on “resourcing models”: how EOSC stakeholders access the financial means required to carry out their activities. First the existing knowledge about cost-estimation, funding and pricing of the provision of data services to enable Open Science is explored. Then we consider the contributions to EOSC from EU Member States and Associated Countries (MS/AC). Next we consider EOSC’s value propositions with the goal of developing business models for its stakeholders that maximise the value they extract from and add to EOSC. Finally, in 4.4 we describe work on the paths to sustainability for services from EOSC-related projects from the Horizon 2020 INFRAEOSC calls. The full results will be covered by deliverable D5.2 which is due in March 2025.

The discussion on pricing and costing models of chapter 4 is expected to be relevant for the long-term sustainability of all resource types envisioned to be accessible through EOSC, including data and services. In the context of EOSC, the term “data” encompasses in its broadest scope many different things, spanning data repositories, publications, or software. While the particularities that concern each of them will have to be taken into account for the design of suitable business models, the general considerations included in this deliverable should apply to all resources.

1.1. Scope & place of deliverable in the EOSC Focus’ timeline

D5.1 appears halfway through the EOSC Focus project lifetime², at a critical point for both EOSC and the EOSC Association. On 24 November 2023, the EC announced the three consortia (one of them comprised of many of the partners in the EOSC Future project³) selected to deliver the central components of the “EOSC EU Node” from 2024-2026 [R1], the EOSC Partnership tripartite has met in Madrid (Spain) on 28 November 2023, and EOSC-A’s Task Forces are ending their current mandate by the end of the year. EOSC-A is discussing the implications of the nodes concept for its membership,

¹ The concept of EOSC as a federation is not new, and in fact can be traced back to the origin of the idea of EOSC. More on that can be found in chapter 2.

² D5.1 was initially scheduled to be submitted in M16, but a delay of two months was agreed with the Project Officer and with the EC in the second amendment of the Grant Agreement.

³ EOSC Future is a Horizon Europe-funded project <https://eoscfuture.eu/> that will end in March 2024.

and has published a position paper to plan the road ahead. The possible choices for the EOSC governance after the end of Horizon Europe in 2027 have been narrowed to a few scenarios, and a decision and a roadmap to get there from the current situation is expected to be reached by mid-2024. This will leave the relevant actors enough time to work out the details.

Against this background, EOSC Focus plays a key role for EOSC-A in the collection and analysis of documentation and experiences on the topics at hand gathered thus far: design of the EOSC Federation through the Rules of Participation, Access Policies and Acceptable Use Policies, and financial sustainability, including contributions from the EU MS/AC. EOSC Focus will thus continue supporting the EOSC Partnership objective of establishing Open Science as the “new normal” by specifying how to advance into an operative scenario. This will happen in parallel with the provision of a first instance of the EOSC EU Node delivered via the procurement contract starting in 2024. Ideally, both approaches will converge to workable solutions accepted by all stakeholders.

To meet these expectations and support the EOSC Association effectively, EOSC Focus is working towards developing the following aspects:

- Create an updated set of documents describing the Rules of Participation, Acceptable Use Policies and Access Policies that establish how nodes can join the EOSC Federation;
- Contribute to the EOSC tripartite discussions on the future governance of EOSC post-2027 using the information collected from the EU MS/AC and their implementation of Open Science policies, including the allocation of funding in national budgets aligned with the objectives of the EOSC Partnership;
- Elaborate funding mechanisms for sustaining the operation of EOSC and the organisations that participate in it as providers and consumers.

1.2. Alignment with TF FinSust, TF RoP, etc.

From the outset, the collaboration of EOSC Focus with the EOSC-A TFs was foreseen as a further support from the project to the activities of the expert groups from the EOSC-A membership represented by the TFs. In WP5, this has been achieved through the participation of project members in the Financial Sustainability Task Force of EOSC-A (TF FinSust) and TF RoP.

The participation in the TF FinSust of two members of the EOSC Focus project team has resulted in two concrete sub-tasks (see chapter 4): the work subcontracted with Boundaryless⁴ on business models and the value proposition of EOSC, and the exploration of the sustainability of outcomes from the H2020 INFRAEOSC projects. Further conversations within the TF and with the EOSC Focus consortium will be held to steer these subtasks into the desired direction, with the view of using them as input for further work to be done by the TF, and eventually help in preparing its conclusions.

In parallel to this collaboration, two members of EOSC Focus project team participated during 2023 in the meetings of the TF RoP, to improve the coordination between the progress of the RoP by the TF and the related activities of the EOSC-A. As follow-up of the TF activities, Task 5.1 of the project will continue to develop the RoP to adapt them to the framework of the EOSC Federation of nodes. The final deliverable of WP5, D5.2, will incorporate input from the TF FinSust’s final report (due in January 2024).

⁴ <https://boundaryless.io>

2. EOSC Federation

This chapter outlines the current conception of the EOSC Federation, compares this with more general definitions of federations of technical capabilities (“systems of systems”), and then positions the concept of “EOSC Nodes” in their relation to the EOSC Federation.

2.1. The EOSC Federation

In the short paper, “EOSC Association Board position paper on the EOSC Federation and the role of Nodes” [R2], EOSC is defined as: “an open, trusted, federation of research communities and related infrastructures that enables European researchers to store, share, process, analyse, and reuse research digital objects (e.g. data, publications and software) using a range of services operated by or supplied to those research communities”. The EOSC Association therefore defines EOSC as a federation according to the principles shown in Figure 1:

Main points in the position paper

EOSC Federation

- is a federation of distributed systems (‘system of systems’)
- enables collaboration to achieve common goals and users to access additional resources beyond their usual environment
- has policies and rules defined by the legal entity governing the EOSC Federation
- consists of multiple “Nodes”
- can be scaled by adding more Nodes

EOSC Nodes

- contain resources adding value to the Federation
- act as the legal representative that can interact with EOSC’s governance structure
- offer interfaces that comply with the EOSC Interoperability Framework
- control their own operations and resources and ensure that policies are followed within the Node
- may vary in their local policies, the resources to which they provide access and the infrastructure on which they are built

Initiatives (European, national, regional, institutional or thematic) may join the EOSC Federation and become EOSC Nodes when they meet the requirements for EOSC Nodes

Figure 1 - Main points in EOSC-A’s position paper on EOSC Nodes

Specific considerations related to EOSC Nodes are presented in section 2.5.

2.2. Essential Characteristics of Federation as they relate to EOSC

Federation is defined [R3] as “one form of multi-organisational alliance in which some processes and related policies and activities are governed and coordinated in a collaborative way, and sometimes delegated to a central “federating entity” by the federation members, while other processes, policies and activities remain the responsibility of the members of the federation.” These essential characteristics are reflected in the NIST Cloud Federation Reference Architecture [R4], which considered the common requirements needed to integrate distributed, autonomously managed, technical systems (not just cloud systems) into useful “systems of systems”:

1. **A federation is an alliance of multiple organisations.** This is true by definition, but this also means that a federation is a collective entity that is not necessarily “owned” by any single organisation.

- For EOSC, this means that the EOSC Federation is both a technical “system of systems”, as well as an alliance of organisations. The relevant legal and governance aspects of this alliance must be made clear.
 - The EOSC Federation does not exist today. How should it be created? In most governance structures (of any entity), there is an initial formation stage, where relevant stakeholders agree on goals, value propositions, rules, procedures, standards, etc. to which they will then commit when they formally join the entity as members. The need for common goals, as well as the specific aim of sharing resources, is noted in point 2 above. Rules could include updated rules of participation (building on the original Rules of Participation developed in 2021 (“RoP”) [R5]), possibly extended with more detailed standards and specifications, such as the “Inclusion Criteria”, created by the EOSC Future project as criteria that could be more objectively applied, consistent with the RoP.
 - Once stakeholders reach consensus on the rules they will abide by, these should be formalised as the governance framework of EOSC, which would then be adopted by the legal entity governing the EOSC Federation.
2. **Participating organisations are “members” of the federation and collaborate for common goals.** Federation members typically “join” the federation by acknowledging the common goals of the federation, agreeing to collaborate with other members, participate in governance, contribute to its financial sustainability, and abide by agreed standards, policies and procedures.
- Unlike a purely technical federation, where simply complying with a suite of technical standards might enable two systems to interoperate, achieving the goals of the EOSC Federation requires participating organisations to more broadly “sign on” to the governance framework of EOSC, in order to achieve the broader collaboration and sharing objectives conceived for EOSC.
 - The need to formally join and agree to the EOSC governance framework requires that participating organisations must have their own legal character and the capacity to commit to the individual components of that governance framework.
 - EOSC Nodes are contemplated as the principal entities that would join the EOSC Federation and enable its growth. Initial concepts for the EOSC Nodes are presented in section 2.5 below. As conceived, these EOSC Nodes would have their own legal character and would be able to act as the representative of their respective resources within the EOSC Federation, but in some cases they still may not be able to commit to EOSC’s governance framework on behalf of those represented resources. EOSC Nodes would certainly participate in the EOSC Federation from an operational standpoint, and they may have a well-defined governance role as well.
 - The members of the EOSC Association need not become “members” of the EOSC Federation, nor are the “Providers” or “Community Catalogue Operators” of the prototypical instance of EOSC created by EOSC Future. However, they are clearly important stakeholders and should be involved in the processes that will define the EOSC Federation’s governance framework.
3. **Each federation has a “federating entity” at its core**, which can be either virtual or a real organisation separate from any member. The federating entity supports federation governance, collaboration and a range of possible coordination activities agreed by the members.
- As a “federating entity”, the proposed legal entity governing the EOSC Federation might engage in a range of activities, from simply supporting the governance process (as a form of secretariat), to coordinating the provision of key activities required by the Federation, to actually

performing some of those activities. The form of legal entity chosen must be consistent with the scope of activities it must perform.

4. **Members agree to conform with various technical standards and operating procedures that enable interoperation, collaboration and sharing, appropriate to the type and purposes of the federation.** Agreeing on these standards and procedures is enabled by agreement on federation goals and governance. An important subject of federation governance is the very process of agreeing to these standards and procedures.
 - As noted above, the governance framework for the EOSC Federation should initially be developed in a consultative fashion involving those stakeholders who are expected to join the EOSC Federation and take advantage of what it has to offer. Once formed, the governing entity of the EOSC Federation must be able to apply and enforce the agreed governance framework, and must be able to maintain and evolve that framework, in consultation with members, to ensure it remains “fit for purpose” as circumstances change.
5. **Participation can involve a degree of sharing resources (including data, services, metadata or other assets).** At minimum this requires members to make their shareable resources discoverable and accessible to other federation members. Data and service interoperability are common features, and this depends both on agreement to technical standards and procedures and on a willingness to make those data and/or services available through the federation. Resource sharing is an explicit objective identified by the EOSC Association for the EOSC Federation. This sharing is also expected to be consistent with the FAIR principles (findable, accessible, interoperable, reusable; see [R6] for the original presentation of these overarching principles), and it is also expected that the resources shared should be of suitable “quality” (which might be interpreted as “fit” for various declared purposes).
 - Enabling this important objective is a key purpose of many of the Core Services in EOSC Future, which can be considered a prototype of the EOSC EU Node:
 - i. The EOSC Federated AAI allows resource providers to know with whom they are sharing their resources.
 - ii. The EOSC Catalogue and Marketplace provides a mechanism for resource providers to declare which resources are available for sharing and under what terms, and then makes that information available to users.
 - iii. EOSC Order Management service facilitates access and use, particularly for sensitive data and consumable services (such as compute and storage).
 - These Core services build on a foundation of taxonomy of resource types and metadata schemas to describe them consistently across multiple communities.
 - These services, as well as the frameworks and standards they rely on, represent important components of the EOSC Federation expected to evolve and improve to provide value to all research communities that join the Federation at any point of time.

The discussion of the essential characteristics above highlights the different roles that different actors might play over time:

- **Formation:**
 - Initially “convening” the Federation should be led by an identified organisation, which would conduct a consultation to build consensus around common goals, as well as the specific

aspects of organisational governance and technical requirements that may be needed to achieve the Federation’s goals.

- Stakeholders can participate in this consultative formation process. The convening entity will manage the process, and ideally stakeholders will commit to the process and engage to ensure robust outcomes.
- Specific questions to be discussed and agreed include (but are not limited to):
 - How to create the federation?
 - Is a federating entity needed, what are its responsibilities, what form should it take?
 - What roles are defined for the federation, and what are the eligibility criteria – e.g. participant in governance (“Member”), operator of services essential for the operation of the Federation (“Core Service”, “Core Service Provider”), provider of other resources through the federation (“Provider”), user of resources?
- The collectively agreed structure, rules, procedures, standards and frameworks would constitute the governance framework for the Federation. (Chapter 3 explores the components of this framework in more detail and presents the status of several components that have been addressed by the EOSC Focus team.)
- **Federation Launch:**
 - Depending on the form agreed among the convening stakeholders, a federating entity would take steps to create the Federation – possibly through constituent agreements that record the consensus of the convening stakeholders, to which would-be members would then adhere. Alternatively a legal entity could be created, where membership in the entity represents membership in the Federation (and the constituent agreements are part of the legal entity’s founding agreements).
 - In similar entity launch steps (for example when creating a new legal partnership), certain founding members “kickstart” the process, either by collectively signing the constituent agreements, and/or by identification as the first “Members” of the legal entity to be created.
- **Federation Growth.**
 - As a “multi-organisational alliance”, others need to join the Federation as Members or Participants, commit to its goals, and agree to its principles, governance frameworks and interoperability standards. If there is an “onboarding” or adherence process, the federating entity could perform this role.
- **Federation Operation:**
 - Governance: Members participate in formal governance activities, making decisions about the ongoing evolution of the rules and procedures that govern both operations and technology. Members may also be Participants in the operation of the Federation, but they may be excluded either because of eligibility rules, or because a Participant chooses not to engage in governance activities.
 - Operation: Participants participate in the operation of the Federation. Some Participants may provide essential services for the Federation. Some may simply use the services of the Federation, notably by registering resources for sharing across the Federation and then making those resources available as users request access.
 - Supervision and Monitoring: One important Core Service is the collection and review of information about the Federation’s operation, from Member and Participant onboarding, to the

actual uses of shared resources and review of whether these uses comply with the rules set by their Providers. Governance decisions will have determined what information is needed, what should be done with it, and who should take action if agreed rules and procedures are not being followed.

- **Federation Sustainability:**

- Although this phase of activity is not an “essential characteristic” of a federation (as defined in [R3]), there should be an ongoing process to ensure that the design and structure of the Federation continues to be “fit for purpose” for achieving the common goals of its Members.

These roles and this timeline should be considered as EOSC Association plans its strategic work over the coming months and years.

2.3. Considerations from EOSC Future project

2.3.1. EOSC Core Services

As noted above, some services are important for the smooth operation of the EOSC Federation itself. As organisations join the Federation, they can use these Core Services both to participate in the operation of the Federation and in order to share resources across the Federation, and possibly to enable interoperation of several resources to help users meet their objectives. Examples from the EOSC Future project of Core Services that enable sharing are the EOSC AAI Federation, which allows user credentials from one community to be recognised by Providers from a different community, as well as the EOSC Catalogue and Marketplace, which allows Providers and Catalogue Operators to register resources in the EOSC Catalogue and make them visible, discoverable in, and potentially usable from, the EOSC Marketplace.

The operation of EOSC Future, as a prototypical instance of the EOSC EU Node, is based primarily on central provision of Core Services, using components that are collectively referred to as the “EOSC Core”. Most of EOSC Future’s Core services are each provided by a single service provider, using their own infrastructure; but the infrastructure itself, considering all service providers, is operated in a distributed way. There are some specific Core services that are themselves operated and delivered in a distributed way, with the respective service providers complying with agreed technical standards to ensure each of these services is delivered consistently and reliably.

As the EOSC Federation evolves into a more complex “federation model” of operation, new Participants may join, either operating their own versions of certain Core Services, or wishing to take advantage of the Core Services available from EOSC.

- A common example of the first case is resource search, discovery and use, as implemented in a variety of different catalogue systems already in use across many research communities. To facilitate sharing of resources across Participants, mechanisms to integrate these different catalogue functions will be needed, which will be achieved by creating Interoperability Guidelines for this integration, perhaps based on DCAT⁵ or similar approaches. Compliance with this and other Interoperability Guidelines would be agreed by the Federation as a requirement for joining the Federation.

⁵ <https://www.w3.org/TR/vocab-dcat-3/>

- In the second case, participants could use existing EOSC Core Services in their own operations, ensuring integration with the corresponding Federation Service in other domains through compliance with the same Interoperability Guidelines. In this case, the new Participant would need access to the necessary software, documentation, training and other materials to enable them to implement and use these existing services. Compliance with relevant Interoperability Guidelines would also be needed, but would be more directly achieved since the same technologies are being used.

To reiterate, today there are no formal standards for interoperability among homologous EOSC Core Services offered by different participants in EOSC Future. In some cases, certain Core Services are delivered on a distributed basis, relying on explicit technical standards that have not yet been formalised as Interoperability Guidelines. These standards could form the basis for future standards for the interoperation of Core Services across the EOSC Federation, for EOSC, where functions are distributed across a number of providers, enabling delivery of such services across distributed providers and Participants.

More general standards for such common services do exist, and these could be formalised as standards for EOSC. Examples include the standards created by “Authentication and Authorisation for Research and Collaboration” (AARC, a series of EC-funded projects which use AAI to bring researcher collaborations closer together), as well as DCAT (a resource description framework (RDF) vocabulary designed under the auspices of W3C to facilitate interoperability between data catalogues published on the Web).

For example, AARC has developed a blueprint architecture for Authentication and Authorisation Infrastructure (AAI)⁶, with the objective of “finding the way to integrate identity services across different infrastructures, and providing research communities with the support they need to securely share data and resources. (...) To address this issue, it is necessary to gather requirements for federated identity management, which are specific for each scientific community, research infrastructure and e-infrastructure, without forgetting possible technology constraints, with the aim to adopt solutions that are sustainable both in economic and technology terms” [R7].

2.3.2. Interoperability across the EOSC Federation

Operating key Core Services seamlessly and consistently across the EOSC Federation is only one kind of Interoperability that must be enabled. Three other categories include:

1. Mechanisms for accepting new Participants and Resources into the EOSC Federation (“onboarding”).
2. Interoperation of resources with EOSC Core Services. This category might include future efforts to better achieve the FAIR principles, at least in the context of Findability, Accessibility and Re-usability of data and other resources..
3. Interoperation between EOSC resources that have been shared through the EOSC Federation (“onboarded” to one or more Core Catalogue or Marketplace services that are visible across EOSC). This category includes both semantic interoperability and the operation of services that are not specific to one domain or community and that might be useful to researchers from

⁶ <https://aarc-project.eu/architecture/>

multiple communities (referred to as “horizontal services”, some of which are being procured by the EC as part of the EOSC Procurement [R1]).

Each of these categories is explored below.

2.3.2.1. Mechanisms for Accepting new Participants and Resources into the EOSC Federation

High level principles for inclusion are outlined in the RoP [R5] although these have not been formally adopted. In the EOSC Future prototypical instance of EOSC EU Node, the project defined specific “Inclusion Criteria” [R8] to make evaluation of Provider and resource suitability more objective, and easier to implement by project staff. In particular, EOSC Future defined Inclusion Criteria for “Catalogue Operators” along with a Catalogue Operator Onboarding Agreement [R9] in which the Catalogue Operator acknowledges the requirements of the RoP and agrees to apply the same rules when it selects specific resources from the Catalogue to onboard into EOSC Future’s Catalogue and Marketplace.

This relationship, between a set of high level principles proposed for EOSC as a whole and a specific set of Inclusion Criteria implemented in one “instance” of EOSC, illustrates a possible hierarchy of “rules of participation”: one set for the EOSC Federation as a whole, and derivative sets of rules that will be applied by each Participant to the resources under its responsibility, provided those rules are not in conflict with the rules for the whole Federation. This approach reflects the principle of “subsidiarity” that is often noted as a key principle of federation. Ideally, each of these sets of rules would be transparently declared so that any differences are clear for both Providers and users.

2.3.2.2. Interoperation of Resources with EOSC Core Services

Each Federation Service will have its own standards to ensure interoperation of each resource with that service. The EOSC Future project has developed over 20 guidelines in its Interoperability Framework [R10], most of which address this category. Here are a few examples:

- Interoperation with the EOSC Catalogue and Marketplace: After new resources have been accepted for inclusion in EOSC, descriptive information (metadata, known as an “EOSC Profile”) about each resource is submitted to the EOSC Catalogue and Marketplace, so that the resource can be displayed in the Marketplace where it can be discovered and used.
- Interoperation with EOSC Monitoring and EOSC Accounting for Services. For resources that are services (rather than static Research Products or Training Resources) these Core services monitor the availability and reliability of the service, and track the usage statistics for the service, respectively. After a new service is onboarded, Providers have the option to integrate their service with each of these Core Services. Integration ensures that users have consistent information about the reliability and the usage of different services available in the EOSC Future Catalogue and Marketplace.

2.3.2.3. Interoperation of Onboarded EOSC Resources with Other Onboarded EOSC Resources

This category of interoperability has two important subcategories:

- Semantic interoperability: This is a broad topic and a “grand challenge” in its own right. It is being addressed by the EOSC Association’s Semantic Interoperability TF, as well as, more broadly, by the Research Data Alliance (RDA), working over the last 10 years, and involving more than 10,000 participants worldwide. EOSC Future has proposed to use Interoperability Guidelines to help with this problem by documenting discipline- or community-specific semantic interoperability guidelines in parallel with the onboarding of Research Products from those communities into a wider, discipline-agnostic EOSC Federation. This assumes that interoperability standards may be well known within a community, without their being explicitly associated with each Research Product or piece of research data from that community. As these resources are onboarded, they could each be linked to these “tacit” community standards, exposing those standards to researchers outside the home community. EOSC’s Interoperability Guidelines could be a mechanism for recording and disclosing these standards to the wider user base.
- Horizontal Services: Some services in EOSC can be used by a range of disciplines and more than one community. Examples include computational and storage resources (e.g. virtual machines in OpenStack, clusters in Kubernetes, high performance computing (HPC) systems, storage systems such as dCache), as well as services performing specific functions (depositing research data into a repository, transferring data from a repository to a storage system where it can be processed, providing a generic platform for structured calculations, such as a Jupyter Notebook). As part of the EOSC Procurement, the EC will procure and prepay for such “horizontal services” through its Lot 2 and Lot 3 procurements. The EC has specifically asked the EOSC-A and EOSC Focus for guidance in setting up appropriate Access Policies for such services (see section 3.3). In EOSC Future, a few Interoperability Guidelines have been published to enable such horizontal services, for example covering “Data Transfer” and “Research Data Deposition” (see [R10]).

2.4. The Role of EOSC Nodes in the EOSC Federation

The concept of an EOSC Node was first introduced by the Horizon 2020 EOSCpilot project in 2018:

“EOSC Nodes are the “organisational pieces” of the EOSC System called to contribute to the provisioning of one or more EOSC Services. [...] In the majority of cases, EOSC Nodes are expected to correspond to existing “systems” (EOSC is a System of Systems). However, and depending on per-EOSC Service design and deployment decisions, new nodes can be developed.” [R12]

The EC issued a call for tenders in December 2022 to procure production capabilities of EOSC as a managed service to be delivered on behalf of the EC:

“The procurement is to build and deploy an operational, secure, cloud-based EOSC infrastructure, including a federated EOSC Core Platform and the EOSC Exchange, offering high quality professional services and superior user experience for a large number of users, with the functionalities available 24/7. It should build on the key concepts of federation, standards and processes for Open Science, such as the EOSC Interoperability Framework, FAIR-by-design data, and composable services.”

The tender used the concept of an EOSC EU Node to distinguish the services that the EC would procure from those being delivered by others [R1]:

- *“The (first) EOSC EU Node at the European level consists of the procured EOSC Core Platform and a set of horizontal services in the EOSC Exchange operated and maintained (state-of-the-art IT Services*

Management) under one single administrative domain (i.e. owned by the European Commission in the form of managed service contracts).⁷

- “The (later) National/Regional/Institutional EOSC Nodes can be replicas and/or subsets of the “blueprint” EOSC Node at the European level, operated by their national/regional/institutional administrators/owners tailored to their specific needs (set of services inside their borders, local languages supported, etc.). All connected together forming the EOSC Federation (i.e. EOSC federated system).”

The EC used the diagram below (Figure 2) to illustrate the relationship between the EOSC EU Node, and other EOSC Nodes as well as other Participants in the EOSC Federation. The EC has provided few details about how an EOSC Node might be defined or what its key characteristics might be, prompting discussion in the EOSC community about these issues.

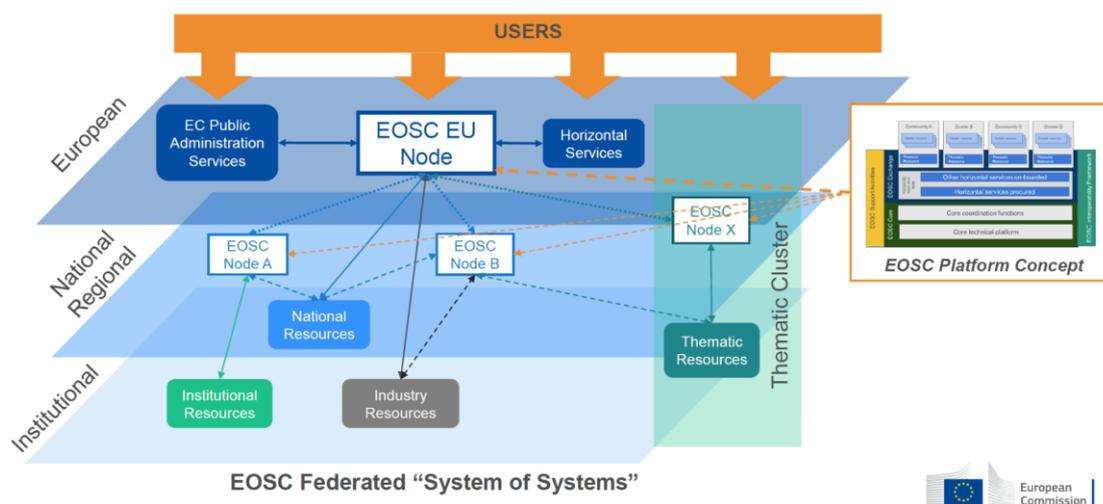


Figure 2 - EOSC EU Node as illustrated by the EC in the procurement documentation [R1]

EOESC-A conducted a number of meetings in September 2023 (with the ESFRIs, Mandated Organisations, and in an “unconference” session of the EOSC Symposium in Madrid on 21 September 2023⁸). In these, EOESC-A received feedback from around 150 people representing organisations from across the EOSC community, and based on this feedback, EOESC-A prepared a brief paper (the “Short Paper”) that tries to better describe not only the EOSC federation, but also the “EOESC nodes” as put forward by the EC. The Short Paper was shared in mid-October 2023 with participants of the 2023 EOSC Symposium, MOs and RIs, and revised to reflect a number of detailed comments. The current revised draft has now been shared with the larger community through the EOESC-A website [R2]. Further contributions to the discussion are expected from several EOESC-A Task Forces (e.g. FinSust, Technical Interoperability) and other stakeholders such as GÉANT [R13].

The EOSC Association’s consultations with stakeholders determined that EOESC Nodes could add value to the EOSC Federation in three important ways:

- Nodes act as the legal representative that can interact with EOSC regarding each resource in the Node.

⁷ This “first” Node is referred to as the “EOESC EU Node” in this and other documents.

⁸ <https://symposium23.eoscfuture.eu/symposium/unconference-session-eoscfuture-nodes/>

- Nodes provide entry points for end-users to access the full EOSC Federation.
- Nodes align their own governance frameworks with the overarching governance framework of EOSC, starting with the Rules of Participation and extending to Inclusion Criteria, Acceptable Use Policies, Access Policies as well as technical standards such as the EOSC Interoperability Guidelines. Specific Interoperability Guidelines will be created to enable interoperability among all EOSC Nodes.

Additional questions about the EOSC Node concept, and the EOSC EU Node in particular, are prompted by the analysis above:

1. EOSC Nodes would clearly be valuable Participants in the EOSC Federation. The requirements for this participation need to be defined and agreed. This could include additional points in the Rules of Participation, as well as specific “inclusion/exclusion criteria” as mentioned in the Short Paper.
 - As noted in section 2.2 it is unclear how a given EOSC Node might be able to “vouch” for and take responsibility for the resources shared from that Node – the relevant legal entity may only be able to act as their representative in connection with the EOSC Federation.
2. Can initiatives that are not EOSC Nodes participate in the EOSC Federation? (This might be inferred from Figure 1.) If so, what are the requirements for this participation?
3. Should EOSC Nodes be “Members” of the EOSC Federation, i.e. have a role in the governance of the EOSC Federation?
4. What model of federation will be used by the procured EOSC EU Node? How can the EOSC Community influence the development and implementation of this federation model, including its rules, procedures and standards, which will be implemented by the EC’s selected contractors?
5. What aspects of federation are implied by the EC’s statement “(later) [...] EOSC Nodes can be replicas and/or subsets of the “blueprint” EOSC [EU] Node”? For example, can the EOSC EU Node provide common Core services to other EOSC Nodes? Or could the federation have other reference nodes in addition to the EOSC EU Node (e.g. a thematic node as blueprint for a specific community)?

WP5 has been tasked to support the EOSC Association to continue the consideration of these issues and the integration of ongoing feedback from the community, and will report further on the construction of EOSC as a federation, the role of nodes in that federation and implications for governance of EOSC overall.

3. Governance Framework for the EOSC Federation

Section 2.1 explored how the EOSC community will need to develop consensus around a governance framework for the EOSC Federation, including both the rules, policies and standards to be adopted, but also the procedures for their maintenance, monitoring and enforcement. Other parts of Section 2 touched on a variety of policies, in the context of interoperability standards, that would govern the operation of the EOSC Federation. This section details the components that would comprise a complete governance framework for the EOSC Federation, and highlights how the EOSC Federation Governance Framework should be a true “framework” for the rules, policies and standards that might be individually adopted by Participants in the EOSC Federation.

3.1. Potential building blocks of the EOSC Federation Governance Framework

Chapter 2 touched on several kinds of rules, policies and standards that define the governance framework:

1. Common Goals: What is the purpose of the EOSC Federation? How does it create value? All participants need to “pledge allegiance” to these objectives, and Members (those who participate in the governance) should define the rest of the governance framework to promote these agreed goals and enable users to realise the promised value proposition(s).
2. Participation/Membership, Resource Inclusion:
 - a. What entities can become Members of the EOSC Federation and participate in its governance? Participation in governance means having a voice in setting all the rules, policies and standards that are adopted by the EOSC Federation, as well as the procedures that EOSC will implement to put them into practice (including compliance monitoring, enforcement, sanctions, and potentially removal).
 - b. What entities can participate in the EOSC Federation itself – as providers of resources, as operators of Core Services, and/or as Users? These rules would address inclusion/exclusion of Nodes into EOSC, as well as potentially other kinds of entities.
 - i. Each Participant would need to confirm that they support the goals of the Federation, agree to the Federation’s governance framework and abide by the procedures set for the Federation to manage compliance.
 - ii. Each Participant would present itself along with its own governance framework, which would have to be assessed for consistency with the governance framework of EOSC as a whole.

The “Rules of Participation” were originally proposed by the EOSC Executive Board’s Rules of Participation Working Group (EOSC EB RoP WG) in 2019, and enhancements to these RoP were suggested by the Rules of Participation Task Force. These concepts are explored further in Section 3.2 below.
 - c. What resources can be included in the EOSC Federation, i.e. what types of resources will be handled, and what are the inclusion criteria for each?
3. Interoperability of Core Services: As various Participants join together in the EOSC Federation, certain essential services will need to be performed in a consistent manner across all Participants. These essential services are called “Core Services”, and even if different technologies are used for the same function by different Participants, these technologies still need to work together

seamlessly, consistently, and without creating barriers for Users. These Interoperability Standards for these Core Services must be defined by the EOSC Federation.

4. Interoperability between Core Services and shared resources. Section 2.3 discussed this in more detail. Two aspects of this kind of interoperability, namely Access Policies and Acceptable Use Policies are discussed further in Sections 3.3 and 3.4 below.
5. Interoperability among shared resources, even when these resources have been included by different Participants. Section 2.3 discusses this kind of interoperability. These Interoperability Standards must be defined by the EOSC Federation.
6. Interoperability between Participants in the EOSC Federation and other Platforms (such as Data Sources). A number of initiatives provide services, functions and resources that complement EOSC and/or might benefit from access to EOSC resources, including EC-operated initiatives such as CORDIS, EMODnet, Copernicus data services, and new “Data Spaces” being created through the Digital Europe Programme. There should be consistent mechanisms for interoperability between the resources of these initiatives and those included in the EOSC Federation.

Table 1 summarises the status of these building blocks of the EOSC Federation Governance Framework.

| Governance Building Block | Description | Status | Prepared by |
|--|--|--|--|
| Common Federation Goals | Common Goals for the EOSC Federation agreed by stakeholders in advance of the creation of the Federation | Outlined in the EOSC-Federation and EOSC-Nodes paper of EOSC-A (see above) | EOSC Focus & EOSC BoD |
| Rules of Membership | Rules to become a Governance Member of the EOSC Federation | To be agreed. | |
| Rules of Participation (RoP) | RoP for Service Providers and other potential Community Catalogue Operators from the research community. | Additional principles proposed by TF RoP (2023), not adopted | TF RoP (2023), EOSC Focus |
| | RoP for Research Users. | High level principles. | <i>Report from EOSC EB RoP WG (2019)</i> |
| | RoP for non-research providers, citizen scientists, corporate users, public sector | Not addressed. | |
| Resource Inclusion Criteria | Definition of resource types, related Inclusion Criteria. | Applied in EOSC Future project | EOSC-Future (2023) |
| Interoperability of Core Services | Standards for interoperability of essential services that must operate seamlessly across the Federation. | Some technical standards applied in practice by the EOSC Future project. | EOSC-Future (2023) |

| | | | |
|--|--|---|-----------------------|
| Interoperability between Core Services and Included Resources | Standards for interoperability of essential services with resources included in EOSC Federation by Participants. | Over 20 Interoperability Guidelines have been adopted by the EOSC Future project. | EOSC-Future (2023) |
| | Access Policies: Baseline approach, trust based, automated and scalable for targeted users and use cases. | AP template for the EC-procured horizontal services drafted by EOSC BoD, shared April 2023. | EOSC Focus & EOSC BoD |
| | Acceptable Use Policies: Assessment of range of relevant AUPs and identification of common denominators | Drafted by EOSC-A, not formally approved | EOSC-A |
| Interoperability between Included Resources | Standards for interoperability between certain resources and certain Horizontal Services. | 2 Interoperability Guidelines have been adopted by the EOSC Future project. | EOSC-Future (2023) |
| | Semantic Interoperability Standards within Disciplines | Subject of active work by many communities. | |
| Interoperability between EOSC Federation and other platforms. | Standards for interoperation with Data Spaces, Copernicus, EMODNet, CORDIS, etc. | No consistent framework. | |

Table 1 - Status of Components of the EOSC Governance Framework

Each of these categories of components must be addressed in detail as part of the “Formation” consultation described in section 2.3. Here we summarise the status of a few of these components: Rules of Participation (RoP), Access Policies (AP) and Acceptable Use Policies (AUP).

3.2. Rules of Participation (RoP)

The TF Rules of Participation and Compliance Monitoring (TF RoP) took the “deliberately minimal” (p. 4 of [R5]) RoP of the previous EOSC EB WG and added a few more, by “analysing the context, i.e. existing principles of participation, and the implementation i.e. inclusion criteria currently set out by EOSC-Future” (TF RoP interim report, not published). EOSC Focus participants working on T5.1 will support the EOSC-A Board in the further development of the RoP.

3.3. Access Policies

Access Policies (AP) regulate how resources can be accessed; they describe which users are eligible to access each resource. Specific APs should address each combination of resource (perhaps differentiated by its provider) and a potential type of user. Figure 2 illustrates the combinations of user and resource that would merit development of specific APs.⁹

⁹ As section 4.3. will show, this identification of roles is something common to platform design.

| Accessing ↓ User Type → | Researchers, Students (grad, postdoc) | Corporate Users | Public Sector | Citizen |
|----------------------------------|---------------------------------------|------------------------|------------------------|-----------------|
| EXCHANGE SERVICE PROVIDER | | | | |
| Research Provider | Yes ① | Yes | Yes | Yes |
| Commercial Provider | Commercial access: CSPs, ISVs ② | | Commercial access | Possibly |
| DATA PROVIDER | | | | |
| Research Provider | Yes (open – but see FAIR opinion) ③ | Yes (see FAIR opinion) | Yes (see FAIR opinion) | |
| Commercial Provider | Commercial access ④ | | | |
| Public Sector Provider | Yes (open) | Yes (open) | | |
| Citizen Provider | Possibly (PIMs) | Possibly (PIMs) | | Possibly (PIMs) |
| COMMUNITY CATALOGUE | | | | |
| Research Provider | Yes - Fed AAI | | | |
| Commercial Provider | Commercial access | | Commercial access | |
| Public Sector Provider | Yes - Fed AAI | | | |
| Other Platforms | Yes - Fed AAI to Data Spaces? | | Yes | |

Figure 3 - Access Policies required for different combinations of types of users and the types of resources (as provided by specific types of providers)

In Figure 3, the activities inside the pink box indicate APs that should be developed as a priority for EOSC, since they represent the most common interactions to take place in the platform during the first stage when EOSC will serve researchers at public research institutions. The numbers in Figure 2 refer to the following four cases:

1. Researchers Accessing Exchange Services Provided by Research Providers
2. Researchers Accessing Exchange Services Provided by Commercial Providers
3. Researchers Accessing Research Data Provided by Resource Providers
4. Researchers Accessing Commercial Data

Case numbers 1 and 3 correspond to existing patterns of access within the research community, although it would be valuable to transparently document the related eligibility criteria and service offers in specific cases. These access patterns have the following characteristics, which would need to be made more explicit:

- Within research communities, access has been historically “free at the point of use”;
- Researchers assume that funding of the services has been provided to each community, typically scaled to serve the community alone;
- If the services are offered to researchers outside the community as part of the horizontal services, the AP has to foresee the creation of the required capacity as well as the sustainability of the services.

Case number 2 (“Researchers Accessing Exchange Services Provided by Commercial Providers”) is specifically contemplated in Lots 2 and 3 of the EC’s EOSC Procurement [R1]. Case numbers 2 and 4 align with a variety of commercial service offers already arranged for researchers through the EOSC Future project (WP8).

In April 2023 the EOSC Board of Directors drafted an AP (see Appendix 1) for the services to be procured by the EC as part of the EOSC Procurement [R1]:

- Researchers can use “Lot 1” services (i.e. EOSC Core services) without limit and without cost.

- Researchers can use “Lot 2 and 3” services (“horizontal services) without cost (since these services will have been prepaid by the EC) but only to the extent that capacity is available, for which use will be monitored and accounted for.

Although not mentioned in the draft AP, the EC also indicated their intent to provide these prepaid horizontal services to researchers in limited quantities per researcher, which would require the corresponding monitoring and accounting systems to record personal data in order to ensure that these limited quantities were respected, which in turn would require the consent of the individuals wishing to access these horizontal services.

Only “researchers” are eligible, with researchers defined as “individuals having a trusted identity from a home institute in Europe that has been authenticated via the eduGAIN federated identity management system”. However, the eduGAIN system cannot consistently identify users who are accredited “researchers”, so alternative mechanisms would be needed to ensure eligibility.

3.4. Acceptable Use Policies

Acceptable Use Policies describe how resources can be used (and re-used) by users. They must be consistent and supportive of the EOSC Federation’s value proposition, and allow users to achieve their own objectives through the use of the resource(s). AUPs would address questions such as:

- Can your service be used for commercial purposes?
- Do you require citation of the infrastructure in published works?

EOSC-A has created an “AUP template” draft in spring 2023 (still pending approval), with the idea that providers of the services procured by the EC adapt them and issue to their users; the exception is the legal and ethical parts, which cannot be modified).¹⁰

3.5. RoP, AP, and AUP in the Context of EOSC Nodes

The discussion has evolved with the (re)appearance of the “node” concept, and the procurement for the “EOSC EU Node” by the EC. Even if the exact definition of “node” is missing, the status of RoP as “high level” rules that set who can participate in EOSC does not change, although further refinement may be needed in general, and in order to address the role of such Nodes.

Similarly, the structure of the APs and AUPs do not have to change in response to the concept of EOSC Nodes. At the same time, all components of the governance framework need to consistently handle the possibility of multiple Federation Participants, each including their own sets of resources for possible use by Users who also access the Federation through services provided by each Participant.

¹⁰ The AUP template has important implications because it makes reference to authentication & authorisation, which means SPs need to require users to identify themselves unequivocally, but this has not yet been solved. EOSC must select an AAI system that works well, so that users can rely on it without having to do several authentication steps, which is understood would drive them away.

4. Resourcing models

The long-term operation of EOSC depends on the access to appropriate funding, and it is one of the goals of EOSC Focus and the EOSC Partnership to define models for availability and costing of services (Operational Objective 14) [R14]. This applies to all entities in the EOSC Federation, including the federating entity. The current fragmentation of the funding landscape, and especially the dependence on funding from projects, does not facilitate the stable operation of services, which causes big uncertainties in many providers about their future. If providers rely exclusively on project funding, services may be discontinued after projects end¹¹.

Several of the challenges related to this question are addressed in the current chapter. Section 4.1 looks into costing and pricing models that can be used to ensure the long-term availability of data and services. Section 4.2 describes the state of play of the ongoing discussions about the contributions from MS/AC in the future governance structure of EOSC. Sections 4.3 and 4.4 contain the preliminary results of the work done by the company Boundaryless on value proposition and business models and the findings on the sustainability of services resulting from Horizon 2020 INFRAEOSC projects.

4.1. Current knowledge about cost-estimation models, funding and pricing of OS service provision

Service and data providers know well how much money they *spend* doing what they do, but it is harder for them to know how much their activities *cost*. The difference lies in the various tasks indirectly related to e.g. the provision of a service that remain unaccounted for. However, insight into real costs is needed in order to calculate how much money is needed to operate a service, and it is a critical ingredient in the design of business models. Regardless of the pricing model chosen (free or against a fee), service and data providers need information on the costs they incur to talk to the public institutions (EC, MS/AC, or other) that fund them. Finally, insight in the costs enables the correct distribution of responsibilities—i.e. who should pay for what—and price setting.

The content of this section is related to work done in previous EOSC-related projects and initiatives (e.g. EOSC-hub, or the EOSC EB WG under the previous EOSC governance period) as well as with the more recent findings of the TF FinSust [R15].

4.1.1. Data

Research data is an essential ingredient of the EOSC landscape: FAIR and validated data is the material with which EOSC can fulfil its mission, and only if EOSC has enough quality data will it attract more users, which is crucial to ensure the long-term operation and sustainability of EOSC in that EOSC needs to attract users to realise its full value. A crucial expectation for EOSC is that the use of research data will remain *free at the point of use*. This is not a requirement of the European strategy for data [R16], but is essential to enable data reuse, and fits well with how data has been shared in various disciplines thus far. The “ongoing experience with the research community with the EOSC” is considered in the European strategy for data as key on which the “European Common Data Spaces”

¹¹ An example of this is offered by openRDM.eu, <https://openbis.ch/index.php/openrdm-eu/>, a tool that offered data management as a service based on the openBIS platform, discontinued after the end of the EGI-ACE project in June 2023.

is to be built, given that science has been at the forefront of data sharing for a long time. The question of how data providers that participate in the federative model can become *financially* sustainable therefore requires a closer look at the particularities of cost models for the provision of and access to data. By clarifying how research data providers can become sustainable, EOSC will further contribute to a stable and sustainable framework for data.

Business models for data repositories were the subject of an OECD study [R17] that started from the premise contained in its foreword that “based in local and national research institutions and international bodies [data repositories] are where the long-term stewardship of research data takes place and hence they are the foundation of open science”. The report notes that business models of repositories typically “combine structural or host funding with various forms of research and other contract-for-services funding, or funding from charges for access to related value-added services or facilities”, although other combinations (e.g. “deposit-side funding combined with a mix of structural or host institutional funding, or with revenue from the provision of research, value-added, and other services”) are possible. Structural/host funding enables research data to be free to use, which matches its “public good characteristics”. A “charge-for-use model” for accompanying “value-adding services and facilities”, which typically do not display this behaviour, should be used to complete the funding streams of repositories.

A central question here is how to calculate the costs associated with enabling access to data for users beyond the community or scientific discipline for which the RI was initially conceived, since this requires additional resources that may not have been taken into account at the time of design¹². These extra costs can be grouped into (1) costs of making data FAIR, (2) ensuring long-term access to data, (3) making experiments reproducible, as well as (4) the additional costs brought by establishing the EOSC Data Federation [R18].

The case put forward by European Research Infrastructure Consortia (ERICs) illustrates how this is currently dealt with by several RIs as data providers. ERICs are an important source of research data, and “play an important role in the defragmentation of the European Research Area” ([R19], paragraph 7). ERICs are generally aware of the extra costs associated with collecting and providing data for users that come through EOSC (i.e. outside the original community). This additional usage of their data requires to scale the resources for data access, analysis, visualisation, and interpretation.

ERICs are consortia with EU MS/AC or intergovernmental (research) organisations as members. The ERIC governing councils determine the financial (cash) contributions of the members, i.e. membership fees to be paid by MS/AC, as well as additional contributions from the ERIC Members or Observers, remuneration from services provided to third parties, royalties or income derived from the exploitation by third parties of intellectual property rights owned and/or licensed by the ERIC; grants (specific to the ERIC activities or not), and additional resources in kind or in cash. The funding and long-term sustainability of ERICs, and therefore the sustainability of research data provision and access, depends to a large extent on the funding priorities and policies of the respective MS/AC who govern

¹² From an economic perspective [R17], products or services with low or zero marginal costs like data, finding a path to sustainability is hampered by the difficulty of setting a price: it cannot be set to zero or nearly zero (which is the real marginal cost of accessing information) because then the costs incurred by data providers are not recovered. How can a price be set that is not too far from the marginal cost and still be sustainable?

the RIs. This points at the need to harmonise those policies across Europe to achieve a coherent funding landscape for data providers.

4.1.2. Costing models

Costing has received the attention of private (for-profit) SPs, since the traditional way of estimating costs has been deemed not fully suited for digital technologies where it is more difficult to attach costs (in particular indirect costs) to products. More recent accounting methods have turned instead to separate service delivery into the activities required for services to be actually delivered to gain better insight into where the costs are really incurred. This is similar to how projects are designed and budgeted in project proposals (to develop OS services for example): objectives are broken down into tasks, and the resources needed to perform each task are then estimated in terms of staff and equipment costs.

Knowledge of the costs of manufacturing a product or delivering a service is an essential element in the design of any company’s activities and has therefore been extensively studied, although the translation of this knowledge to Open Science is not immediate. Key considerations are that the basic quantity in the calculations, the “unit cost” of transactions, is generally not well-known, and that the economic value of the resources is usually wrongly estimated by providers and users. As recognised in the FAIR Lady report [R15], sustainable business models require adequate guidelines to calculate the elements of cost calculation. Also important is to separate costs linked to the provision of a service through EOSC from those that come from provision of access within the original users’ community landscape. This can help identify the right funding sources for each cost category, thus contributing to setting the price for services, and ultimately providing information with which suitable business models can be developed.

4.1.2.1. Available costing models for data and services

As mentioned above, providers need to know the full costs associated with the provision of data and services, which usually differs with the money they spend because of the indirect costs that are attributed to other activities. There are various ways to calculate the costs:¹³

- Bottom-up: to calculate the costs of delivering a service, one can estimate beforehand the costs of the individual components involved (like e.g. hours worked), then add them up. This model is good for projects at early stages, where many details are still not defined (e.g. regarding costs of provision, which can only be known once the service is actually provided).
- Top-down: drawing from previous experience in delivering other services, a provider can estimate the total costs first, and then break that down into individual components. This is more suited for later stages of a project when the total costs can be reasonably estimated.

However, “the limitation of traditional costing systems is that they are unable to allocate the indirect costs of many resources of a company (i.e. specific costs related to marketing, research, depreciation, support, training, electricity) in an accurate way” [R20]. As an alternative method, *Activity-Based Costing* (ABC) was developed in the 1980s to create a costing model appropriate for industries with lower material and labour i.e. direct costs, but with higher indirect costs, like digital industries. Here, costs are assigned to all activities necessary to deliver a service, so it is possible to get a detailed

¹³ Content from [R21] was used for these descriptions.

picture of where the costs are actually incurred. Then the cost drivers for each activity are identified. The idea is that by considering all activities it is possible to uncover the indirect costs that make up the overheads related to activities, thus allowing to calculate the overheads beyond estimations¹⁴. As a drawback, ABC requires more effort to perform, which might make it not suitable for all organisations, especially smaller ones.

A simpler version, in which the time spent on performing an activity as a part of the production of a product or service, is related to the cost that this activity has by looking at what resources it requires, is offered by *Time Driven ABC* (TDABC). Using the cost of the resources, and how much they are used, the cost of providing a service (including here the provision of and access to data) can thus be calculated. This supersedes traditional costing systems and standard ABC in that it is more precise than the former, but is less time-consuming than the latter.

The costing exercise carried out by the PaNOSC Science Cluster described below shows that RIs can follow this method, adapted to their needs, to achieve a better knowledge of the cost of providing OS services for researchers.

4.1.2.2. Current situation

The EC introduced a method to calculate the costs incurred in projects for its Horizon 2020 funding programme so that providers could be reimbursed and to ensure that services remained *free at the point of use*, i.e. that researchers do not have to pay providers directly.¹⁵ Although the methodology to calculate the costs of service usage by VA or TNA may remain relevant, these are however not appropriate funding mechanisms for long-term sustainability, if only because organisations not involved in EC-funded projects cannot use it.

Projects resulting from competitive grants are thus a good instrument to fund the use of services; they are however not conceived to cover service operation, so RIs need to resort to other sources when looking for the appropriate funding to run their services.

Cost estimation of RIs was studied in the Str-ESFRI report [R24]. Despite the known differences of legal and accounting systems among the different countries, the general rules for costing methods in the report constitute a useful guide that can be adapted to the provision of digital services. The PaNOSC science cluster gives a good example of how to do this in practice: they collected costs “for the data services provided to the community, including the costs involved in data management, provision of FAIR data and participation to the EOSC” [R25]. For this exercise, PaNOSC asked RI managers to report separately the costs of tasks “inherent to facility operation”, i.e. those incurred by the provision of services to their respective user community, from the additional costs from the integration in EOSC. The study is aware that several services for users outside the PaN community, i.e. to be accessed through EOSC, were immature at the time of writing, so the costs of service provision were based on the available budget, instead of “the actual costs driven by demand”.

The cost categories identified by PaNOSC RIs together with the methodology to calculate their respective size for a given RI suggest that activity-based costing systems offer a good way to establish the real costs associated with OS service provision.

¹⁴ See e.g. [R22]. A complete description of costing methods is available in e.g. [R23].

¹⁵ For further information see https://wiki.egi.eu/wiki/EOSC-hub:VA-TNA_FAQ.

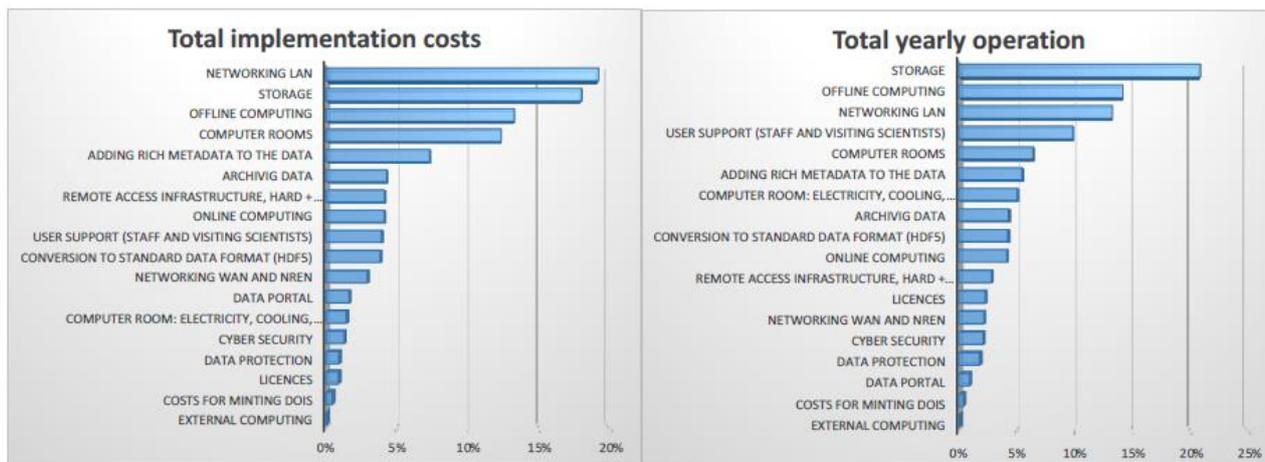


Figure 4 - "Indicative percentage of contribution of every category to the cost of implementation (setup) in five years, and early operation" (from [R25]).

4.1.3. Pricing models

The significant investment needed upfront for the provision of digital services for research requires to put appropriate cost-recovery mechanisms in place. Several such mechanisms are already in use by service and data providers in the EOSC ecosystem, including (but not limited to) those offered in the EOSC Marketplace. A known problem of many digital products and services (like data) is that, from an economic perspective, they are not entirely suitable for a pure market approach, since their behaviour is mostly that of a “public good” in that its use does not prevent others from re-using, so in many cases they do not become scarce in the sense of normal market products. The consequences this has have been explored for the viable business models of digital repositories (see above). Digital services for research that have a limited availability (e.g. access to high power computation), on the other hand, require the consideration of suitable pricing strategies and models. This was identified in the Vivus study [R26] as a key ingredient to enable sustainability of providers and of EOSC (specifically EOSC Core).

In the OECD report cited above [R17], it is noted that “what someone is willing to pay for something depends on the perception of its value”. This is important because, in the case of repositories studied there, users (i.e. researchers) perceive the value of a repository more directly than funders, but it is the latter who need to be convinced to pay the majority of costs associated with the free access to data, i.e. they need to see the tight *value proposition*, whereas this is much more evident for researchers: the value of the repository is to enable access to data to perform their scientific work.

4.1.3.1. Pricing for digital products and services

Pricing strategies for digital products [R27] are based on different viewpoints: price can be set based on costs, use the value perceived by the customer, or the price set by competitors. For Open Science services delivered by public or not-for-profit organisations, only cost-based pricing is really meaningful. The rigidity of public budgets leaves little room to do differently. It may still be difficult to set the price of digital services based on the full costs of delivering a service (staff, infrastructure, etc.), since it is not easy to link price to true cost. A value-based pricing in which “digital products and services [are] priced according to their value and each individual customer’s willingness to pay” [R27] may make more sense, but requires deeper knowledge of customers and market.

4.1.3.2. Pricing of Open Science services

The study of pricing for EOSC Core services done in the Vivus study found that “there is there is not yet a full understanding by all the service operators of the true costs of running a service in a manner that ensures the organisation is able to cover its costs and retain sufficient funds that enable it to grow” (p. 17). Costs are generally underestimated, and since they underpin prices (p. 18), these are underestimated as well.

Price models for OS services in EOSC need to take into account the particular characteristics of the ecosystem. Most importantly, services are (mostly) developed with public resources and offered to public researchers through RIs, themselves built with a mixture of national and European or international public funding. There are many providers (around 250) but they are not truly competitors (although competition exists in some disciplines or some service types), since there are similar services that might continue to co-exist to serve different scientific or geographical communities. The “market” is relatively small, with a total (maximum) of around 2 million users in research activities.¹⁶ Some “horizontal services” of general application that will attract researchers across disciplines, exist along with discipline-specific or niche services that cater for a small number of users. The pricing models, and in fact the business models with which the smaller services operate, will differ from those of the larger ones, especially when it is taken into account that for public institutions the main target is cost recovery and not profit. Some services may even operate at a loss: what they offer cannot be found in the private sector (because of the lack of profitability) but is still needed to progress certain disciplines or achieve very specific goals.

4.1.3.3. Pricing models of Open Science services, with examples from EOSC Marketplace

The TF FinSust progress report [R18] suggested a more in-depth analysis was needed to explore which mechanisms are really feasible and whether different mechanisms could potentially coexist, and noted that some mechanisms require research institutions to act as an intermediary whereas others, e.g. the voucher/token model, would allow a more direct transaction, which may be preferable in some cases to facilitate acquisition of services. Below a short description of the different payment mechanisms is given, together with examples of services from the EOSC Marketplace that use them.

Subscription: Access against payment of a fee at regular intervals can be a very successful means for customer retention and to build brand loyalty, since it turns a one-time sale into recurring sales.¹⁷ It is often offered together with freemium options: some services are available for free, but access to the full product requires users to pay. Subscriptions tend to be linked with tiered pricing (see below). The TF FinSust found that subscription is of interest for EOSC stakeholders, but may require some extensions from current models in order to bring its full value to users. On the negative side, some consider that (EC-funded) projects in particular should not be allowed to use services through subscription due to their limited life span. This may however not apply for subscriptions funded by other means, e.g. global budget of a university.

¹⁶ It is envisioned that EOSC will offer services for citizens of MS/AC. While the costing or pricing models may not change that much when the number of potential users is much larger, the choices made by service providers will probably need to change to adapt to the new setting. For that reason, the scenario where “citizen science” is enabled by EOSC is not considered here.

¹⁷ <https://www.subbly.co/blog/subscription-services/>

EDC EOxHub Workspace:¹⁸ This service provides online workspaces to manage the analysis and processing of large datasets obtained from Earth Observation (EO) networks (e.g. satellites) from a single place—the workspace—that enables data ingestion, visualisation, or development of applications, among other possibilities. The pricing includes a freemium option for trial. The service, provided by the company EOx as part of the Euro Data Cube partnership, is offered through the EOSC Marketplace, but can also be accessed through the partnership’s own marketplace. Extra features can be purchased independently.

For the example above, the (tiered) subscription model allows to attract customers with different needs, ranging from research projects to platforms dedicated to the development of commercial applications that use EO data, by offering packages that suit different needs.

Usage pricing / pay per use: Here, users are charged only for the actual resources used. This can be good to attract smaller customers with less payment capability. This mechanism allows customers to shift costs from fixed to variable, because instead of purchasing the product or service they only rent or lease it for the time they use it. Pay per use is also offered in combination with a basic subscription and additional price for extra usage. As a drawback, if users do not perceive the value early, they might stop using the service, and will therefore stop paying.

Virtuozzo Application Platform:¹⁹ This platform-as-a-service (PaaS) tool is designed for organisations (also companies) that need a software-as-a-service (SaaS) solution to host their services. Similar to small companies, public service providers can benefit from a pay per use solution that enables them to adjust costs as their user base grows, without having to set up large resources from the start. Additional support can be provided against extra payment.²⁰

Puhti supercomputer:²¹ The supercomputer service of the Finnish public service provider CSC. For this service, pricing²² is a combination of basic subscription (“basic package”) plus additional charges for increased usage. CSC offers other services with similar pricing models. Since CSC is owned by the State (70%) and the higher education institutions (30%), Finnish researchers have access to the services for free, which makes their pricing model a combination of subscription/pay per use and tiered pricing (see below).

Tiered pricing / freemium: The idea of this mechanism is to offer different product packages to different types of users, thus adapting the product offering to who demands it. This can include a free version of the service/product to attract customers (i.e. freemium). Personalisation can also apply to groups of customers, or to parts of the full market: for example, in EOSC, users within the same project or country who have contributed to the development costs may get a lower price (see also the case of services from CSC above). According to the Deloitte study [R27], tiered pricing is a sort of “versioning” or *second-degree pricing* (i.e. users pay a different price depending on what version they use), in that the price paid sets what exactly a customer can do: full capability for those who pay more, incomplete for those who pay less.

¹⁸ https://eurodatacube.com/marketplace/infra/edc_eoxhub_workspace

¹⁹ <https://www.virtuozzo.com/application-platform/>

²⁰ <https://www.virtuozzo.com/support-plans/>

²¹ <https://research.csc.fi/-/puhti>

²² <https://research.csc.fi/purchasing>

OpenLab Drilling:²³ A web-enabled drilling simulator and lab facility for research, education and demonstration of drilling technology. As detailed in the pricing webpage²⁴, there is a free option for trial, and two possible prices for academic or commercial users. This shows why tiered pricing can make sense for services from public providers that are of interest for industry: it is a straightforward way to distinguish between academic (i.e. public funded) and profit-driven commercial customers, who in principle have access to more resources, especially in the case of larger companies.

EGI High-Throughput Compute:²⁵ This service, co-funded by the EC, allows to analyse large datasets that require the execution of a high number of computational tasks. In this case, the different tiers are determined by the funding received by the applicant: “sponsored users” are those from EC-funded or in-kind projects, “paid access” through contract, “Long-Term Partnership” for institutions (i.e. not individual projects).

Other pricing models available for digital services not used by providers in the EOSC Marketplace can be found in Appendix 3.

4.1.3.4. Services in the EOSC Marketplace that do not specify any cost recovery mechanism

Other services available in the EOSC Marketplace do not specify any cost recovery mechanism and are offered for free to users. That does not mean that there are no costs involved, but that these are covered by other means, usually involving national public funding schemes, EC support, or others, so that users do not need to worry about who pays for usage. The examples from the EOSC Marketplace are offered without any request to users to engage in any payment mechanism:

- GPAP (Genome Phenome Analysis Platform)²⁶: This service for the study of the organisms that cause rare diseases was developed by EC grants in the FP7 funding programme, and is currently operated and supported by Spanish national and Catalan regional governments, in collaboration with the European Bioinformatics Institute²⁷.
- iImagine²⁸ offers a portfolio of image datasets, high-performance image analysis tools empowered with Artificial Intelligence, and Best Practice documents for scientific image analysis. The tool was developed and is maintained through EC project funding, with the idea of exploring possible business models that could be adopted after the end of the project.
- B2ACCESS²⁹ is a horizontal service that provides federated identity and authorisation. Originally offered in the DICE project³⁰, it is currently available through EUDAT. It does not specify any cost-recovery mechanism, but since it would be placed in EOSC Core (similar to other EUDAT services), it would be funded centrally.
- GÉANT Cloud Services³¹: These services are conceived to enable institutions to access virtualised commercial cloud services. For public institutions that cannot use procurement to

²³ <https://openlab.app/>

²⁴ <https://openlab.app/pricing/>

²⁵ <https://www.egi.eu/service/high-throughput-compute/>

²⁶ <https://platform.rd-connect.eu/#/>

²⁷ See <http://www.cnag.eu/> and <https://www.ebi.ac.uk> for more information.

²⁸ <https://www.imagine-ai.eu/services/imagine-ai-platform/>

²⁹ <https://www.eudat.eu/catalogue/b2access>

³⁰ <https://www.dice-eosc.eu/>

³¹ <https://clouds.geant.org/>

acquire certain commercial services, the OCRE project gives them the opportunity to use procurement-free contracts through the GÉANT framework³² (i.e. through NRENS).

4.2. Contributions from countries

4.2.1. EOSC governance in the current Horizon Europe Co-Programmed EOSC Partnership

EOSC is currently governed and financed in the form of a Co-Programmed Partnership. This model implies the signature of a non-legally binding Memorandum of Understanding (MoU) between the EC and EOSC-A [R14]. By signing the MoU, the EC and EOSC-A commit to financially support the implementation of the objectives of the EOSC Partnership in an equal way. The EC has thus agreed to invest 490 million Euros between 2021 and 2027 in EC funded grants and procurements to support the implementation of EOSC, while 500 million Euros will be provided by the members of the EOSC-A via in kind contributions.

As can be derived from the text above, in the Co-Programmed Partnership model MS and AC do not have any obligation in terms of a specific direct financial contribution to EOSC. They contribute to the governance model in the form of an expert group of the EC, called EOSC Steering Board³³. In addition, a substantial part of the in kind contributions reported by the members of the EOSC-A is financially supported by national budgets coming from the countries. Consequently, the countries play a very relevant role in the EOSC governance and financing already today.

4.2.2. Future EOSC governance and the role of the countries

The current EOSC Co-Programmed Partnership ends at the end of 2030. In 2024, the EOSC Tripartite Collaboration (EC, EOSC Steering Board and EOSC Association) intends to decide whether to renew the existing Co-Programmed Partnership or establish a new governance and financial model for EOSC post 2027. To this end, in 2022 the Tripartite Collaboration started to explore suitable governance models for EOSC beyond 2027. A preliminary analysis by the EC has defined the main tasks to be sustained for the efficient and successful implementation of EOSC after 2027 [R28]:

- Task 1: Deploying and operating the EOSC EU Node (Core, Exchange, FAIR Data Federation).
- Task 2: Maintaining and updating the EOSC EU node and expanding the EOSC Federation (with elements that are close to the ‘market’).
- Task 3: Enabling a “Web of FAIR data and service for science”.
- Task 4: Developing, prototyping and testing new elements supporting the evolution of the EOSC Core and Exchange and the tools enabling the EOSC Federation (focus on elements that can be made ready for the ‘market’).
- Task 5: Enabling Open Science policies and the uptake of Open Science practices.

Tasks 1 and 2 focus are related to the deployment of the EOSC EU Node and the establishment of the EOSC Federation and its operation. Task 3 relates to the development of support actions to turn FAIR into practice and develop a “Web of FAIR data and services for science”. Task 4 focuses on the development of new state-of-the-art technologies and user-driven service elements for the EOSC EU Node and the Federation, basically the innovation and development needed for the EOSC Federation.

³² <https://clouds.geant.org/geant-cloud-catalogue/geant-cloud-catalogue-ocre/>

³³ <https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?lang=en&groupID=3756>

Finally, Task 5 works on the alignment and further implementation of Open Science policies, including investments and practices, at European, national, regional and institutional levels.

After the identification of the activities to be sustained after 2027, the EC organised a series of “infoshare” meetings with EOSC SB members to present the different potential governance models: e.g. EDIC, ERICs, Article 187, etc. This led to the May 2023 tripartite event where the options were discussed. There were two main outcomes of the meeting:

- There was a broad consensus that the co-programmed partnership model is not considered ideal for the future of EOSC post 2027: this model relies entirely on grants for implementation and on the funding of the EC plus in-kind contributions. These two factors impose a lot of limitations and are perceived as a barrier for a successful implementation of EOSC;
- A direct consequence of the first point is the role of the countries. Their commitment (including financial commitment) is perceived to be essential to achieve long-term sustainability of EOSC.

The discussions held during the tripartite event were useful also to discard some of the models (e.g. EDIC or ERIC), but the list of options was still too broad, and the pros and cons of the different models were not analysed in depth. For this reason, the EC proposed as the next step to write a paper summarising the potential governance models for EOSC post 2027, including an assessment of the advantages and disadvantages of the different models. It was agreed that the paper would be written by a group of champions of the EC, the EOSC SB, and the EOSC-A. At that point in time, EOSC-A suggested to support this work via EOSC Focus, by producing informative material on the governance models through webinars organised during the summer to increase the knowledge of the MS/AC on the options and keep them engaged in the process. The EC considered this effort too premature and preferred to postpone the engagement of the countries until the paper was ready. After having received the first draft version, the EOSC-A Board suggested an extra model to be included for consideration in the paper. The content of the paper and the new model suggested by EOSC-A were then presented at the EOSC Symposium 2023 in the session on “Governance models for EOSC post 2027”³⁴ (Figure 5 below).

The session was useful to present to the community for the first time the options under exploration by the tripartite collaboration, and to collect feedback. In October 2023, the EC, the EOSC SB and the EOSC-A worked closely together to finalise the paper that was shared with the entire EOSC SB at the end of that month.

The EC also decided that the paper in its entirety was not to be shared outside the tripartite collaboration; its purpose was to prepare the EOSC tripartite event on 28 November 2023 in Madrid (Spain). At this event, the EC expressed its preference for the “integrated scenarios”, ruling out any other possibility going forward. The consequences of this will be further investigated and detailed in early 2024 to provide the countries with additional information that can support an informed final decision process. This will take place during the European Tripartite event of 16 April 2024.

³⁴ <https://symposium23.eoscfuture.eu/symposium/governance-models-for-eosc-post-2027/>

eosc Different options for EOSC post 2027

- Option 0 (baseline scenario): EOSC is implemented directly by the European Commission mainly via FP10 instruments
- Option a: Integrated scenario with EOSC Tasks 1 to 5 implemented as an Article 185 of the Treaty on the Functioning of the European Union with a new private law body with a public service mission including Member State organisations
- Option b: Integrated scenario with EOSC Tasks 1 to 5 implemented as an Article 187 of the Treaty on the Functioning of the European Union with a new EU body in charge of a Joint Undertaking
- Option c: Integrated scenario with a private law body with a public service mission
- Option d: Hybrid scenario with EOSC Tasks 1 and 2 implemented by an external entity and EOSC Tasks 3, 4 and 5 implemented through a continued EOSC European co-programmed Partnership
- Option e: Hybrid scenario with EOSC Tasks 1, 2 and 4 implemented by an external entity and EOSC Tasks 3 and 5 implemented through a re-established EOSC European co-programmed Partnership
- **Option f: Hybrid scenario with EOSC Tasks 1, 2 and 4 implemented by an external entity and EOSC Tasks 3 and 5 implemented through an 'Open Science' programme of the EU**

Figure 5 - List of the seven governance options under discussion. Slide courtesy of the EOSC-A.

4.2.3. EOSC Focus contribution

The EOSC-A firmly believes that the countries have a fundamental role in the success of EOSC, and that they have to become co-responsible of its governance and financial sustainability after the end of Horizon Europe in 2027. Thanks to the activities carried out in the context of the national tripartite events, the EOSC-A has developed a quite good understanding of the different status of the countries when it comes to Open Science and EOSC and is fully aware that there are countries more mature and advanced than others.

This background information is of fundamental importance to understand what could be the expectations in terms of commitment from the countries but also to assess the type of activities in terms of awareness creation and discussions that is necessary to put in place after November 2023, once the shortlist of governance options is available. To support this effort, EOSC Focus has mapped the “Open Science/EOSC” relevant information for all the EU countries in a matrix (Fig. 5). The information in the matrix, organised in four categories, answers the following questions:

- **Engagement:** is the country represented in the EOSC SB? Does the country have a Mandated Organisation, and what is its role in the country? How many EOSC-A members are there in the country? How many organisations are active in INFRAEOSC projects? Is the country active in OS related initiatives (e.g. CoARA³⁵, CoNOSC³⁶) and/or infrastructure related initiatives (e.g. EuroHPC)? Does the country host Research Infrastructures?
- **Policy:** How active is the country on relevant OS/EOSC policies?
- **Financial:** Does the country have OS / EOSC dedicated programmes and if yes what is the size of the funding?
- **Demographic:** How many researchers are there in the country? The demographic numbers are mainly meant to normalise the other values included in the matrix to compare them.

³⁵ <https://coara.eu/>

³⁶ <https://conosc.org/>

| Regional Hubs Central (TU Graz) East (NCA) West (BELNET) South (CREAF) Nordic (OSC) | Engagement | | | | | | | | | | | |
|--|---|---|--|---|---|---|--|---|---|---|--|---------------------------|
| | Representation in Steering Board (SB) (updated 12.4.2023) | Name of the organisation representing in SB (updated 12.4.2023) | Mandated Organisation (MO) appointed (updated 12.4.2023) | Name of the Mandated Organisation (updated 12.4.2023) | Role of the Mandated organisation | Type of the Mandated organisation | Engagement policy | Number of EOOSC-A members (updated 12.4.2023) | Number of EOOSC-A members not representing an EU organisation | Number of EOOSC-A observers (updated 12.4.2023) | Number of organisations engaged in WP21-22 INFRAEOOSC (EO's ppt) | Number in Coast Resea (C) |
| Austria | Yes | Austrian Federal Ministry of Education, Science and Research | Yes | ACONET Association | Association for Promotion of NREN (not the actual NREN) | Association for Promotion of NREN | The ACONET Verein Association has been appointed by the Austrian institutions, members of EOOSC National structure: the interregional concertation group Open Science of the International | 5 | | 2 | 6 | |
| Belgium | Yes | Department of Economy, Science and Innovation (EWI) | Yes | Belnet | Representing members and non-members in the EOOSC-A. Facilitating communication | NREN | | 12 | 7 | 9 | 19 | |
| Bulgaria | Yes | Ministry of Education and Science | No | - | - | - | | 1 | | - | 1 | |
| Croatia | Yes | University of Zagreb, University Computing Centre - EOOSC | Yes | University of Zagreb University Computing Centre (SRCE) | Competence centre for information and communication technologies, as well | e-infrastructure provider for science and education | SRCE and the Ruđer Bošković Institute have participated in the INFRAEOOSC | - | 2 | 1 | 2 | |

Figure 6 - Screenshot of the country matrix

The matrix is a living document, and will not be published as it includes some sensitive data. The purpose of the matrix is to support the work of the EOOSC-A and the EOOSC Partnership after November 2023. Once a shortlist of models is agreed by the tripartite collaboration, the models will be further detailed, so that each country understands the impact of the selected models at national level. The detailed activities that EOOSC Focus will perform to support the EOOSC-A will be defined after November 2023 as the decision depends on the results of the November tripartite meeting.

4.3. Business models for specific customer segments: interim results of the collaboration with Boundaryless

EOOSC Focus has subcontracted the company Boundaryless to explore the *core value proposition* of the EOOSC platform using the Platform Design Toolkit (PDT), an alternative methodology to the more common business canvas³⁷. The PDT methodology seems appropriate for EOOSC: EOOSC is to be organised as a federation that enables participating entities to obtain *added value derived from the collaboration* through the platform created for sharing resources. In PDT, one identifies the roles of participants in the ecosystem and the relationships between them (who gives/obtains value from which relationship), singling out those relationships that can benefit most from taking place through the platform. The services that mediate the relationships (who does what for whom?) are then identified, and they lead to formulate value propositions for different types of stakeholders: the services indicate what the stakeholders can obtain by carrying out their activities in or through the platform, as compared to the situation in which it was not there. In turn, the business models will be defined based on the value propositions.

4.3.1. Scope and aims

In PDT, the “platform strategy” represents the guided patterns used to define who consumes what kind of value in the platform (EOOSC in our case as the environment where providers and users exchange value), what is possible, what is (not) allowed, and what interactions are incentivised. This leads to defining the core value proposition of the platform. The activities carried out so far are described in detail in Appendix 2.

³⁷ For comparison, the business canvas analysis considers all elements of the value chain of a product or tool. Here, for example, the relationships between participants is not a relevant question, since there is usually only one “producer” involved, or at least in most cases the business canvas analysis refers to a product developed by a single organisation. A first application of PDT for EOOSC was done in the EOOSC-hub project [R29].

4.3.2. Timeline and expected outcome

- Boundaryless, with the support of EOSC Focus members, will involve representatives of relevant actors in the EOSC ecosystem to validate the work done so far through the feedback obtained. The conversations are expected to provide further information for the next steps in the process.
- Once the central value propositions for EOSC have been validated, the paths to sustainability will be explored. Here the focus will be placed on the roles rather than on individual entities, to ensure that as many interactions in EOSC as possible are included.
- The full outcomes of the work will be included in an actionable report, which is expected to be ready in early 2024. Both the outcomes and the report itself will be discussed with EOSC Focus and EOSC-A for feedback and potential improvements.

4.4. Sustainability of services created in H2020 INFRAEOSC projects

The INFRAEOSC projects funded in the Horizon 2020 programme of the EC have generated a great variety of services and tools with the vision of integrating them to form the EOSC. This sub-task of T5.3 has developed early findings collected by EOSC-A and explored the sustainability of the H2020 INFRAEOSC project results in more detail. Here, the work so far and the timeline and expected outcome of this activity are described.

4.4.1. Background

In April 2022, EOSC-A in collaboration with RDA asked the (then still running) H2020 INFRAEOSC consortia to provide information on the maturity and long-time perspectives of the results obtained during their lifetime. Projects funded under the H2020-INFRAEOSC-2018-2³⁸, -3, and -4³⁹, H2020-INFRAEOSC-2019-1⁴⁰, H2020-INFRAEOSC-2020-2⁴¹, and BG-07-2019-2020⁴² calls were asked to select up to six Key Exploitable Results (KER) per project and respond to a survey about exploitation, sustainability, internationalisation, besides specification of results maturity through Technology Readiness Levels (TRL). The report was published in November 2022 [R30].

In parallel, the TF FinSust became interested in this topic, and noticed that the information reported by the projects regarding sustainability plans, or funding models to sustain service operation, could be better detailed. Since the measures devised by project partners to ensure the long-term operation of the services created (or advanced) is a key issue towards achieving a sustainable EOSC, the TF asked EOSC Focus for support. At their request, Task 5.3 set out to gather the relevant information that had not been collected in the report. The work started in August 2023.

³⁸ INFRAEOSC-04-2018 - Connecting ESFRI infrastructures through Cluster projects, <https://bit.ly/CORDIS-cluster-projects>

³⁹ INFRAEOSC-05-2018-2019 - Support to the EOSC Governance, <https://bit.ly/CORDIS-EOSC-regional-projects>

⁴⁰ INFRAEOSC-02-2019 - Prototyping new innovative services, <https://bit.ly/CORDIS-EOSC-innovative-services>

⁴¹ INFRAEOSC-07-2020 - Increasing the service offer of the EOSC Portal, <https://bit.ly/CORDIS-07-projects>

⁴² BG-07-2019-2020 - The Future of Seas and Oceans Flagship Initiative, <https://cordis.europa.eu/project/id/862409>

4.4.2. Scope and aims

The starting point was the understanding of “sustainability” according to the definition offered in [R31] by the H2020 FAIRsFAIR project: *sustainability - planning for risk mitigation, business continuity, disaster recovery, and succession; secure funding; and providing adequate governance* (p.28). The focus of the study was shifted from the INFRAEOSC projects themselves to their KERs, and in particular the RI-user resources - services, data sources, tools, software, workflows - onboarded on the EOSC Marketplace. While the projects are important, the concrete services they have produced, together with their nature, quality, and sustainability, are more relevant in that they are the tools that bring value to EOSC and to users.

Following the importance of the 5 ESFRI Science Clusters highlighted in the EOSC-A report in ensuring RI services are represented in EOSC, the decision was made to focus mainly on them initially, for the following reasons:

- The 5 ESFRI Science Clusters have a particular role to play in EOSC, given that their KERs listed in the EOSC-A report are mainly *discovery vehicles* (i.e. portals, hubs, Virtual Research Environments (VREs), marketplaces and catalogues) which serve as gateways to services offered by cluster member RIs; these are hosted elsewhere (i.e. not centralised in the clusters) and, importantly and have not been onboarded in the EOSC Marketplace. Appendix 3 shows each Cluster’s KER portals on the EOSC Marketplace, along with the limited number of member-RI services onboarded to date.
- The setup whereby RI services hosted elsewhere are discoverable and accessible on the marketplace through the Science Cluster portals offers significant potential benefits both for EOSC and for users:
 1. It allows the EOSC Marketplace to spotlight the Cluster gateway while leaving member-RIs to take care of exposing and managing their many services on secondary portals, thus making the Marketplace appear less cluttered and more user-friendly;
 2. it frees EOSC from having to list each individual RI service on the Marketplace and having to bother with onboarding, quality, maintenance, and admin requirements for each; yet it allows EOSC to guarantee users full and open access to all RI services through the Cluster gateways on the Marketplace;
 3. it makes users happy as they can continue to access their favourite RI services via their familiar Cluster/RI portals or hubs, many of which have existed for years and have strong and loyal followings;
 4. it reinforces the visibility and value of the Science Clusters which, as main conduits to RI services in EOSC, become front-line promoters/facilitators of FAIRness, particularly interoperability, and also of links to the Data Spaces;
 5. it boosts awareness of the Science Clusters and their member RIs as leading sources of top-rate scientific services and of socio-economic benefits among Member States and funding bodies, thereby greatly strengthening their impact and sustainability.

On the other hand, 07-projects KERs are mostly enabling services contributing to the EOSC Core, which is expected to be at least partially centrally funded and maintained. Their sustainability therefore is a less pressing issue. That said, however, they will be also looked in detail later as well, as their

dependence on project funding requires the organisations that operate them to evaluate the viable options ahead.

With the goal of assessing the sustainability prospects listed in the EOSC-A report over the next 4 years through 2028, a draft questionnaire of basic sustainability information to seek from each project has been developed, based on input from Trust-IT and others (see Appendix 4). The questions are designed to collect comparable information (ideally figures) from everyone.

4.4.3. Timeline and expected outcome

Steps planned for the next months include:

- A. Starting with EOSC-Life, schedule online interviews with representatives of each Cluster to validate the overall list of KERs and discuss the sustainability questionnaire.
- B. Conduct similar meetings with each Cluster member-RI service-provider to gather more in-depth information on RI services, particularly why some have been onboarded on the EOSC Marketplace whereas the majority are only accessible through the Cluster/RI gateways.
- C. Undertake similar outreach activities for each of the 07 projects.

5. Concluding remarks

The principles of federation of services (for data and tools) are related to the “system of systems” approach to EOSC put forward by the EC through the procurement of the EOSC EU Node. In the preceding chapters, these principles and their relation to EOSC have been laid out to allow for planning the steps from the current situation until the launch and operation of the EOSC Federation.

The state of play of the discussion with stakeholders of the role of the EOSC Nodes in the EOSC Federation following the decision on the procurement of the EOSC EU Node by the EC has been presented (chapter 2). The current EOSC tripartite governance needs to establish a process to effectively implement the steps that lead to the creation of the EOSC Federation, identifying the specific tasks, a responsible party, and a timeline for each.

The status of the EOSC governance framework elements has been reviewed, and the path for their respective further development under the nodes setting chosen for EOSC has been sketched (chapter 3). The process to set up the governance framework of the EOSC Federation can be developed starting from this sketch, and a timeline (compatible with that for the creation of the Federation itself) should be established.

Resourcing models (chapter 4) have been approached from different angles, including:

- Current knowledge of costing models, with examples from service and data providers on the EOSC Marketplace. The examples suggest that providers can acquire the knowledge about the cost of their activities, thus enabling them to engage in conversations with their funders to establish resourcing mechanisms other than project funding.
- Contributions from countries (both MS and AC) to EOSC and its relation with the governance model chosen for EOSC. The information gathered by EOSC Focus will allow the EOSC governance to steer the conversation with MS/AC once decisions about the post-2027 scenario have been taken.
- Value proposition of EOSC for different stakeholder groups. By identifying the roles of stakeholders in the EOSC ecosystem, the actions they perform, and the value this brings to them, will deliver a set of value propositions that can later be “fleshed out” to business models that maximise the value EOSC brings to all stakeholders.
- Experience from Horizon 2020 EOSC-related projects on sustainability. Knowledge of what has and has not worked in the previous rounds of EC-funded projects is important to extract the necessary lessons.

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Appendix 1 - Draft Access Policies for EC-procured horizontal services

The draft, prepared by the EOSC-A Board of Directors in collaboration with the EC, was shared in April 2023, and it is pending approval/adoption.

This policy defines which users may access the set of services procured by DG CNECT via the tender entitled “Managed Services for the European Open Science Cloud (EOSC) Platform – CNECT/LUX/2022/CD/0023 2022/S 245-709092”. This policy and any subsequent changes must be approved by the EC.

The policy enters into force as the procured services become operational and remains valid for the full duration of the procurement contract.

Those procured services that constitute the EOSC Core (procurement lot 1) will be available at no charge to all researchers in Europe.

Those procured services that constitute horizontal services (procurement lots 2 & 3) will be available to all researchers, upon request, at no charge up to specified limits.

The consumption of the procured horizontal services will be regularly monitored and additional mechanisms to access unconsumed capacity may be introduced at a later date.

Researchers are defined as individuals having a trusted identity from a home institute in Europe that has been authenticated via the eduGAIN federated identity management system.

Appendix 2 - Business models for specific customer segments: full description of the collaboration with Boundaryless (cf. 4.3)

1. Description of activities

We describe here in more detail the activities carried out by Boundaryless so far and the plan until completion of the work.

1.1. Arena Mapping and Experience Scans

The EOSC ecosystem was first mapped in several “arenas” (i.e. environments where interactions between organisations take place, see Figure 7), followed by a scanning of the “experiences” (i.e. the interactions in which the organisations, or entities, become involved). Two arenas stood out as the most important for EOSC⁴³:

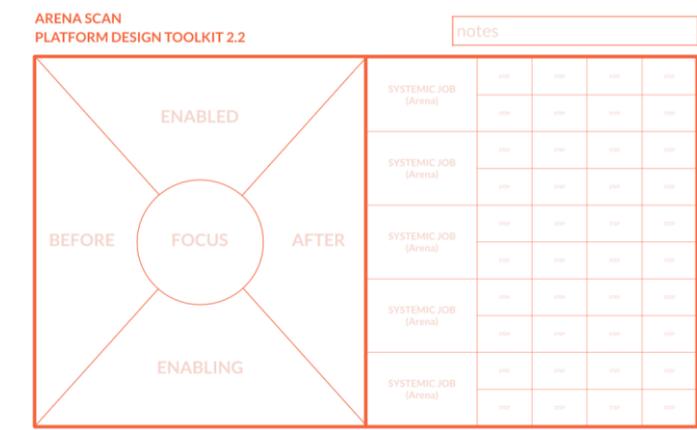


Figure 7 - Arena scan for PDT.

- **Resource provisioning and orchestration.**⁴⁴ One of EOSC’s main tasks is to enable the discovery of and access to the right tools and resources researchers need to carry out data management and analysis, and integrate them so that the goals set can be reached.
- **Data reuse and interoperability.** EOSC tackles the challenge of enabling seamless combination of data from different origins. This requires that datasets are or become interoperable.

1.2. Ecosystem Mapping

The entities in the ecosystem are clustered into “roles” that describe the actions or objectives they want to achieve. The ecosystem was then split in mirroring sides of consumers and providers of horizontal/thematic services and data. A key role in EOSC is the one played by what we call “Service Provisioning Units” (SPU), which are entities (or groups/parts within them) that act as a liaison or

⁴³ Other arenas also identified as relevant for the EOSC ecosystem, but not further studied here, were: Data collection and preparation, platform support functions, and exploitation of results/commercial use.

⁴⁴ “Orchestration” refers here to the organisation of the EOSC Platform, i.e. the governance structure, processes, rules of participation, and interaction channels and interfaces, that regulate the mutual relationships among different entities.

mediators between researchers and the institutions, products and services. SPUs also optimise and add value to data, and may have expertise in consulting, data processing, etc.

1.3. Value chain analysis and identification of platform opportunities

The mapping of the ecosystem and the entities is used to construct the relevant value chains. This analysis can reveal opportunities to develop the platform’s “product/service bundle” and the marketplace interfaces (i.e. where consumers and providers “meet”), i.e. what other goals beyond access to FAIR data and services can potentially be reached by EOSC by further developing the platform.

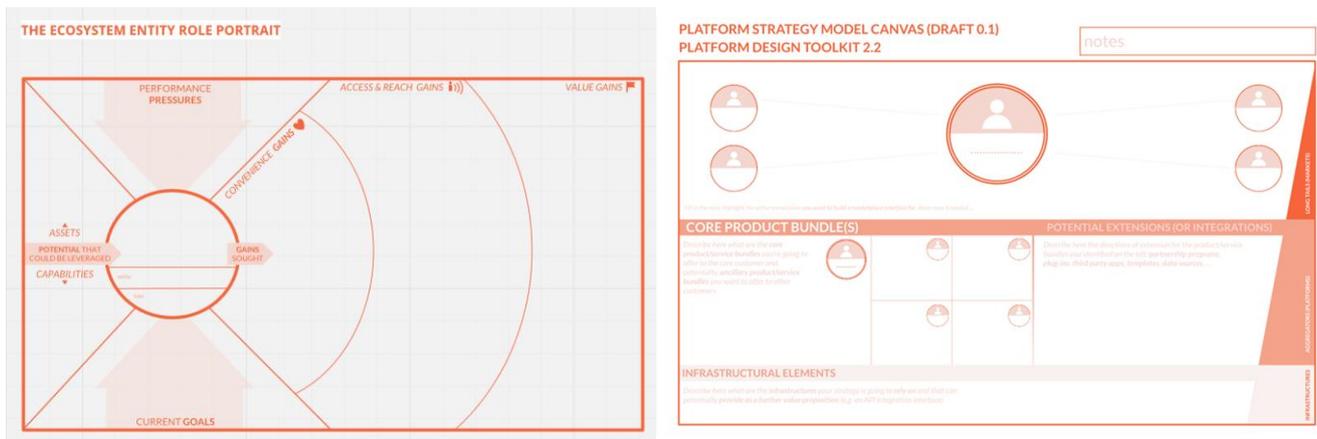


Figure 8 - Ecosystem Role Portrait (left) and Platform Strategy Model canvas (right)

2. Current status

To visualise the essential elements of a platform strategy, three **Platform Strategy Model (PSM) canvases** (cf. Figure 8 (right) above) were developed using the knowledge gathered in the arena description and the experiences/interactions in them, and the roles identified in the mapping of the ecosystem. The *value propositions* “emerge” from this canvas in that the service bundles point to the products/services from the producer side that can best realise the value to the customers. They need however to be interpreted as value propositions. The canvases are included in the Appendix for reference, and can also be consulted online.⁴⁵

3. Summary of the three Platform Strategy Models (PSM)

PSM canvas 1: help researchers perform research, attract more resources, improve reputation, increase trust in the data they use or generate, publish more and better results. This canvas describes the value proposition for researchers as the central “entity-role”, connected to RPOs (national and large/international RIs, who might act as a proxy for funding, and other entities that enable multidisciplinary research). It is related to the first objective in the SRIA [R32], “**Ensure that Open Science practices and skills are rewarded and taught, becoming the ‘new normal’**”. Researchers access resources and service bundles through the EOSC platform, leveraging infrastructures available in EOSC Core. The first value proposition thus sees EOSC as the marketplace seen from the researchers’ perspective. Three service bundles have been identified:

⁴⁵ https://miro.com/app/board/uXjVMFg3G38=?share_link_id=587909925870

- Empowerment of researchers by improving their research and, consequently, their reputation in the science system.
- Ability to browse or populate “last-resort data repositories” (i.e. repositories for the long-term preservation of data), software related to search and use datasets, and matchmaking with other entities to perform multi-disciplinary research.
- Match researchers with national/large RIs and multidisciplinary research: a streamlined access and booking system for underutilised fixed assets that can benefit researchers and increase the return on investment.

PSM canvas 2: help smaller research centres to develop a portfolio offering as if they were large RIs, to incentivise them to become competitive and be used by researchers in their work. Here, the focus is put on the aggregation and coordination of services for researchers, including data management, which is related to the second objective for EOSC in the SRIA, “**Enable the definition of standards, and the development of tools and services, to allow researchers to find, access, reuse and combine results**”. National/large RIs and multidisciplinary research are the central nodes, connected to researchers, SPUs and horizontal providers. Here two service bundles were found:

- One bundle aims to develop procedures and processes to publish semantic artefacts through catalogues, thus guiding the population of institutional repositories to become machine-actionable.
- The second bundle is related to facilitating research centres access to journals and repositories, together with peer-review processes, tools to prevent “data and paper mills”⁴⁶, and to provide a platform for research software through development, preservation, citation, and reuse.

PSM 3: enabling OS and sharing scientific results through a federated infrastructure. In this canvas, the central entities are national RIs, connected to their peers in other countries as well as to RFOs. A key element of the value proposition that comes out from this canvas is how funding flows from RFOs, including the EC, to researchers, providers and RIs. Until now, the “tender – bid – evaluation by a committee” pattern has allowed to develop many parts of the system, but is regarded as an highly inefficient tool since the EC has very limited time to evaluate projects which prevents the necessary assessment of results and their integration into a coherent “whole”. The alternative scenarios for the future suggested by this canvas will be analysed to develop potential funding mechanisms. This will have consequences for EOSC’s federated governance structure.

⁴⁶ This refers to low-quality data or papers, usually created by computers, that need to be distinguished from “real” data resulting from research activities.

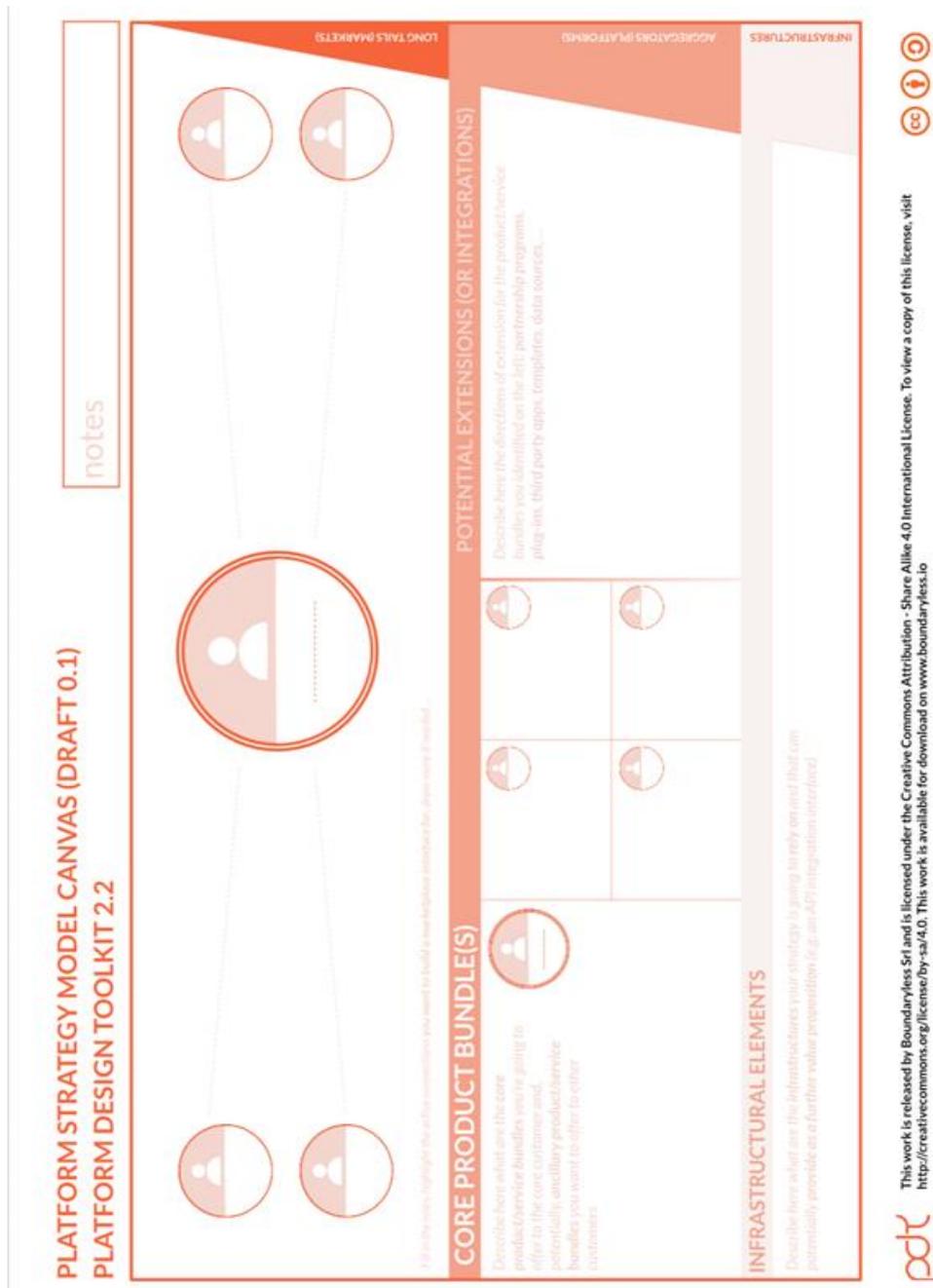


Figure 9 - Platform Strategy Model Canvas (empty)

Each canvas focuses on one main “entity-role” as user/consumer, who is connected to other entities through producer-consumer relationships that bring value to them. The services that enable to accomplish the *tasks* identified in the arena mapping are grouped into *product/service bundle(s)*. These are the services that the producers should offer users through the platform in order to maximise the value they get from it. Other elements in the canvas are the *marketplace interfaces*, the *infrastructural elements* (i.e. the infrastructure used to deliver the value), and further (potential) elements that could be added to the platform to extend its services and increase the value it brings.

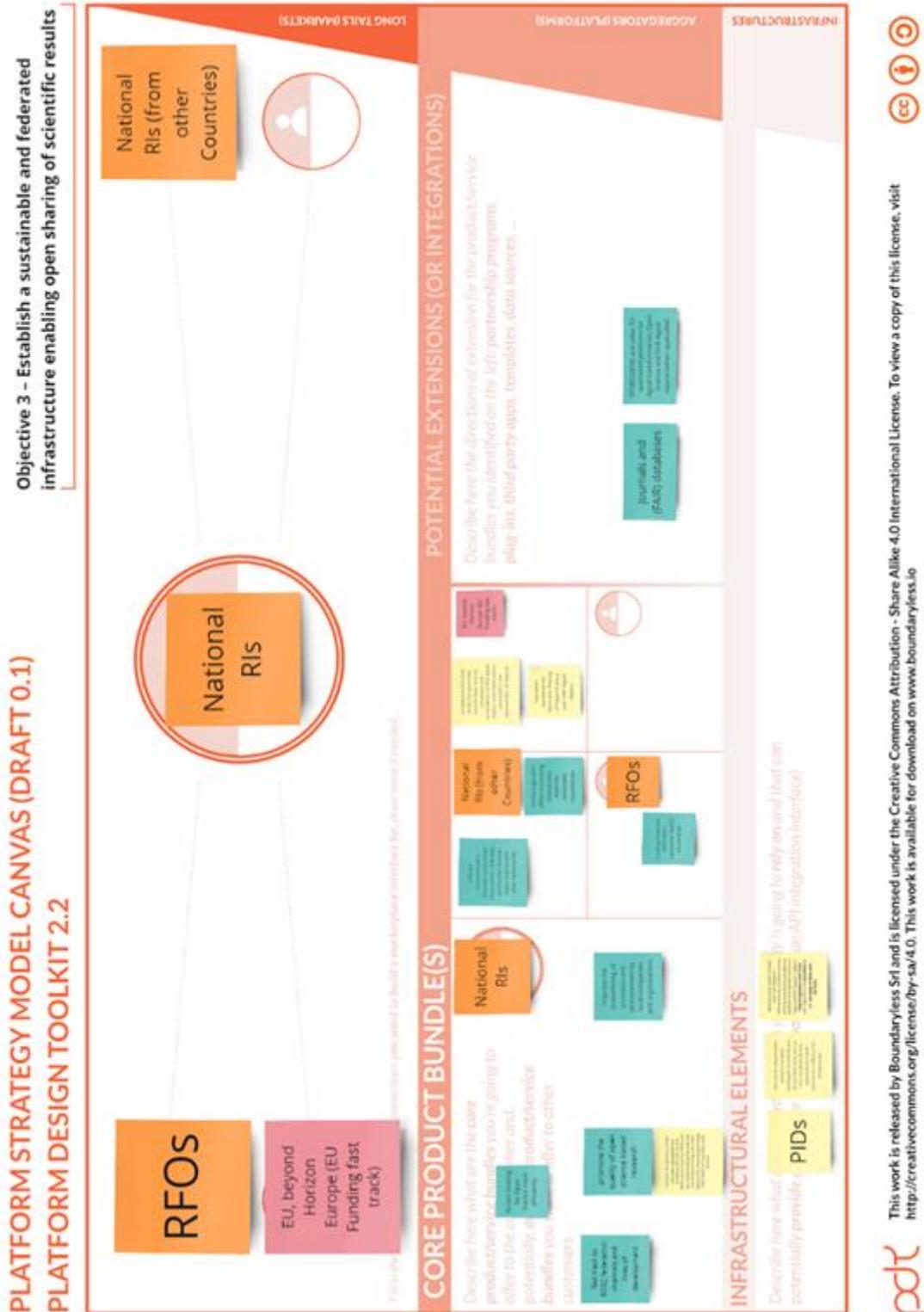


Figure 12 - Platform Strategy Model (PSM) canvas 3

Appendix 3 – Other pricing models for Open Science services currently not in use by services onboarded in the EOSC Marketplace

User-count pricing: Here, charges depend on the number of users from a single business (either by packages or on a purely linear basis), regardless of usage. This model can drive away customers with a large user base. As an alternative, it is also possible to introduce a fee per active user, while for the rest (not active) only the basic fee applies. People might share logins, so you get less revenue (might not apply to authenticated users in EOSC).

Direct payment: This option involves customers that pay for their usage of service without intermediaries (except those necessary to make the payment technically possible), like using e.g. a credit/debit card, or some tool like PayPal. This option was considered as important for future versions of the EOSC Marketplace in the consultation done by the TF FinSust.

Flat rate: With this model, users get unlimited access to a resource with a single payment. This option is usually good to attract users, since they know that no additional costs will come their way. The fact that users get everything at once can cause some product features to remain unused. Further problems are that it is not intended to be personalised for specific uses; also, it is not flexible against changes in the market, or surges in prices to deliver a service, or if a user or group of users uses too much of it. It is good to scale (for users), since they can add more features (thus increasing the fee they pay) when they need and can afford them. It can be confusing because customers may not know what they need, requiring strong engagement with them to clarify the offering.

Voucher/token: In voucher or token schemes, a researcher interested in using a service applies to the corresponding funding agency and, if successful, gets a voucher that can be redeemed at the provider. This keeps the service “free at the point of use” since it is the funder who engages directly with the provider to get the associated costs recovered. Virtual and Transnational Access are an implementation of this idea employed in the Horizon 2020 funding programme. Vouchers to pay for the use of commercial services was explored in the OCRE project, but these services have not yet been onboarded in the EOSC Marketplace, and it remains to be explored whether that is a viable option.

In the TF FinSust’s consultation, respondents indicated that vouchers and tokens are the second most relevant payment model, pointing out their potential to be used to incentivise service uptake in EOSC, and their relevance for the long-tail of science. They suggest addressing potential quality issues to reduce risks. However, it was also noted that their implementation in the EOSC may not be straightforward because it does not provide enough information to establish cost-based accounting.

Appendix 4 – Questions for INFRAEOSC science cluster and 07 project providers on EOSC onboarded services sustainability

Q1: When was this service onboarded to EOSC?

A1: <date>

A2: not onboarded yet, will do so soon in 2024

A3: not onboarded and no plans to onboard any time soon

Q2: If this service is not yet onboarded, why not?

A1: users prefer to access it through our cluster/RI portal

A2: we have been too busy working on other, more pressing, things

A3: we fear onboarding could weaken user awareness of who is the actual provider of the service

Q3: Please indicate the extent to which this service meets the following EOS Providers/Service Catalog registration requirements:

3.1 The service is accessible by users outside its original community.

A1: yes

A2: no

3.2 The service is described through a common template focused on value proposition and functional capabilities

- yes
- So-so
- minimally

3.3 At least one service instance is running in a production environment available to the user community.

- yes
- working on it
- planned

3.4 This service is FAIR and meets the EOSC Interoperability Framework specifications.

- yes
- so-so
- minimally

3.5 Release notes and sufficient documentation are available for the service

- yes
- so-so
- minimally

3.6 Helpdesk channels are available for support, bug reporting and requirements gathering.

- yes
- so-so
- minimally

Q4: How many daily active users/unique users does this service have per month (estimate)?

A1: # per month
A2: don't know

Q5: What is your target number of unique users per month of this service in 2024? 2025?

A1: < 1000
A2: > 1000
A3: > 10,000
A4: > 50,000

Q6: How is this service currently supported/funded?

A1: via EU EOOSC/H2020 projects
A2: through EU Member States' national RO/RI funding programs

Q6.1 how many/which Member States supported the service financially in 2023?

Q6.2 how many expected in 2024? 2025?

A3: no clear/specific funding for this service – supported from misc. RI membership fees and/or RI budgets

Q7: How much does this service cost to run annually (estimated total staff, organizational, equipment, maintenance, development, customer service costs) ?

A1: estimated € figure in 2022, 2023
A2: don't know

Q8: How much fresh funding do you estimate is needed to ensure uninterrupted operation of this specific service in 2024, 2025?

A1: € estimated amount
A2: don't know

Q9: Where do you expect these fresh funds to come from? Please rank.

- EU programs/projects
- Member States national S&T programs
- Joint projects with the private sector and/or universities
- Licensing, pay per use, consultancy fees
- Other (crowd funding, citizen science...)