EOSC Future

D2.4b
Project Strategy Plan

D2.4b / Project Strategy Plan

Led by Technopolis Group Belgium (TGB)

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Abstract

This is the second updated version of the project strategy plan for the EOSC Future project. The plan provides a strategic direction for the continuation of project activities and alignment with key external stakeholders in the EOSC ecosystem towards the end of the project and beyond. The plan reflects on lessons learned from the implementation of the project, proposes eight key exploitable results of the project to strategically steer the creation and continuity of major project outcomes, and focuses on strategic alignment with key stakeholders in the EOSC ecosystem. The plan will serve as input for the remaining duration of the project and as strategic input for the next stage of EOSC implementation.

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Glossary

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

List of Abbreviations

Acronym	Definition
AAI	Authentication and Authorisation Infrastructure
AAP	Additional Activities Plan
API	Application Programming Interface
ATHENA	Athena Research Centre
CESSDA	Consortium of European Social Science Data Archives
CNRS	Centre National de la Recherche Scientifique [National Centre for Scientific Research]
CSC	CSC – IT Center for Science
CTO	Chief Technology Officer
DSBA	Data Space Business Alliance
DSSC	Data Spaces Support Centre
EC	European Commission
EGI	European Grid Infrastructure Foundation
EOSC	European Open Science Cloud
EOSC-A	EOSC Association
EOSC-SB	EOSC Steering Board
EPIP	EOSC Portal Infrastructure Proxy
ESCAPE	European Science Cluster of Astronomy and Particle Physics ESFRI Research Infrastructures
ESFRI	European Strategy Forum on Research Infrastructures
FAIR	Findable Accessible Interoperable Reusable
FZJ	Forschungszentrum Jülich [Jülich Research Centre]
GA	General Assembly
HPC	High-performance Computing
HTC	High-throughput Computing
IAM	Identity Access Management
IF	Interoperability Framework
IP	Intellectual Property
JNP	JNP Strategy and Management Consulting
KER	Key Exploitable Result
KH	Knowledge Hub
KPI	Key Performance Indicator
MS/AC	Member States and Associated Countries
OCRE	Open Clouds for Research Environments
PMB	Project Management Board
RDA	Research Data Alliance
SGA	Subgroup A on National Contributions to EOSC

SIMPL	Smart Middleware
SOB	Strategy and Oversight Board
TCB	Technical Coordination Board
TGB	Technopolis Group Belgium
UGent	Ghent University
WP	Work Package

1 Executive Summary

The EOSC Future project responds to the INFRAEOSC-03-2020 call to provide integration and consolidation of the existing pan-European access mechanism to public research infrastructures and commercial services through the European Open Science Cloud (EOSC). The project is building an operational EOSC platform that provides access to research products, services, and infrastructures integrated into EOSC to researchers across Europe. The EOSC Future project builds on results from previous EOSC-related projects (such as the existing EOSC Portal) and is further designing and implementing new EOSC architecture and integrating data and services from non-commercial and commercial service providers. The project is being implemented by a large and diverse consortium of almost 100 stakeholders from the EOSC ecosystem, including e-infrastructures, research infrastructures, science cluster communities and their related research infrastructures, and organisations with experience and expertise in EOSC and Open Science. The project is working closely with EOSC-related projects (such as the INFRAEOSC-07-2020 projects) to offer via the EOSC platform state-of-the-art research resources across domains from national, regional, and institutional infrastructures in Europe.

EOSC Future is a large and complex technological project with a diversity of partners from e-infrastructures, research infrastructures, science clusters, and the EOSC community. This size and complexity were necessary to build on and integrate relevant outputs from EOSC projects, break down the silos of different stakeholders with different cultures, and incorporate the diverse expertise and viewpoints from the EOSC community to deliver an operational EOSC platform that is tailored to the needs of resource providers and users. The first project strategy plan provided an initial strategic direction to guide the technical implementation of the project and coordinate and align activities within the project and with key external stakeholders. The project has shown that a system-of-systems approach works successfully and is on track to realise the three strategic tenets of the first project strategy plan: (1) EOSC-Core and EOSC-Exchange are operational and will be further developed to deliver an EOSC platform with interoperable and composable resources (2) many resources have been onboarded from the science cluster communities into the EOSC platform and this will continue until the project ends (3) there has been direct involvement of users in the co-design and implementation of the EOSC platform through focus groups, community events, and strategic alignment with key EOSC stakeholders.

This second updated version of the project strategy plan provides a strategic direction for the continuation of project activities and alignment with external stakeholders in the EOSC ecosystem towards the end of the project and beyond. The plan reflects on lessons learned from the implementation of the project, including challenges experienced in developing the EOSC platform, managing a large and diverse consortium, identifying joint intellectual property rights, and defining KPIs to monitor integration and uptake of resources in the EOSC platform. The plan also proposes eight key exploitable results to strategically steer the creation and continuity of major project outcomes, focusing on main components of the EOSC platform, ten dedicated science cluster projects, commercially procured services, support activities for EOSC, and the stakeholder community created by the project. The plan lastly focuses on strategic alignment with key stakeholders in the EOSC ecosystem, including the EOSC Association, EOSC Steering Board of Member States and Associated Countries, EuroHPC, relevant EOSC projects, European Data Spaces, industry, and the global research community. The plan will not only serve as vital input for the remaining duration of the project but will also serve as strategic input for the next stage of the implementation of EOSC beyond the project.

One of the successes of the EOSC Future project has been the breaking down of the silos of different communities and bringing together diverse stakeholders in the EOSC ecosystem, including e-infrastructures, research infrastructures, science cluster communities, and the research community. This has resulted in better collaboration and mutual understanding of the needs of these stakeholders and consensus agreement on the development of the EOSC platform and integration of resources into the EOSC platform. A major risk for the future of EOSC is that these stakeholders will again go their separate ways, losing the synergy of working together after the project ends. Continuous collaboration among these stakeholders should thus be a priority both for these stakeholders and for future funding calls to develop and operate EOSC under Horizon Europe.

2   Introduction

The EOSC Future project [1] responds to the INFRAEOSC-03-2020 call [2] to provide integration and consolidation of the existing pan-European access mechanism to public research infrastructures and commercial services through the European Open Science Cloud (EOSC) [3]. The project is building an operational EOSC platform that provides access to research products, services, and infrastructures integrated into EOSC to researchers across Europe by using results from previous EOSC-related projects (such as the existing EOSC Portal [4]), designing and implementing new EOSC architecture, and integrating data and services from non-commercial and commercial service providers. The project is being implemented by a large and diverse consortium of almost 100 stakeholders from the EOSC ecosystem, including e-infrastructures, research infrastructures, science cluster communities and their related research infrastructures, and organisations with experience and expertise in EOSC and Open Science. The project is working closely with EOSC-related projects (such as the INFRAEOSC-07-2020 [5] projects) to offer via the EOSC platform state-of-the-art research resources across domains from national, regional, and institutional infrastructures in Europe.

This report is an updated version of deliverable **D2.4a - Project Strategy Plan** for EOSC Future [6]. The first plan provided an initial strategic direction to guide the technical implementation of the project and coordinate and align activities both within the project and with key external stakeholders in the EOSC ecosystem. This initial strategic direction consisted of three key tenets: (1) realisation of the EOSC-Core and EOSC-Exchange to create an EOSC platform with interoperable resources (2) integration of resources from the science cluster communities into the EOSC platform (3) direct involvement of users in the co-design and implementation of the EOSC platform. The first report specifically presented the vision and mission of the consortium, strategic objectives and governance of the project, high-level architecture with main components and functionalities of the EOSC platform, research resources to be offered via the EOSC platform, and plans for user engagement. The project is now entering its closing phase and an update of the strategy plan is needed for future guidance.

This revised plan provides a strategic direction to focus the continuation of project activities coordinating and aligning with key external stakeholders in the EOSC ecosystem towards the end of the project and beyond. The plan first reflects (in §3) on lessons learned from implementation of this complex technological project. This includes challenges with developing the EOSC platform, managing a large and diverse consortium, identifying joint intellectual property (IP) rights, and defining key performance indicators (KPIs) to monitor integration and uptake of resources in the EOSC platform. The plan secondly (in §4) addresses Key Exploitable Results (KERs) of the project to strategically steer the creation and continuity of major project outcomes. This includes main components of the EOSC platform, science cluster projects, commercially procured services, support activities for EOSC, and the stakeholder community created by the project. The plan lastly (in §5) focuses on strategic alignment with key stakeholders in the EOSC ecosystem. This includes EOSC Association (EOSC-A) [7], EOSC Steering Board (EOSC-SB) of Member States/Associated Countries (MS/AC) [8], EuroHPC [9], relevant EOSC projects, common European Data Spaces [10], industry, and global research community.

The strategy plan essentially looks at the challenges and achievements of the project thus far and builds on the lessons learned to prepare for the closing of the project and continuation of key project outcomes. The innovation and exploitation potential as well as the future sustainability of the KERs will be further developed in deliverable **D1.5 - Compendium of EOSC Opportunities and Challenges** for EOSC Future. The public EOSC procurement in 2023 [11] will play a major role in taking over, maintaining, and developing the EOSC platform. This includes components of the EOSC-Core and EOSC-Exchange as well as the EOSC Interoperability Framework (IF) and value-added horizontal services to enable research across the whole research data cycle.

This strategy plan has been jointly developed in collaboration with the KER Champions, members of the Strategy and Oversight Board (SOB), and members of the Project Management Board (PMB) of EOSC Future. The plan closes (in §6) with brief conclusions and recommendations for the future of the EOSC platform.

3 Lessons Learned

The project has encountered several challenges in terms of coordinating and managing a complex research and innovation project and an extensive consortium of diverse partners within a limited project duration. Noteworthy lessons learned experienced by the project relate to the identification of joint IP rights of project results and the definition of KPIs to monitor the integration and uptake of resources in the EOSC platform. The lessons learned in the project will feed into and support the next stages of the implementation of EOSC.

3.1 Challenges

The EOSC Future project has brought together a consortium consisting of partners from e-infrastructures, research infrastructures, and the EOSC community to deliver an operational EOSC platform, bring in content, and connect with stakeholders (especially research communities). The project has encountered several challenges which offer valuable lessons learned for the next phase of EOSC and future EOSC-related projects:

- *System of systems*: The project has adopted the viewpoint that EOSC should be a system of systems rather than a singular centralised access point for research-enabling resources. The implementation of such a system of systems requires the interoperation of many different systems, some of which are complex and mature, while others still in an initial implementation phase. Creating an open and homogenous EOSC platform that guarantees the interoperability between a variety of systems managed by different stakeholders is much more complex than developing a centralised system;

- *Breaking down silos*: Multiple silos exist in the EOSC ecosystem. Many EOSC projects under Horizon 2020 were typically not coordinated and worked with their own views and implementations of EOSC. The e-infrastructures with a technology-driven approach and horizontal services have worked independently from the disciplinary/regional research infrastructures with a content-driven approach and thematic/regional resources and research communities. The project has brought together many organisations from EOSC projects to reach a common understanding and build on existing outputs. The project has brought together e-infrastructures and science clusters, making e-infrastructures more aware of the needs of researchers and making clusters more aware of sharing and combining resources and using aggregators for collective bargaining with (commercial) service providers.

- *Community consensus*: The definition of EOSC interfaces, application programming interfaces (APIs), and protocols to interconnect e-infrastructures and research infrastructures requires collaboration across research communities to achieve consensus. A different approach would lead to a lack of participation that, as a consequence, would cause the failure of the EOSC vision to create a unique integrated environment where researchers in Europe can work together and share data and services;

- *Integration balance*: Defining the type of integration of resources into EOSC is not simple. On the one hand, the integration model should be flexible and take into account the diverse requirements of resource providers. On the other hand, the model should maximise standardisation across infrastructures. The model should clearly identify the right balance between the level of integration with EOSC and complexity to integrate a resource into EOSC as well as define different levels of integration to allow providers to choose what best fits their own cost-benefit analysis;

- *Value proposition*: Clear messages should be developed to communicate the EOSC value proposition to data and service providers and to users. Otherwise, providers will not integrate their resources into EOSC and a lack of interest in EOSC from the research community will hinder the creation of the EOSC collaboration environment where researchers can collaborate on cross-disciplinary research;

- *Managing expectations*: The short-term and long-term expectations for both EOSC Future and EOSC need to be set clearly. The project is a research and innovation action with the goal of realising an operational EOSC platform, onboarding data and services from providers, and engaging users. The goal is not to make EOSC the platform of choice of researchers in Europe within the duration of the project: it typically takes years for digital platforms to mature and become leading. The goal is also not to centralise all data and services in one place: EOSC is a federated infrastructure which makes use of existing infrastructures and provides the architecture and tools to connect them. Convincing providers and users to adopt EOSC is a long-term commitment that goes far beyond the project.

3.2 Consortium

EOSC Future is a €41 million project consisting of a consortium of over 90 partners which builds on previous and current EOSC-related projects to develop and implement the EOSC platform. The size and scope of the project and consortium placed a heavy burden on the overall coordination and management of the project:

- *Governance*: An intricate governance structure was set up consisting of a General Assembly (GA) of all project partners, an SOB of key partners for strategically coordinating the project and aligning with external stakeholders, a PMB of work package (WP) leaders for project implementation, and a Technical Coordination Board (TCB) of experts for technical implementation of the EOSC platform;
- *Communication*: The consortium and governance bodies of the project were only able to meet virtually in the first year as a result of COVID-19. This hampered the cohesion of the consortium, which consisted of a wide range of organisations and cultures with different viewpoints on EOSC. In the first year, regular virtual meetings of the consortium and governance bodies were held, including cross-over meetings (such as joint SOB-PMB and WP- science cluster meetings). During the second year, face-to-face meetings of the consortium and governance bodies were held, immediately improving communications and joint understanding, and showing booster effects. Dedicated meetings are now held internally on technical, training, and engagement activities as well as externally with the EOSC community via focus groups, webinars, and the annual EOSC Symposium;
- *Dependencies*: There have been capacity issues at the start of the project due to delays in other infrastructure projects, whereby needed technical and specialised expertise has not been available. The extension of the Open Clouds for Research Environments (OCRE) project [12] resulted in procurement activities in the project starting later than planned. Alignment activities with EOSC-A, EOSC-SB, Gaia-X, and Data Spaces have been dependent on the priorities and timelines of these stakeholders. Good communication and flexibility have been crucial to adapt to these dependencies;
- *Management*: In response to recommendations from the European Commission (EC) and the project reviewers, the technical roadmap was further extended into actionable roadmaps for all activities, with a detailed breakdown of planned activities, implementation timeline, and responsibilities of partners. This roadmap has been implemented via Jira for monitoring and management of the project and regular updates on project progress are now shared with the EC and project reviewers.

3.3 Joint IPR

The identification of relevant IP rights and their ownership on exploitable results from the project is a complicated, detailed, and time-consuming task and is an ongoing activity within the EOSC Future project:

- *Background IP*: Some background IP results were already identified and protected as part of the Consortium Agreement, but it is possible that additional background IP will need to be identified and recorded before the end of the project to enable the further exploitation of the eight project KERs;
- *Foreground IP*: There is foreground IP being generated from the significant amount of ongoing work to deliver the project results. In many cases, the foreground IP is jointly owned by several consortium partners and its exploitation will entail agreements to be developed between the involved parties. For many of the KERs, forms of protection for foreground IP are still in the process of being determined;
- *Third party and sideground IP*: Some third party IP is being used in the project and some sideground IP may be identified as a result of the ongoing definition of specific project results linked to the KERs.

IP rights are important in their own right but need to be considered within the broader context of the project. IP is a means to an end and not an end unto itself: IP should be defined within the overall narrative of the exploitation of project results and should include considerations of future sustainability after the project. This is especially important given that the EOSC procurement in 2023 should take over the operation of the EOSC platform after the project ends. The exact nature of the procurement will affect the future exploitation plans of the KERs and will be highly relevant for the sustainability of the EOSC-Core, EOSC-Exchange, and EOSC IF.

3.4 Setting KPIs

An initial set of KPIs to monitor the integration and uptake of resources in the EOSC platform was proposed at the start of the project. This KPI framework included indicators on integration with EOSC-Core services by the

European Strategy Forum on Research Infrastructures (ESFRI) [13], resource providers and resources in EOSC-Exchange, connecting major thematic/regional catalogues to EOSC-Exchange, engagement of users with EOSC-Exchange, and EOSC uptake. It was difficult, however, to initially predict what could be achieved. Experience in operating the EOSC-Core and EOSC-Exchange as well as interacting with service providers made it easier to define the KPIs and targets for the KPIs. The KPI framework was thus extended to include a subindicator on EOSC-Exchange services registered in the catalogue and integrated with EOSC-Core, further definition of the indicator on EOSC uptake to provide number of accesses to EOSC resources, and quantifiable targets for the KPIs across the project duration ending in the final month (Month 30) as in Table 3-1.

Table 3-1: EOSC Future Key Performance Indicators for Integration and Uptake of Resources in the EOSC Platform

KPI #	KPI Description	Target at Month 30
KPI #1	Integration with EOSC-Core Services by ESFRI	30
KPI #1a	Percentage of EOSC-Exchange Services Registered in the Catalogue Integrated with at least 1 EOSC-Core Service	75%
KPI #2	Resource providers/resources in EOSC-Exchange	250/500
KPI #3	Connecting Major Thematic/Regional Catalogues to EOSC-Exchange	7
KPI #4	Engagement with EOSC-Exchange by Unique Monthly Visitors	3000
KPI #5	EOSC Uptake in Number of Accesses to EOSC Resources over Six Months	1000

This extended KPI framework allows the project to measure the success of exploitation activities towards the science clusters and thematic/regional research communities that are involved in EOSC and at the same time helps the identification of challenges that may hinder the uptake of EOSC by resource providers and users.

4   Key Exploitable Results

The project has identified 8 KERs [14] to strategically steer the creation and continuity of key project outcomes: EOSC-Core (KER # 1), EOSC-Exchange (KER # 2), science projects (KER # 3), EOSC Observatory (KER # 4), EOSC IF (KER # 5), EOSC Knowledge Hub (KH) (KER # 6), commercially procured services and industry support to engage with EOSC (KER # 7), and stakeholder and community relations created by the project (KER # 8). Each of the KERs is strategically managed and promoted externally by two KER Champions who are closely involved in the development of their respective KERs in the project. The status of the KERs is described below with regard to current achievements, relevant lessons learned, innovation management, community engagement activities, next steps towards the end of the project, and continuity after the project.

4.1   EOSC-Core

The EOSC-Core provides a set of internal services which allows the EOSC platform to operate and enables science communities to find resources for research and make their own resources available to other science communities at a central location. The EOSC-Core includes a core technical platform with a wide set of capabilities to deliver core functions of the EOSC platform, which were initially proposed by the EOSC Executive Board [15] and further developed in EOSC Future, including the Authentication and Authorisation Infrastructure (AAI) and an AAI registry supporting the EOSC AAI Federation, accounting, configuration management system, helpdesk, marketplace, monitoring, and resource catalogues. The EOSC-Core also includes non-technical coordination functions to operate and facilitate the core technical platform, including onboarding, order management, procurement activities, rules of participation, security coordination, and service management. These components make it easier for providers to integrate and interoperate their resources with the EOSC platform and improve user experience for researchers and research communities.

Achievements: The project has taken a variety of stand-alone components (such as for accounting, helpdesk, and monitoring) and integrated them into a functional EOSC platform. The project has also defined the main capabilities of the EOSC-Core and provided recommendations for the EOSC procurement in 2023 [16]. Following the availability of the EOSC-Core, the project has pursued an active service integration strategy, especially with the science clusters, which have been onboarding their resources into the EOSC-Exchange.

Lessons learned: Integration and consensus building is a complex and time-consuming process and as a result much time has been dedicated to ensuring that all stakeholder input has been gathered and incorporated. Experience has also shown that it is better to adopt regular releases rather than only a few major releases. The project has thus adopted a more frequent release schedule every 1.5 months for the duration of the project.

Innovation: The project is innovating by integrating and evolving a series of already existing services into a single EOSC platform that guarantees their coordinated behaviour and a uniform user experience. The platform delivers a single catalogue for a homogeneous and seamless offering of research resources and enables the interoperability and interworking of resources coming from different research communities. Resources from the catalogue are exposed to end-users via the EOSC Portal and thematic/regional portals. Some background IP rights exist for individual components which are being integrated into the EOSC-Core. No specific IP rights are being generated as a result of these integration activities, although some IP rights are being generated as a result of the development of specific components for the EOSC-Core in the project.

Engagement: The EOSC-Core has been presented at many projects, EOSC and research community events, and several articles and blog posts have been published explaining the work on EOSC-Core. Project members involved in developing EOSC-Core also participate in other EOSC-related projects and in the EOSC-A task forces to ensure alignment and that the wider EOSC community is informed and consulted about EOSC-Core.

Next steps: The project will continue to integrate and deploy new services via EOSC-Core as well enhance the functionalities of services that are already in production and integrated in EOSC-Core. Continued community engagement and community feedback gathering is critical for the success and uptake of the EOSC platform.

Continuity: A functioning and operational EOSC-Core will be delivered at the end of the project (whereby all components will then be minimally TRL 8). The EOSC-Core provides the technological backbone of the EOSC

platform and will need to be maintained after the end of the project. The EOSC procurement in 2023 will take over the operation of the EOSC-Core. Future funding for EOSC-Core will be required after the procurement.

4.2   EOSC-Exchange

The EOSC-Exchange offers a wide range of services for storing, exploiting, and preserving research data that is Findable, Accessible, Interoperable and Reusable (FAIR) and encouraging the reuse of this research data. The EOSC-Exchange is being created by onboarding thematic, regional, and horizontal research resources from e-infrastructures, research infrastructures, science clusters, EOSC-relevant projects, and commercial service providers to create a marketplace serving the needs of research communities as well as to the private sector and general public. The EOSC-Exchange adds significant user value to EOSC by providing a catalogue and marketplace so that resources can be advertised to a wider range of users and by supporting science cluster communities to expose and share their research resources for wider exploitation and research collaboration.

Achievements: The EOSC-Exchange has onboarded over 235 resource providers and over 350 research resources, with the majority of resources currently coming from the science clusters and e-infrastructures as well as other research infrastructures and the private sector. The first procurements for horizontal resources (for computing, storage, and networking) are being realised by the INFRAEOSC-07 projects. The project is also defining key functions and inclusion criteria for resources in the EOSC-Exchange as well as procedures to onboard resources via the EOSC Providers Portal [17] into the EOSC Catalogue and EOSC Marketplace [18].

Lessons learned: The project has learned through practice how the EOSC-Exchange fits into the evolving EOSC platform and the manner of interaction and dependencies of EOSC-Exchange with the other KERs. The activity of describing the EOSC-Exchange within the context of the KERs has helped the project to be in a better position to market the EOSC-Exchange to the research community and develop future sustainability. The quality of each resource in the EOSC-Exchange needs to be assured by the originator and inclusion of a resource into EOSC-Exchange involves checking the ownership and rights of the provider. Resources that are deemed to be of low quality or are not being used should be identified and removed from EOSC-Exchange.

Innovation: The resources onboarded into EOSC-Exchange come from many different resource providers. The EOSC-Exchange is innovating by facilitating this integration and providing discovery and easy access to available resources. This includes connecting and integrating resources from e-infrastructures and research infrastructures, which need to adjust and align their processes for collaboration. The EOSC-Exchange also facilitates composability: the opportunity to combine existing resources for new scientific discoveries and include the results in the EOSC platform. The IP rights of resources will remain with the resource providers.

Engagement: The EOSC-Exchange has been presented at relevant scientific and computing conferences, has been communicated via the science clusters, and has been presented at the annual EOSC Symposium. The EOSC-Exchange needs to be explained to scientific communities to encourage uptake. The EOSC-Exchange should be presented as a resource to be exploited by researchers and research communities to avoid redeveloping existing solutions and as a mechanism to share software and services that have been developed.

Next steps: The project will analyse and clarify the most workable way to expose resources listed in the catalogues being onboarded to the EOSC platform and address ways to make them findable. The project will also propose mechanisms for users for seamless access to resources and account for usage of the resources. Appropriate support mechanisms and long-term funding will hereby need to be identified for the use of these resources. The project will further investigate how best to integrate onboarded services to EOSC-Exchange with EOSC-Core and ensure that resources exposed through the EOSC platform meet the needs of the users.

Continuity: A catalogue and marketplace of EOSC resources is already operational and will be further developed, expanded, and made accessible to research communities, researchers, and citizen scientists by the end of the project (whereby the catalogue will then be TRL 9). The sustainability of EOSC-Exchange is dependent on user demand being proven in the future. Resources from the INFRAEOSC-07 projects, science clusters, and other research infrastructures will be made available for use via the EOSC-Exchange. Demand for these resources is expected to be high although it is not yet clear how the future use of these resources will be financed. The EOSC procurement in 2023 will take over operation of key components of the EOSC-Exchange.

4.3   Science Projects

The EOSC Future science projects implement interdisciplinary use cases which develop and utilise EOSC resources to improve cross-disciplinary research and collaboration. The science projects break down the barriers between research communities and between e-infrastructures and research infrastructures, invest in the 'trading zones' between the science clusters, and show how EOSC can be used to create knowledge from the interoperability and interworking of resources across research communities. The ten science projects demonstrate how data, services, and other kinds of research resources can be used by different research communities as well as to test the same hypotheses and compare results by using and combining resources. The science project results will show the value of integration and composability of resources for research provided by EOSC and the value of EOSC to researchers for the future of big data research and Open Science.

Achievements: The onboarding of research resources (especially data and services) from the science cluster communities into the EOSC-Exchange has been developed and is operational. Over 200 resources have already been onboarded from the science clusters and are being structurally integrated where appropriate with the EOSC-Core services. The science projects focus on a range of thematic and cross-disciplinary topics. Some projects focus on the creation of a monitoring dashboard, such as on the state of the environment, climate change, COVID-19, and climate-neutral and smart cities. Other projects focus on the integration and collaborative use of resources, such as on dark matter, gravitational waves, tracing biostructures, and dynamics of biological processes. Yet other projects focus on access management for distributed research infrastructures and opening up resources for new audiences and facilitating their use. The more mature science projects are already demonstrating potential in the form of workflows and cross-domain research.

Lessons learned: The collaboration of the science clusters and e-infrastructures has built on the initial stages of EOSC implementation where both were working in isolation and creating their own environments independently from each other. The science projects developed as a natural next step to bring more synchronisation, harmonisation, and integration into EOSC and ensure that the EOSC platform is developed to address the needs of all types of users, including researchers, policymakers, and citizen scientists. An important lesson learned from the science projects is that linguistic and cultural differences (especially regarding terminologies) can obstruct the development of multi-disciplinary and cross-domain research. Another important lesson learned is that the science clusters and their research infrastructures have much in common and can not only learn from each other but that there are many potential synergies for collaboration.

Innovation: The project is innovating by bringing different science cluster communities together and revealing their collaborative cross-disciplinary interfaces within the framework of the EOSC platform. The increasing challenges on major societal issues (such as with health, environment, and climate change) no longer allow individual disciplinary approaches but rather demand cross-disciplinary collaboration and thus the reusability, integration, and composability of resources across disciplines. The science projects will develop 'trading zones' between disciplines to seamlessly integrate and compose resources across the different disciplines. The projects will build on existing resources and the resulting outputs will be reusable via open and free licences.

Engagement: Each science project has developed an engagement and dissemination plan to engage with the research and EOSC community and maximise the impact of results coming from the science projects. The science projects have been presented at several project and cluster events and the annual EOSC Symposium. The collaborative 'trading zones' will provide after the project a solid basis for the design and implementation of new cross-disciplinary projects, which will in turn enhance the exploitation and uptake of project results.

Next steps: The science projects will continue with the onboarding and integration of resources into the EOSC platform and developing 'trading zones' and workflows for collaborative cross-disciplinary research. A service integration roadmap will monitor the integration of resources prioritised by the needs of the science projects. The science projects will further develop showcases to demonstrate how the projects will use EOSC-Core and horizontal services in EOSC-Exchange across the full research lifecycle from data collection to publication.

Continuity: The science projects will deliver operational pipelines of resources that are integrated with core services in EOSC-Core and horizontal services in EOSC-Exchange at the end of the project (which will then be TRL 9). The 'trading zones' between the science cluster communities and e-infrastructures should be further

developed after the project and will serve as fertile areas for the creation of new cross-disciplinary projects. Future steps could include the collaboration of the science projects and EOSC platform with other major initiatives addressing major societal challenges, such as the initiatives for Destination Earth and Green Deal. Activities in the science projects will be continued after the project via a dedicated Horizon Europe Research and Innovation Action to extend the cross-domain collaboration and EOSC alignment in the science clusters.

4.4 EOSC Observatory

The EOSC Observatory [19] is a policy intelligence tool to monitor the implementation and uptake of EOSC across Europe. The observatory collects and displays validated data from MS/AC in the EOSC-SB on policies, practices, and impacts that are related to EOSC and focus on the thematic categories of publications, data, software, services, infrastructure, skills/training, assessment, and engagement. The observatory may in the future collect and present data from EOSC-A which is relevant for the EOSC Partnership [20]. One of the aims of the observatory is in fact to align the timing and content of annual surveys for EOSC-SB and EOSC-A.

Achievements: The dashboard of the observatory is fully operational and in production (which is now TRL 8). The observatory team has supported EOSC-SB to develop the first EOSC-SB survey on National Contributions to EOSC 2021 [21] and run the survey in the observatory. The survey data has been collected and validated by 34 countries [22] and is now publicly available in the observatory. An analysis of the data has also been conducted [23]. The observatory team has further supported EOSC-SB to develop a new Monitoring Framework for National Contributions to EOSC [24], an EOSC Catalogue of Best Practices [25], and a new revised survey for National Contributions to EOSC 2022 [26] which has also been published in the observatory. An EOSC Observatory community has lastly been created on Zenodo to share relevant documentation [27].

Lessons learned: The observatory team experienced issues with linking the observatory log-in to the EOSC Portal Infrastructure Proxy (EPIP) and setting up the Acceptable Use Policy, which were resolved in collaboration with the relevant EPIP colleagues in EOSC Future. The observatory team also experienced issues with the Data Privacy Policy for publishing and collecting data from the EOSC-SB surveys on National Contributions to EOSC, which were resolved in collaboration with EC and EOSC-SB. The observatory team has moreover adapted to many support requests from EOSC-SB, including adjusting planned timelines, tailoring functionalities, setting up an Operational Agreement, and detailing exploitation and sustainability plans.

Innovation: The observatory offers an innovative dashboard to monitor the implementation and uptake of EOSC in Europe as well as national data that is validated by MS/AC. There are multiple components of the observatory (including the dashboard tool, monitoring framework, surveys and collected data, and documentation) that are now being discussed within innovation and exploitation management of the KERs.

Engagement: The observatory has already been widely promoted at multiple EOSC events, including National Policies Relevant for EOSC Deployment [28], EOSC Future Open Days [29], and EOSC Symposium 2022 [30]. An introductory video [31] and explanatory article [32] on the observatory has also been published. The observatory is mainly aimed at EC, EOSC-SB, and EOSC-A as well as policymakers at national and institutional levels to monitor the implementation and uptake of EOSC. The members of EOSC-SB will be continuously engaged to run and collect data for the annual surveys and to further develop the survey tool and visualisation of collected data. EOSC-A and other stakeholders will also be engaged in future to develop the observatory.

Next steps: More advanced functionalities for the observatory will be developed during the project, including new data visualisation, data comparison, and data download options. The second EOSC-SB survey on National Contributions to EOSC 2022 has been published in the observatory, whereby the data will be collected, validated, and openly published in the observatory as well as the publication of a report on the survey results during the project. The observatory team is also planning to integrate a data set from EOSC-A and publish the third EOSC-SB survey on National Contributions to EOSC 2023 before the end of the project. The EOSC Tripartite Governance [33] has agreed to utilise the observatory as the tool to support the joint monitoring capacity for EOSC and the observatory will provide data to the ERA Monitoring Mechanism [34].

Continuity: The Monitoring Framework for National Contributions to EOSC for EOSC-SB, observatory platform (including the front-end, back-end, and statistical tool), surveys and collected data on National Contributions to EOSC, and relevant documentation for the observatory will be delivered at the end of the project (whereby the

observatory platform will then be TRL 9). The observatory is the chosen tool to collect and present data for the joint monitoring capacity for the EOSC Tripartite Governance, including collecting and publishing data for the EOSC-SB surveys on National Contributions to EOSC as well as providing data to the ERA Monitoring Mechanism for Action 1 on EOSC. The observatory will accordingly need to be maintained and developed in the long-term. The continuity and maintenance of the observatory is guaranteed for the next three years after the end of the project by a dedicated Horizon Europe Coordination and Support Action.

4.5   EOSC Interoperability Framework

The EOSC IF is composed of a set of guidelines which promote standards and community best practices on the technical interoperability of services and semantic interoperability of data within EOSC. This interoperability is essential, given that EOSC is a system-of-systems infrastructure, to deliver services to users and enable the sharing and composability of resources within and across research disciplines. The EOSC IF facilitates the interoperability capabilities of EOSC-Core services and EOSC-Exchange resources across the boundaries of e-infrastructures and research infrastructures. The EOSC IF is supported by a registry consisting of a collection of onboarding guidelines to which resources can refer so as to specify their interoperability features. The registry can be flexibly used to host metadata relating to guidelines and reference which resources comply with them, and as such is the first attempt to establish a bottom-up framework to describe (and exploit for discovery and composability purposes) resource interoperability capabilities across different domains. The EOSC IF is also supported by a governance structure that will manage the set of interoperability guidelines.

Achievements: The EOSC IF registry contains interoperability guidelines for EOSC-Core components, EOSC AAI Federation and EOSC Infrastructure Proxy, accounting for research products, accounting for services, data source profiles, helpdesk, monitoring, order management, provider profiles, resource profiles, and security baseline. Other areas of interest have also been identified, including for High-throughput Computing (HTC)-High-performance Computing (HPC) compute, identifiers, machine learning, metadata and ontologies, and resource description framework. The EOSC IF governance has been launched and consists of the EOSC Interoperability Advisory Board and EOSC Interoperability Area Chairs, for which charters have been drafted.

Lessons learned: Research communities already have well-established technical solutions for interoperability and composability of services (including workflow languages and virtual research environments) and build their scientific workflows on these solutions at European and global levels. This connects with the system-of-systems approach adopted by the project and ensures the usability of the EOSC IF. A top-down approach where EOSC unilaterally imposes standards upon research communities would simply not have been viable.

Innovation: The EOSC IF uses a registry to support and facilitate the search of EOSC IF guidelines. The metadata used to describe the EOSC IF guidelines (as properties in a database) is based on DataCite [35]. The registry is being developed as a database table inside the component for resource providers. The EOSC IF governance is based on similar governance structures being used in the research and education community. The IP rights related to the EOSC IF will be discussed as part of the innovation and exploitation of the KERs.

Engagement: The EOSC IF has been shared with the EOSC community via a public consultation and has been communicated at several events, including national EOSC events, EOSC Future Provider Days, and EOSC Symposium. There has been a joint call between EOSC Future and the Research Data Alliance (RDA) [36] for EOSC IF contributions as well as a webinar to explain the EOSC IF and call. It is important to engage the EOSC community to explain the EOSC IF and how it builds on existing IFs already in use by research communities.

Next steps: The EOSC IF registry is being tested and will go into production before the end of the project to ensure modelling of EOSC IF guidelines for the EOSC-Core and EOSC-Exchange. The EOSC IF will also be updated to include information and tools that are required to enable forms of machine-driven composability.

Continuity: The EOSC IF registry for EOSC-Core services (which will be TRL 9), registry for composability by compatibility (which will be TRL 8), registry for machine-enabled composability (which will be TRL 7), registry for horizontal services (which will be TRL 8), and governance structure will be delivered at the end of the project. The EOSC procurement in 2023 will maintain the EOSC IF in the short term after the project ends.

4.6   EOSC Knowledge Hub

The EOSC KH is an interactive platform to deliver a curated catalogue of training resources and a state-of-the-art Learning Management System (LMS), which is based on open-source software and will be seamlessly integrated with the EOSC Portal. The catalogue focuses on training resources for FAIR data, EOSC, and Open Science, which will be relevant for a wide range of stakeholders, including researchers, resource providers, policymakers, and training and support staff. The EOSC KH will create modularised openly licensed training resources that are tailored to different user groups. The EOSC KH will also include external (commercial) resources where applicable and effectively act as a hub for any relevant training resources related to EOSC.

Achievements: The specifications for the EOSC KH training catalogue and LMS have been described [37] and an analysis of the needs of user groups has been conducted. A metadata model for the training catalogue has been adopted, and the training catalogue has been incorporated into the EOSC Catalogue and EOSC Marketplace, whereby training resources are now available in the EOSC platform. Quality assurance criteria for the training resources and the rules of participation for resource providers have lastly been developed.

Lessons learned: The project decided to use existing off-the-shelf platforms and tools where applicable rather than developing new platforms and tools to save time and effort. The content component of the LMS is based on OpenPlato [38], which is itself in turn based on the popular open source community LMS Moodle [39].

Innovation: The EOSC KH is innovating by aiming to become the de facto platform for training resources related to EOSC by using commonly agreed metadata standards for sharing training resources. The existing platforms, tools, and resources that will be offered in the EOSC KH come from a variety of providers and the IP rights will remain with the original developers and providers. The IP rights of the training resources that are developed during the project lifetime will be discussed as part of the innovation and exploitation of the KERs.

Engagement: Engagement and continuous dialogue with existing and potential resource providers and users is critical for the uptake and success of the EOSC KH. The platform has already been promoted and discussed at various internal project meetings, cross-project meetings with the INFRAEOSC-07 projects, and the EOSC Future Open Days. The project has also engaged with existing training resource catalogue owners to understand the metadata standards being used by the community and adopt common metadata standards.

Next steps: The EOSC KH is being integrated into the EOSC AAI to support user log in and the onboarding process for providers and their resources will be further streamlined. More training resources are now being developed and included in the platform and a helpdesk for providers and users of the EOSC KH is being set up. The LMS is now being integrated into the EOSC Portal and will be made publicly available in the EOSC Portal.

Continuity: Key components of EOSC KH will need to be sustained after the project. This includes maintaining the catalogue of training resources (which will then be TRL 8) and LMS (which will then be TRL 8) as well as the hosting of the platform and integration with the EOSC AAI. This also includes managing the rules of participation for onboarding providers and resources into the EOSC KH and maintaining the helpdesk to support resource providers and users. This further includes the development of new training resources and the collection and curation of resources for the EOSC KH. Continuous awareness raising and engagement with the wider EOSC community will furthermore be needed to promote and increase the uptake of the EOSC KH.

4.7   Commercial Services and Support for EOSC

The project has committed to involving and supporting industry (especially SMEs) and integrating commercial services in EOSC to improve the exploitation of research products. The project is building on the work done in the OCRE project, which developed a procurement framework and agreements with research-relevant service providers to deliver commercial cloud services for storage, compute, and networking to researchers under favourable terms and conditions. The EOSC Digital Innovation Hub (DIH) [40] will serve as a contact point to engage SMEs and support them in offering services through EOSC, while the project will act as a contact point (through GÉANT) for large commercial providers. The end users of the EOSC platform will also be consulted to determine the services they need for their research and improve the commercial service offerings in EOSC.

Achievements: The EOSC service portfolio has been populated with services from commercial service providers from the OCRE procurement framework. The focus now is on how to make the OCRE framework widely

accessible to EOSC users and how to stimulate its uptake through adoption funding. The first adoption funding call will demonstrate a mechanism by which the portfolio of commercial services can be distributed through partnerships between OCRE suppliers and aggregators (such as e-infrastructures and research infrastructures). A second planned call will demonstrate the distribution of commercial and (paid-for) public sector resources through EOSC to researchers in different disciplines. A third planned call will demonstrate the use of pre-procured commercial platform services in the deployment of a horizontal 'container' service, allowing researchers to containerise their workloads in terms of high-performance compute capabilities and storage. Four pilot campaigns have further been launched to onboard DIH business pilots to use EOSC services. A survey is lastly being developed to identify gaps between services that have been procured in the framework and potential demand for other new services that could be included in future procurement calls.

Lessons learned: The EOSC-hub, EOSC Future, and OCRE projects have investigated options for financial mechanisms to support innovation activities through business pilots, including subcontracting, purchase of goods and services, and adding benefitting parties as beneficiaries to the projects, but none of these options has proven fit for purpose. The support to third parties and cascade funding option in EOSC Future could be a better way to stimulate uptake of innovative services and support SMEs in improving their service readiness.

Innovation: The project will develop innovative mechanisms to increase the reach of the OCRE framework and improve access to commercial cloud services by EOSC users. New channels to end users will be investigated, such as preprocuring commercial cloud services in bulk on behalf of aggregators, which will in turn distribute these services to their end users. Innovative services will also be onboarded from commercial service providers with support from the EOSC DIH and these services will be technically integrated into EOSC and made available to researchers via the EOSC platform. The IP rights of the mechanisms will be discussed as part of the innovation and exploitation of the KERs and the IP rights of services will remain with the service providers.

Engagement: Commercial services for research will add greatly to the service offer for researchers. It is thus essential to continue to make commercial service providers aware of the benefits of offering their services through EOSC and make users aware of the portfolio of commercial services available in the EOSC platform. Multiple outreach and networking activities have already been organised with the business community. SMEs and their services are now also being successfully onboarded into the EOSC DIH. The first adoption funding call has been widely advertised among service providers and future funding calls will be similarly advertised.

Next steps: The results of the first adoption funding call are clearly demonstrating the value of channelling commercial services through aggregators as an efficient and sustainable mechanism. The second and third adoption funding calls will demonstrate similar mechanisms based on actual researcher demand for resources and the availability of resources. An analysis of project procurement activities will unpack the sustainability of these mechanisms in terms of support for EOSC-related procurements downstream as well as funding models and right of access. Continuous support will lastly also be offered for business pilots through the EOSC DIH.

Continuity: A portfolio of existing agreements with commercial service providers and demonstrated mechanisms for channelling commercial services to end users will be delivered at the end of the project. A governance structure still needs to be created to set the conditions for selecting commercial services and determine whether a service meets the rules of participation for services in EOSC. The procurement of the next commercial cloud framework (a follow-up of OCRE Framework) will take place in the GÉANT-led GN5-1 project [41], which will ensure a continuous availability of commercial cloud services in EOSC. A sustainability plan will lastly be developed to continue support activities for industry by the EOSC DIH beyond the project.

4.8   EOSC Future Community

The project has identified engagement with the research and innovation community as a strategic priority to continuously gather feedback and develop the EOSC platform according to the needs of EOSC stakeholders. A diverse community of providers and users of EOSC resources has been created through many internal and external workshops, consultations, collaborations, focus groups, and community-building events. The project has also regularly engaged and aimed to align with key EOSC stakeholders, including EOSC-A, EOSC-SB, INFRAEOSC-07 projects, EuroHPC, Gaia-X, European Data Spaces, science clusters, other EOSC projects.

Achievements: A community engagement plan to interact with EOSC stakeholders and a specific engagement plan to liaise with EuroHPC were set up at the start of the project and are being implemented. A collaboration agreement has been signed with the INFRAEOSC-07 projects and is being implemented with a focus on common technical, uptake, and engagement activities. There is ongoing close collaboration with EOSC-A (such as involvement of two board directors as liaisons in key strategic activities and project liaisons in all the EOSC-A task forces) and EOSC-SB (such as in the development of the EOSC Observatory). There is also regular interaction with the INFRAEOSC-05 projects [42], stakeholders from the Western Balkans, and with the global research and innovation community via RDA. The project has lastly organised wide range of events including the annual EOSC Symposium (with over 300 participants) and has set up an EOSC Future User Group (consisting of over 300 users from a variety of stakeholder groups) to gather user requirements and feedback.

Lessons learned: The EOSC community is highly interested in the activities and results of the project. The consortium has learned that better community engagement results are achieved when the project organises joint activities with key EOSC stakeholders, especially with EOSC-A, EOSC-SB, and INFRAEOSC-07 projects. Regular engagement with the EOSC community about the EOSC platform should continue after the project.

Innovation: The engagement activities in the project do not directly produce IP rights or require innovation and exploitation management of the results. This will, however, be confirmed towards the end of the project.

Engagement: This KER deals exclusively with engagement activities and managing relations with the EOSC community. The project also communicates widely about project and community activities and results via regular newsletters and social media (including project and partner websites, Twitter, and LinkedIn accounts).

Next steps: The remaining months of the project will be dedicated to continuing close relations with key EOSC stakeholders, managing the user group, organising community events, and disseminating the project results.

Continuity: The community and stakeholder relations created by the project will be passed on after the project to key stakeholders, including EOSC-A, EOSC-SB, EOSC projects, and the EOSC procurement in 2023.

5 Strategic Alignment

One of the project cornerstones is the strategic alignment with key stakeholders in the EOSC ecosystem. The consortium has reached out from the very beginning to relevant stakeholders and in many cases set up regular meetings, co-organised events, and actively developed KERs of the project with these stakeholders. This includes EOSC-A, EOSC-SB, EuroHPC and the INFRAEOSC-07 projects, companies (and especially SMEs and commercial service providers), and the wider global research community. Strategic alignment with the EOSC community is critical not only for gathering feedback but also guaranteeing uptake of the project KERs.

5.1 EOSC Association

The consortium has reached out to EOSC-A from the beginning of the project to ensure strategic alignment and feedback on the development of the EOSC platform. Multiple contact points have been set up to allow regular interactions for bidirectional sharing of relevant information and documents between representatives of the project and EOSC-A. The project director holds periodic meetings with the president and secretary-general of EOSC-A, which typically cover specific topics based on current developments (such as advice from the project to the EC on the EOSC procurement in 2023). Two directors of the EOSC-A board are active members of the project and have been assigned as project liaisons with the board, whereby they provide updates and ensure alignment in both EOSC-A board meetings and in project SOB and WP meetings. The Chief Technology Officer (CTO) of EOSC-A has a standing invitation to TCB meetings to ensure alignment and feedback on the development of the EOSC platform. The project has moreover assigned liaisons in each of the EOSC-A task forces to provide updates and gather input from the community on developments in the project. The project is lastly advising EOSC-A on potential governance models for EOSC after the EOSC Partnership.

One key area of collaboration between the project and EOSC-A is the development of the KERs. This allows concrete alignment on specific key outcomes of the project and helps the consortium to understand the expectations and gather feedback from EOSC-A regarding the development and sustainability of the KERs. An initial series of meetings was first held between directors of the EOSC-A board and representatives from the project to frame the collaboration on the KERs. The project then coupled the two KER Champions for each KER with relevant representatives from EOSC-A to further discuss and develop each of the individual KERs. The work on the KERs is ongoing and will continue until the end of the project with a focus on sustainability.

Another key area of collaboration between the project and EOSC-A is the development and implementation of the EOSC Observatory. The observatory team reached out at the start of the project to EOSC-A and EOSC-SB to gather input on the scope and implementation of the observatory and to align monitoring activities on EOSC and Open Science by EOSC-A, EOSC-SB, and EOSC Future. Biweekly alignment group meetings between representatives of EOSC-A, EOSC-SB, and EOSC Future were set up early in the project and are ongoing. The alignment group agreed that the observatory should be used as a tool to collect and share monitoring data and support the alignment of annual monitoring surveys by EOSC-A and EOSC-SB. The focus so far has been on developing the tool, running the surveys on National Contributions to EOSC for EOSC-SB, analysing the survey data, and presenting the results in the EOSC Observatory. The observatory team has furthermore created a test instance for EOSC-A to test run and fill in the Additional Activities Plan survey and to ingest already collected survey data from completed AAP surveys into the observatory. Close alignment with EOSC-A and EOSC-SB will continue until the end of the project, whereby the current EOSC-SB survey for 2022 will be completed and EOSC-A will be further integrated into testing functionalities of the observatory.

5.2 EOSC Steering Board

The project has strategically engaged EOSC-SB from the beginning of the project, especially the co-chairs of EOSC-SB and Subgroup A on National Contributions to EOSC (SGA). The observatory team set up the observatory alignment group with biweekly online meetings, a dedicated mailing list, and a common drive on Teams for representatives of EOSC-SB and EOSC-A. The alignment group has worked closely together on the development of the observatory platform, publishing of surveys for EOSC-SB, collection of data from EOSC-SB surveys, and alignment of EOSC-SB and EOSC-A surveys aimed at the EOSC community. EOSC-SB has also invited representatives of the observatory team and EOSC-A to attend both EOSC-SB and SGA meetings as well as to engage in a special drive on Teams for SGA. This collaboration has resulted in the publication of the

first survey on National Contributions to EOSC 2021 for EOSC-SB in the observatory and the public launch of the observatory dashboard presenting validated data from 34 countries from the first EOSC-SB survey.

The project has co-organised two main events for EOSC with both EOSC-SB and EOSC-A. This includes the EOSC Policy Event in 2022 that focused on the European policy context surrounding and supporting EOSC [43]. This also includes the EOSC Symposium 2022 to discuss key achievements and strategic challenges for EOSC and to identify priorities and actions to speed up the implementation of EOSC. The observatory team also collaborated closely with EOSC-SB to present the observatory and survey on National Contributions to EOSC at several stakeholder events, including the workshop on National Policies Relevant to EOSC Deployment in 2021, the EOSC Future Open Days, and the EOSC Symposium 2022. The observatory team further held an online workshop with EOSC-SB in 2022 to validate the Monitoring Framework for National Contributions to EOSC and the revised methodology for calculating annual national contributions to EOSC.

The close collaboration between EOSC Future and EOSC-SB is planned to continue until the end of the project. The EOSC Symposium 2023 will be co-organised with EOSC-SB and EOSC-A. The second survey on National Contributions to EOSC 2022 will be completed and the data will be validated and published openly in the observatory. The functionalities of the observatory for data visualisation and exploitation will be further developed and country pages will be created with feedback from EOSC-SB. And the third survey on National Contributions to EOSC 2023 is aimed to be published in the observatory before the close of the project. The data collection for this third survey as well as the publication of the data in the observatory will need to be coordinated with EOSC-SB after the project ends. Given that the observatory has become a key support for the joint monitoring capacity of the EOSC Tripartite Governance and ERA Monitoring Mechanism, OpenAIRE and Technopolis Group as key partners for the observatory have committed to support the maintenance and development of the observatory as well as running the EOSC-SB surveys and presenting the data for National Contributions to EOSC. The continuity of the observatory will be realised in the short-term via a future Horizon Europe Coordination and Support Action, with further discussion needed for long-term sustainability.

5.3   EuroHPC and Projects

One area of strategic importance identified early in the project is collaboration with EuroHPC. An engagement plan was developed to facilitate offering HPC resources through the EOSC platform, coordinate technical developments and align the architectures of EOSC and EuroHPC federated environments, and formulate a value proposition to boost engagement and collaboration between the project and EuroHPC. The plan aimed concretely to pilot the integration of HPC sites and EuroHPC installations and resources into the EOSC platform architecture and make some resources available in the EOSC platform by the end of the project. So far, the requirements of ESCAPE [44] researchers for HPC resources have been gathered, the ESCAPE Identity Access Management (IAM) has been integrated with the Fenix Research Infrastructure (Fenix) [45] AAI, and a proof-of-concept has been developed to provide access to ESCAPE researchers to HPC resources via Fenix. For the remainder of the project, the proof-of concept will be refined, the approach of requirements gathering and access provisioning for ESCAPE users to HPC resources will be applied to other science clusters, the onboarding process for HPC providers and resources will be improved based on provider feedback, and the focus groups will be organised with HPC centres to elaborate the value proposition of EOSC for EuroHPC.

Another area of strategic importance identified early in the project is collaboration with the INFRAEOSC-07 projects. A multi-lateral collaboration agreement was signed between EOSC Future and the projects C-SCALE [46], DICE [47], EGI-ACE [48], Open-AIRE Nexus [49], and RELIANCE [50] to build an appropriate framework and create synergies for dynamically planning, implementing, and monitoring joint activities related to EOSC. The collaboration agreement is managed through a cross-project collaboration board, which is composed of representatives of each of the projects and which meets regularly to track implementation of the agreement. The agreement focuses on three main areas of collaboration to organise joint technical, training, and uptake activities across the projects. The agreement is currently on track to be completed by the end of the project.

5.4   Gaia-X and Data Spaces

The Gaia-X initiative [51] was launched by the German and French Ministries of Economic Affairs in 2019 with the goal of strengthening data sharing and the use and uptake of industry data among businesses in Europe.

The initiative is currently coordinated by a not-for-profit industry-driven association with a shared mission to create an open, transparent, and secure federated digital ecosystem, where data and services respond to common rules and can be securely built, collated, and shared. The EOSC Future project has engaged from the beginning with Gaia-X and keeps up to date on Gaia-X activities to understand the strategic objectives, implementation plans, and technical developments of Gaia-X. Several initial meetings were held at the start of the project with representatives of Gaia-X to foster mutual understanding and explore areas of collaboration. It became clear, however, that EOSC is currently in a more advanced state and that Gaia-X needs time to fully implement its working structure and define and implement its architectural and operational frameworks. The project will continue to monitor Gaia-X activities and liaise with Gaia-X in the context of the Data Spaces via engagement with the Data Space Business Alliance (DSBA) [52], where Gaia-X is a member. The successful consortium for the EOSC procurement in 2023 should continue this engagement with Gaia-X and the DSBA.

A priority for the EC in the 'Digital Decade' [53] under the Digital Europe Programme [54] is the development of vertical Data Spaces that focus on specific sectors and topics. A Data Space is essentially a framework to share, trade, and collaborate on data assets in a way that is compliant with relevant laws and regulations and ensures fair treatment for all involved. A Data Space can be set up by a set of actors sharing a common interest in data sharing among each other. The Data Spaces are now taking shape and will be coordinated and supported in their activities by the Data Spaces Support Centre (DSSC) [55]. It should be noted that EOSC has been proposed as an overarching transversal Data Space for research and innovation, whereby EOSC will be implemented as orthogonal and supplementary to the thematic Data Spaces, which in turn can capitalise on expertise and solutions developed in the context of EOSC [56]. The project has initiated contact with the Data Spaces via the DSSC and will send representatives to the Data Spaces Symposium 2023 [57] to present EOSC in the sessions, engage with representatives of the DSSC and Data Spaces, gain a mutual understanding of the Data Spaces and EOSC, and prepare future areas of collaboration. The project will further develop an analysis of the current landscape of Data Spaces and draft a position paper proposing areas of collaboration and synergies between the Data Spaces and EOSC. The project will lastly provide technical reflections on how the EOSC procurement in 2023 can work together with the Smart Middleware (SIMPL) procurement in 2023 [58].

5.5   Industry Providers and Users

Strategic alignment with commercial service providers is being realised through market engagement prior to a joint procurement exercise for a service category, the joint procurement exercise itself, engagement with selected providers as part of the contract management and usage of the procured agreements, and the project adoption funding to stimulate uptake of the portfolio of commercial services. The current portfolio of commercial services contains the infrastructure-cloud agreements which have been established in the OCRE project and for which the contract management is executed in the GN4-3 [59] and GN5-1 projects. The results of the adoption funding will feed into the renewal of the joint procurement of infrastructure-cloud agreements which will be undertaken in the GN5-1 project and continue engagement with commercial service providers. Commercial service providers will be further supported to engage with EOSC in the EOSC procurement 2023.

The strategic aim for engaging industry is to support companies in supplying and exploiting EOSC resources. The EOSC DIH has so far launched four campaigns to onboard business pilots to use and exploit EOSC resources as well as organised multiple networking activities and contacted many individual companies about EOSC. The EOSC DIH is also committed to engaging with other DIHs to establish partnerships and reach out to more companies through their networks. Looking forward, the project will define a business model to keep on operating and expanding the EOSC DIH after the project ends. The EOSC DIH will in future establish partnerships with organisations to participate in Horizon Europe projects, which will be able to benefit from the expertise and experience that the EOSC DIH has obtained in working with industry. Such partnerships may ultimately attract new companies in future to engage with and provide resources to EOSC.

5.6   EOSC and Global Community

RDA supports strategic alignment with the global research community as well as the internationalisation and facilitation of EOSC and Open Science. The RDA Global Open Research Commons Interest Group (GORC) [60] is creating a roadmap to align and set priorities for the development and integration of a global open research

commons. This interest group includes representatives from international, regional, and thematic research communities and commons, whereby EOSC is represented by representatives from the EC and EOSC-A. In upcoming RDA conferences and workshops, the group will showcase different types of global open research commons, with examples of their frameworks, priorities, and roadmaps (including for EOSC). RDA acts as a bridge to the global research community and global research commons in the project and will continue this liaison role up to the end of the project as well as independently as one of its core missions after the project.

6   Conclusions

EOSC Future is a large and complex technological project with a diversity of partners from e-infrastructures, research infrastructures, science clusters, and the EOSC user community. This size and complexity was necessary to build on, develop, and integrate relevant outputs of EOSC projects, break down the silos of different stakeholders with differing cultures, and incorporate the diverse expertise and viewpoints from the community to deliver an operational EOSC platform tailored to the needs of resource providers and users.

The first project strategy plan provided an initial strategic direction to guide the technical implementation of the project and coordinate and align activities within the project and with key external stakeholders. In the meantime, the project has shown that a system-of-systems approach works successfully, and the project is on track in realising an operational EOSC platform with interoperable and composable resources. Many resources have been onboarded from science cluster communities and from public and commercial service providers. There has furthermore been direct involvement of users in the co-design and implementation of the EOSC platform through focus groups, community events, and strategic alignment with key EOSC stakeholders.

This second project strategy plan provides a strategic direction for EOSC Future to focus the continuation of project activities and to coordinate and align with key external stakeholders in the EOSC ecosystem towards the end of the project and beyond. The plan incorporates lessons learned from the implementation of the project, including challenges experienced in developing the EOSC platform, managing a large and diverse consortium, identifying joint intellectual property rights, develop supporting activities such as training and help desk, the onboarding of service providers, monitoring the uptake of resources and their integration. The plan builds on eight Key Exploitable Results (KERs) to strategically steer the creation and continuity of major project outcomes. The plan will not only serve as input for the remaining duration of the project but will also serve as strategic input for the next stage of the implementation of EOSC. The plan lastly focuses on strategic alignment with key stakeholders in the EOSC ecosystem, including EOSC-A, EOSC-SB of MS/AC, EuroHPC, relevant EOSC projects, European Data Spaces, Industry/SMEs, and the global research community.

The short-term continuity of several of the KERs is already ensured after the project ends in September 2023:
- The EOSC procurement in 2023 for €35 million will build on, deploy and manage key components of the EOSC-Core (KER #1), EOSC-Exchange (#KER 2), and EOSC Interoperability Framework (KER #5)
- Some science projects will be supported via a dedicated Horizon Europe Research and Innovation Action to extend cross-domain collaboration and EOSC alignment in the science clusters (KER #3)
- The operation, maintenance, development, and monitoring activities of the EOSC Observatory will be supported via a future dedicated Horizon Europe Coordination and Support Action (KER 4)
- There is currently no planned continuity funding support for the EOSC KH although the catalogue of training resources, rules of participation, and helpdesk should be maintained and expanded (KER #6)
- Relations with industry/SMEs as both providers and users of EOSC resources should continue via the EOSC DIH and the procurement of commercial services building on the OCRE framework (KER #7)
- Engagement with the EOSC community to gather feedback and needs should continue, including with members of the project focus groups and with key external EOSC stakeholders (KER #8).

One of the successes of the EOSC Future project has been the breaking down of the silos of different communities and bringing together diverse stakeholders in the EOSC ecosystem, including e-infrastructures, research infrastructures, science cluster communities, and the research community. This has resulted in better collaboration and mutual understanding of the needs of these stakeholders and consensus agreement on the development of the EOSC platform and integration of resources into the EOSC platform. A major risk for the future of EOSC is that these stakeholders will again go their separate ways, losing the synergy of working together after the project ends. Continuous collaboration among these stakeholders should thus be a priority both for these stakeholders and for future funding calls to develop and operate EOSC under Horizon Europe.

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