D2.10 EGI-ACE Final Recommendations

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Deliverable Abstract

The EGI-ACE initiative (Jan 2021 - June 2023) has delivered notable impacts in Open Science, Research, Collaboration, Infrastructure Innovation, and Skills and Expertise, through a variety of services and strategic partnerships. This work has significantly influenced areas such as interdisciplinary research, cloud integration strategies, and capacity-building initiatives. In addition, the project provided substantial feedback to the EOSC Multi-Annual Roadmap (MAR) for 2025-2027, proposing to expand EOSC's influence, enhance its Interoperability Framework, and establish a federated infrastructure including also computing and analytics capabilities among other recommendations. To further enhance the functionality of the European Open Science Cloud (EOSC), strategic recommendations were outlined, such as facilitating seamless access to computing/analytics capabilities and thematic services, improving resource composability, and harmonising funding mechanisms. Overall, the project has taken strides to make EOSC an invaluable resource for the European and international research community.

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TERMINOLOGY

https://confluence.egi.eu/display/EGIG

Terminology/Acronym	Definition
EOSC	European Open Science Cloud
ECP	EOSC Compute Platform
PMB	Project Management Board of the EGI-ACE project
SDS	Service Delivery and Support Board of the EGI-ACE project
SFG	Strategy and Foresight Expert Group of the EGI-ACE project
SRIA	Strategic Research Innovation agenda of EOSC

Contents

Executive summary

EGI-ACE was a 30-month project (Jan 2021 - June 2023) coordinated by the EGI Foundation with a mission to empower researchers from all disciplines to collaborate in data and compute-intensive research through free-at-point-of-use services.

The project delivered three **Key Exploitable Results (KERs)** aimed at enhancing the European Open Science Cloud (EOSC):

- **EOSC Compute Platform**, a free-to-use distributed computing environment, integrates a range of resources and services from diverse entities, creating a platform for various distributed data processing and analysis use cases.
- **Services enabling federated computing in EOSC**, including technical elements like a Monitoring service, Usage Accounting system, and a Configuration Database. These services simplify integration into the Compute Platform and the EOSC, providing a scalable resource allocation system for both local and European entities.
- **Data Spaces and processing tools**: these Data Spaces host and integrate datasets and scientific tools, facilitating online analysis of large datasets and operation of complex computing workflows over distributed computer resources.

All these are part of the project's mission to enhance the EOSC by making it more efficient, accessible, and user-friendly. Overall, the project has created significant **impact** in five key areas:

- **Open Science**: EGI-ACE launched 36 free compute services, attracting 189 orders through the EOSC Marketplace and an additional 42 requests via the EGI-ACE Open Call, making up 35% of all EOSC service access orders and benefiting a diverse user base;
- **Research**: EGI-ACE championed interdisciplinary collaborations by incorporating applications and data from 15 scientific groups into the EOSC Compute Platform. This integration led to 36 new Thematic Services, expanding EGI-ACE's service portfolio to 53, reaching nearly 77,000 users, and fueling 69 publications;
- **Collaboration**: EGI-ACE strengthened global alliances with prominent e-infrastructures, deepened partnerships with mature Research Infrastructures (RIs), and engaged actively with industry through the EGI Digital Innovation Hub;
- **Infrastructure Innovation**: EGI-ACE pioneered cloud integration strategies and a novel resource allocation model, leading to an expansion of EGI Cloud to 23 providers in 2021 and a 40% surge in EOSC user capacity;
- **Skills and Expertise**: EGI-ACE promoted capacity-building initiatives, such as assigning 'shepherds' for each use case, facilitating comprehensive training programs, and providing FitSM certification, benefiting over 1,000 participants. The project also played a critical role in knowledge expansion, generating 35 Intellectual Property assets.

Finally, the project identified **five strategic recommendations** aimed at enhancing the efficacy and functionality of the European Open Science Cloud (EOSC) while ensuring that the results and learnings:

1. **Facilitate Seamless Access to Computing and Analytics Capabilities**: We advocate for the development of an accessible channel to essential computing and analytics capabilities, supporting various modes of operation and catering to a wide range of research data usage scenarios.
2. **Reinforce and Expand the Thematic Service Integration and Delivery Programme for EOSC Exchange**: The Thematic Service Integration and Delivery Programme requires reinforcement and expansion, focusing on the selection, integration, and sustained support of thematic services in the EOSC Exchange.
3. **Establish and Coordinate Research Support Network**s: It is recommended that research support networks be established and coordinated across sectors, disciplines and countries to ensure full exploitation of EOSC resources. This approach leverages the proven expertise and experience of EGI-ACE, which has successfully catered to multiple communities.
4. **Improve the Composability of EOSC Resources**: We propose augmenting the description of onboarded resources in EOSC with both human and AI-generated information, and refining and tailoring user interfaces and APIs to enhance the composability of resources along the open science pipeline.
5. **Harmonise Funding Instruments for EOSC Core/Exchange with Publicly-Funded Providers**: Funding mechanisms should be compatible with the operation of publicly-funded organisations and should be managed in the best interests of the community. This harmonisation is vital to enhance participation and engagement within the EOSC.

Each recommendation has been developed to address a distinct challenge within the EOSC ecosystem while contributing to an integrated approach that enhances EOSC's capacity in computing, to serve as an invaluable resource for the European and international research community.

The project also contributed to the EOSC Multi-Annual Roadmap (MAR) 2025-2027, proposing ways to expand EOSC's influence towards the private sector and public authorities, enhance the EOSC Interoperability Framework, and make available a federated infrastructure that provide access to compute/analytics capabilities, among others. New outcomes and call topics for the 2025 Work Programme were proposed, with the aim of better supporting the EOSC user community, validating the EOSC concept, and promoting EOSC stakeholders as innovators.

1 Introduction

The EGI-ACE project, coordinated by the EGI Foundation, has been on a 30-month journey (January 2021 - June 2023) with a mission to democratise access to data and compute-intensive research services for researchers across all disciplines, offering free-at-point-of-use services. This journey culminated in three Key Exploitable Results (KERs) aimed at bolstering the capabilities of the European Open Science Cloud (EOSC).

The first achievement, the EOSC Compute Platform, is a freely accessible, distributed computing environment that consolidates a myriad of resources and services from various providers to form a versatile platform for distributed data processing and analysis.

Next, the project introduced an array of services to facilitate federated computing within the EOSC. These comprise technical elements like a Monitoring Service, Usage Accounting system, and Configuration Database, significantly simplifying the integration into the Compute Platform and the EOSC, and offering a scalable resource allocation system for local and European entities.

Lastly, EGI-ACE pioneered a robust collection of Research Data Spaces and processing tools. These Data Spaces serve as repositories and integration platforms for datasets and scientific tools, enabling large-scale, online data analysis.

These achievements collectively contribute to the project's overarching objective of making EOSC more efficient, accessible, and user-centric. The project's broad impact, spanning five dimensions, is further elaborated in Section 2.

As we move forward, this document outlines five final strategic recommendations designed to preserve and amplify the EGI-ACE project's legacy within the EOSC ecosystem, complemented by expert commentaries in Section 4.

Closing this report, we present two appendices. The first one assesses the implementation of the EGI-ACE Strategic Priorities outlined in D2.2, while the second summarises the consortium's feedback to the draft EOSC Multi-Annual Roadmap for 2025-2027.

2 Overview of project impact

This section presents an overview of the EGI-ACE project impact. More detailed information is provided in the EGI-ACE Impact publication[1].

2.1 Impact on Open Science

EGI-ACE successfully achieved its main goal of delivering integrated computing, platforms, data spaces, and tools aligned with major European cloud federation projects and HPC initiatives. Thirty-six free-at-point-of-use compute services were delivered through the EOSC Portal, comprising 9% of the total services available on the portal.

These services are divided into the Compute Platform and Thematic Data Spaces and Processing Platforms, offering a variety of capabilities from interactive and batch data processing to AI and scalable cloud clusters management.

EGI-ACE services, made accessible through the EOSC Portal and an 'Open Call', garnered 189 orders on the EOSC Marketplace and 42 access requests through the EGI-ACE Open Call. These services were utilised primarily by individual scientists, small research groups, and international research projects, representing 35% of all service access orders handled in EOSC during EGI-ACE's 30-month tenure.

Among these, the 'EGI Cloud Compute' and 'EGI Notebooks' were the most popular. Overall, nearly 77,000 users accessed EGI-ACE services during the project duration.

2.2 Impact on Research

EGI-ACE had a substantial impact on the scientific community by fuelling Thematic Services across diverse disciplines, supporting initiatives such as the EU Data Strategy and the Green Deal, as well as aiding in Health, Fundamental Research, and Social Sciences and Humanities.

Fifteen scientific groups integrated their applications and data with the EOSC Compute Platform, establishing 17 scalable data hosting and processing services for the EOSC Exchange layer. Furthermore, collaboration with additional scientific groups via the EOSC Marketplace and the EGI-ACE Open Call led to the creation of 36 new Thematic Services. Consequently, the total EGI-ACE-related Thematic Service portfolio reached 53, with 35 registered on the EOSC Portal.

Over 30 months, these 53 services catered to nearly 77,000 users, leading to the publication of 69 papers by both providers and end users. Moreover, EGI-ACE was cited 78 times in scientific publications.

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[1] EGI-ACE Impact report https://doi.org/10.5281/zenodo.8119613

2.3 Impact on Collaboration

The project served over 220 user requests that came from European Research Infrastructures, R&D projects, research institutes/groups, representatives of 'communities of practice', industry and the long tail of science. The project also significantly expanded its collaborations beyond Europe, further deepening relationships with key research infrastructures (RIs), and fostering novel partnerships with the industry.

International Collaborations: Prior to the project's initiation, EGI-ACE began drafting 'Memoranda of Understanding' with e-infrastructures outside Europe, aiming to support compute-intensive Open Science via federated compute infrastructures. Joint actions were executed with prominent infrastructures such as the Computer Network Information Center (CNIC) of the Chinese Academy of Sciences, the Open Science Grid in the United States, and the Inter-University Institute for Data-Intensive Astronomy (IDIA) in South Africa.

Research Infrastructure Partnerships: The EGI-ACE consortium incorporated mature RIs that joined the EGI Federation in 2021, enhancing its collaborative relationships. During the project, seven additional collaborations[2] were established with RIs on the ESFRI roadmap. Four partnerships aimed at service delivery, whereas three, all belonging to ESFRI's 'Digital Infrastructures' segment, developed a joint work plan focused on reducing the environmental footprint of European computing infrastructures.

Industry Partnerships: The EGI-ACE established a formal engagement structure with the industry through the EGI Digital Innovation Hub (EGI DIH), a virtual space for companies and technical service providers to collaborate and test solutions. EGI-ACE validated commercial cloud integration scenarios, established a business relationship with MathWorks, and attracted 15 SMEs as users to the EGI-ACE services through the Open Calls or through the EOSC DIH.

2.4 Impact on Infrastructure Innovation

EGI-ACE significantly impacted infrastructure innovation through extensive cloud integration and an inventive resource allocation approach.

Cloud Integration: EGI-ACE extended the federated infrastructure of the EGI Cloud, which included 23 providers in 2021. The project offered three levels of integration scenarios: entry, medium, and full. The entry level[3], aimed at commercial providers, enables a single sign-on across clouds and between EGI-ACE and EOSC services. The medium level[4] was targeted

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[2] METROFOOD-RI (Food and Nutrition Sciences), e-RIHS (Heritage Science), Instruct-ERIC (Structural Biology), EU-OPENSCREEN-ERIC (Chemical Biology), SLICES, EBRAINS and SoBigData (the last 3 belong to the ESFRI Digital Infrastructures Segment)

[3] Entry level: joining the 'AAI federation', this level was the target with the TSystems and CloudFerro commercial providers and provides single sign-on across clouds and between EGI-ACE and EOSC services

[4] Medium level: joining the application federation (through AppDB) and the data federation (through DataHub) besides the AAI federation. This level was targeted by national cloud providers of Moldova, Latvia, Armenia, and Georgia to enable the exchange of applications and scientific datasets between EOSC and those national clouds

by national cloud providers to facilitate the exchange of applications and datasets. The full integration level[5] involved joining the monitoring, accounting, and helpdesk systems of EGI, achieved by clouds from several countries.

Resource Allocation Approach: EGI-ACE implemented an innovative model combining various funding streams to offset service costs. Virtual Access funding from the EC, national and institutional funding, and research community funding led to a significant expansion of the provider base and available capacities. This approach allowed cloud providers to deliver a total of 102 million CPU-hour capacity during the project and increased the EOSC user's capacity by +40%.

Compute Continuum and Data Spaces: The infrastructure layer of the EOSC Compute platform was extended with High Performance Computing (HPC) systems during the project. This addition expanded the system's capabilities, and their effectiveness was validated by four scientific pilots. The project also constructed five scientific Data Spaces, uniting both data and online applications to facilitate scalable big data analysis.

2.5 Impact on Skills and Expertise

The EGI-ACE project has made a significant impact on skills and expertise enhancement through various capacity-building efforts:

- Shepherds and Competence Centres: To ensure user success, 'shepherds' or technical experts were assigned to each use case, offering tailored support. These shepherds formed 'Competence Centres', cross-functional groups skilled in implementing use cases successfully. The project created a network of 22 shepherds from 9 institutes.
- Training Programmes: EGI-ACE delivered a series of webinars and longer training events, both online and in the scope of large conference events, catering to consortium members, external service providers, and users. These training sessions attracted over 1,000 participants in 30 months.
- FitSM Training: FitSM, a lightweight standard for IT service management, was used to enhance service management maturity within the consortium and EOSC service providers. The project successfully held 18 FitSM training sessions since January 2021, attended by over 200 participants who obtained FitSM certification.

Furthermore, EGI-ACE played a significant role in knowledge creation and expansion:

- Scientific Publications: The project facilitated the publication of 69 papers in scientific journals or conference proceedings and was cited 78 times.
- Innovation and Exploitation Management: The consortium members developed a noteworthy process for managing Innovation and Exploitation in collaborative

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[5] Full integration: joining the monitoring, accounting and helpdesk systems of EGI besides the AAI, AppDB and DataHub integrations. This level was reached by OpenStack clouds from Greece (GRNET), Italy (INFN CNAF), Germany (GSI), Hungary (ELKH Cloud), Ireland (Walton Institute), China

projects, which was later used in the EOSC Future and is currently being refined in iMagine[6] and interTwin[7] projects.

- Intellectual Property Assets: The project generated 35 Intellectual Property assets[8], including software code and know-how, further enhancing the Service Portfolio Management and leading to the creation of an Intellectual Asset Inventory for EGI Foundation. The software code increments were released under the same open-source licence of the software package to which they belong to.

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[6] https://www.imagine-ai.eu/
[7] https://www.intertwin.eu/
[8] See EGI-ACE Deliverable D1.6 Section "IP Generated in Project"

3 Final Recommendations

The development and operation of the European Open Science Cloud (EOSC) demands a broad and diverse approach, carefully considering multiple facets of its functionality, sustainability, and reach. As we engage with the evolving EOSC landscape, it is vital to address current challenges and anticipate future opportunities, ensuring we maximise the value of this valuable resource for its diverse user base.

The following five recommendations aim to further refine the EOSC, focusing on diverse areas such as access to computing and analytics capabilities, thematic services, research support networks, resource composability, and funding instrument compatibility. Each recommendation is rooted in a precise understanding of the present context and seeks to address a unique challenge within the EOSC ecosystem from the viewpoint of EGI-ACE.
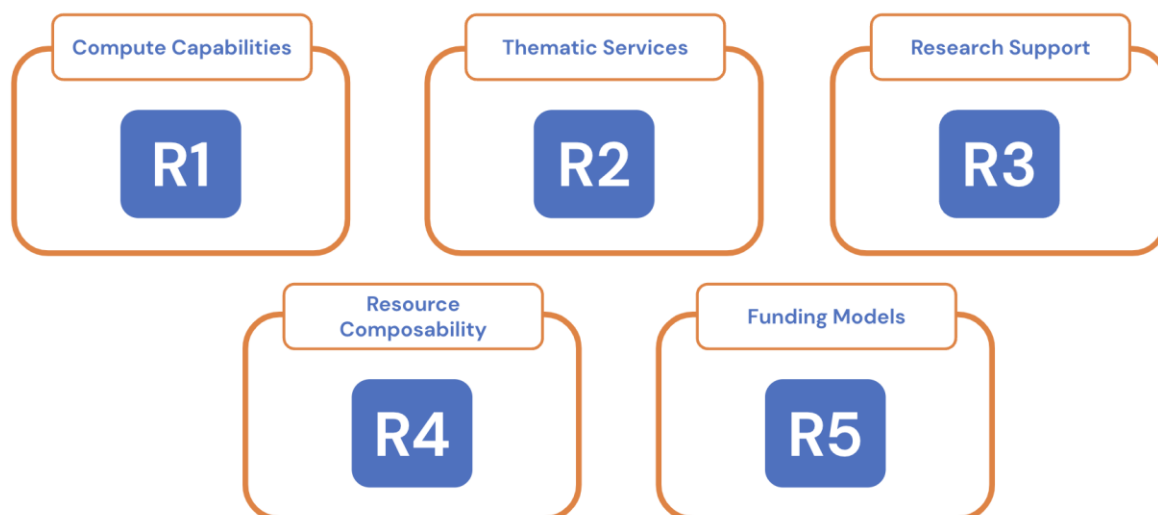
Figure 1: Areas of the EGI-ACE final recommendations

Importantly, these recommendations are not stand-alone propositions. Instead, they intertwine to form a coherent strategy for the evolution of EOSC, with a shared vision of strengthening the EOSC as an invaluable platform for the European and international research community. As you explore these recommendations, consider the roles of various stakeholders, the desired outcomes, and the potential for each recommendation to shape the future EOSC.

3.1 REC1: Facilitate Seamless Access to Computing and Analytics Capabilities

Context and Challenge: While the number of compute services/resources in EOSC is growing, there is not an harmonised approach for their integration, resulting in 'compute islands' that work with different access policies, APIs, etc. This landscape is difficult to navigate as a user. Also, the proposed EOSC Multi-Annual Roadmap for 2025-2027[9]

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[9] EOSC MAR 2025-2027 Draft V3: https://eosc.eu/sites/default/files/2023-01/MAR_2025-27_draft.pdf

neglects the critical need to ensure straightforward access to essential services and platforms for data utilisation and analytics. This requirement is integral to the effective use and reuse of data.

Recommendation: The EOSC should develop and provide a streamlined channel to access computing and analytics capabilities. This channel ought to support various modes, such as operation from a single site versus federated sites, and function at both national and transnational levels. By doing so, it would cater to a broad range of research data usage scenarios, thereby enhancing the potential for research data reuse.

Involved Stakeholder(s): European Commission (EC), Member States (MSs), EOSC Governance.

Desired Outcome: The recommended approach aims to empower researchers with easy-to-use access to the necessary computing and analytics capabilities provided by existing infrastructures. This access will enhance their ability to utilise and reuse research data effectively, thus contributing to a more vibrant scientific research landscape.

3.2 REC2: Reinforce and Expand the Thematic Service Integration and Delivery Programme for EOSC Exchange

Context and Challenge: EGI-ACE has successfully facilitated the integration of various thematic services addressing key scientific areas. However, the lack of continuity for this in future EC calls is posing a threat to the progression and expansion of this category of services.

Recommendation: Reinforce and expand the existing Thematic Service Integration and Delivery Programme, focusing on the selection, integration, and sustained support of thematic services in the EOSC Exchange, with scientific excellence serving as the primary criteria.

Related Stakeholder(s): European Commission (EC), Member States (MSs).

Desired Outcome: The enhancement and expansion of this programme aim to increase both the number and diversity of thematic services within the EOSC Exchange, reinforcing EOSC's role in supporting science and innovation. This will result in a more inclusive and comprehensive platform equipped to cater to a wider variety of research needs.

3.3 REC3: Establish and Coordinate Research Support Networks

Context and Challenge: Presently, there is no agreed strategy to attract and support user communities that require access to or utilisation of multiple EOSC resources. EGI-ACE has provided a successful model with a support programme that has catered to 40 communities, and has integrated 30+ EGI-ACE services into EOSC.

Recommendation: Establish and coordinate research support networks, bringing together experts from various research communities. These networks should leverage the proven expertise and experience of EGI-ACE in providing successful support structures.

Related Stakeholder(s): European Commission (EC), Member States (MSs), Research Communities.

Desired Outcome: The establishment of research support networks will aid scientific communities in fully exploiting or enriching EOSC resources. The implementation of this recommendation will bolster the utilisation and contribution to the EOSC, enhancing its value as a scientific resource exchange.

3.4 REC4: Improve the Composability of EOSC Resources

Context and Challenge: Currently, the resource[10] description provided in the EOSC Portal and the available supporting tools are inadequate to facilitate resource composition. This inadequacy makes it challenging to combine EOSC resources from disparate providers through the different layers (infrastructure, platform, data, applications). The EOSC Future Compute Continuum Working Group[11] is addressing this issue specifically for computing resources.

Recommendation: Improve resource composability through the different layers (infrastructure, platform, data, applications) as well as across multiple Thematic Services (pipelining), e.g. by enriching resource descriptions with information generated by both human experts and AI algorithms, streamline APIs and provide supporting tools.

Related Stakeholder(s): Providers of the EOSC Core, Horizontal and Thematic Services

Desired Outcome: Enhancing resource composability will empower EOSC users to easily create and manage on-demand workflows for combining resources from various independent providers, customised to suit different use cases. This will enhance the EOSC's functionality, making it a more versatile and user-friendly platform for its diverse user base.

3.5 REC5: Harmonise Funding Instruments for EOSC Core/Exchange with Publicly-Funded Providers

Context and Challenge: The application of public procurement to develop and deliver the EOSC Core and parts of the EOSC Exchange poses significant challenges for many EOSC stakeholders who are beneficiaries of public funding, thus limiting their participation.

Recommendation: Ensure that funding mechanisms employed to deliver services crucial to the Research and Education sector are compatible with the modus operandi of most publicly-funded organisations and are managed in the best interests of the community.

Related Stakeholder(s): European Commission (EC), Member States (MSs).

Desired Outcome: As a public good, the EOSC Core should be under the ownership and governance of the Research and Education community. This approach is intended to

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[10] 'Resource' in this context is used according to the following definition from EOSC: "all the possible types of research service, asset, and collections thereof that can be included in the EOSC Catalogue and Marketplace."

[11] https://wiki.eoscfuture.eu/display/PUBLIC/Compute+Continuum+Working+Group

safeguard public values, promote equitable participation, and enhance community engagement in EOSC.

4 Commentary to the recommendations

The EGI Conference 2023 served as a platform to showcase the success stories of the EGI-ACE project, whilst simultaneously soliciting invaluable feedback from community experts regarding the proposed recommendations. A panel discussion[12] offered the opportunity for insightful dialogue, featuring perspectives from key stakeholders across various sectors, encompassing EOSC governance, user communities, as well as service and technology providers. This section provides a synopsis of the salient points that surfaced during these illuminating discussions. For each recommendation, the perspectives of individual contributors are encapsulated in separate bullet points and presented in the order of their delivery.

Recommendation 1: Facilitate Seamless Access to Computing and Analytics Capabilities

- Panellist 1 voiced agreement with the need for computing resources within the EOSC framework. They further advocated for a well-devised plan, incorporating defined priorities complementary to existing actions, to be presented to the EC. Their stance underscored that the primary focus should shift from merely providing raw computing capabilities to offering value-added services. The suggested organisational model was a federated one, bolstered by the EU, that integrates national contributions.
- Panellist 2, from a life sciences perspective, emphasised the essential connection between data and computing capabilities, comparing it to the biological bond between DNA and proteins. They noted that computing necessities emerge at various stages in the research data lifecycle, including the stages of data preparation for publication and public data reuse. Without the provision of essential computing and analytic capabilities for utilising available research data, they warned of a potential lack of incentives for data contribution to the EOSC.
- Panellist 3 criticised the current computing capabilities for research as insufficient. Citing the vision for a digital twin of Earth at the coastal and urban scale, they highlighted the significant demand for computing resources that such projects entail. They championed the integration of all available capabilities, inclusive of commercial providers, and viewed the proposed recommendations as a key solution to these pressing issues.
- Panellist 4 offered a different perspective, suggesting that the EOSC needs not attempt to cover all possible capabilities. Instead, they should focus on delivering fundamental capabilities that are of the most benefit to the majority of users. They also stressed the need for the creation of clear and straightforward APIs that grant users real resource access.

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[12] https://indico.egi.eu/event/6071/contributions/18031/

Recommendation 2: Reinforce and Expand the Thematic Service Integration and Delivery Programme for EOSC Exchange

- Panellist 1 acknowledged the importance of a community of dedicated researchers and research engineers for each thematic service provider. They viewed these individuals as key to developing software, promoting its use, and advancing scientific frontiers. However, they placed this recommendation at a lower priority, implying that if computing, resource composability, and research support were effectively established, research communities would be equipped with sufficient building blocks to develop and maintain their thematic services.
- Panellist 2 called for a focus on enhancing interoperability among thematic services. They championed the adoption of best practices and the onboarding of new communities that are not far off. Furthermore, they suggested that support for interdisciplinary research could significantly benefit from a dedicated funding programme.
- Panellist 3 reflected on the EGI-ACE's support to thematic services as an opportunity to achieve a convergence of services and EOSC building blocks. This convergence would minimise redundancy and provide a valuable platform for communities to transition services.
- Panellist 4 also acknowledged the success of the thematic services within the EGI-ACE framework, describing them as excellent EOSC ambassadors. They noted how EGI-ACE had allowed more researchers to discover EOSC and EGI and provided a platform for local thematic services to reach a global community, thus enhancing their societal impact. However, they posed a question on maintaining the service after EGI-ACE's conclusion and continuing to support access as users would desire. They believed in the potential to increase usage and attract new users, hence, a call for thematic services addressing both the maintenance of existing solutions and the introduction of new ones would be a welcome development.

Recommendation 3: Establish and Coordinate Research Support Networks

- Panellist 1 asserted that every researcher in Europe deserves support and investment, making research assistance and training indispensable. To fully utilise the resources available via EOSC, such support is essential, particularly for those researchers without an extensive IT background who may not be cognisant of the potential the resources offer. It is crucial that neither research infrastructures nor small international research groups be excluded from such aid.
- Panellist 2 suggests that EOSC shouldn't strive for a centrally administered research support service. Instead, it should lean on established platform organisations like EGI to be an integral part of it. Research assistance should operate at varying levels, accommodating the extensive array of science domains. Different organisations may have specialisations in different areas; EGI could potentially serve as a reference point on how to organise these support networks, leveraging their experience from EGI-ACE.
- Panellist 3 observes that support is required at multiple levels: application-level assistance from the community, and infrastructure-level aid from the providers.

Infrastructure-as-a-service (IaaS) offerings can be complex to adopt and expert support is a necessity. International research communities can drive the definition of best practices due to their economy of scale, aiding the long tail of science. The contributor also highlighted the challenge of providing quality support given the rapid pace of technological change.

- Panellist 4 opines that EOSC will not be equipped to support all researchers, hence strategic choices need to be made. There might be various tiers of support: for instance, local assistance by universities, complemented by national and European-level support.

Final question: how should the EGI Federation evolve in the EOSC?

- Panellist 1 acknowledges the tremendous support that the EGI Federation has provided to communities over the years, as evidenced by the results shown by EGI-ACE. They propose that working on the composability of services could offer great added value. However, they also acknowledge the challenge of bridging the gap between the extensive work done by EGI and the high-level portal users who might not be aware of it. Nonetheless, they stress the importance of promoting success stories.
- Panellist 2 suggests that while research communities won't be able to construct thematic services for every scenario, the EGI Federation could enable individual researchers or small groups to efficiently use available resources and compose their own solutions, potentially with AI support. They propose that EGI should identify key horizontal capabilities that are most used, and then advance composability, training, and support to empower researchers to build new solutions.
- Panellist 3 points out that EOSC's mission is to push for convergence on core services. They note that while EGI has worked to create coherence in a set of services, the EOSC landscape is becoming crowded, making it difficult to navigate. They argue that the key is facilitating convergence and the reuse of existing capabilities. They envisage EGI as the "platform convergence coordinator", combining and reusing existing services and driving communities to reuse them.
- Panellist 4 refers to Recommendation 4, which concerns workflow building. They see this as a key area of work for EGI as it creates value for both data and compute resources. They identify user struggles with tasks such as changing data formats, moving data, finding appropriate compute resources to add value to data, and more. They suggest that workflow building, potentially with AI support for pre-processing, post-processing, and data interpretation, could serve as a bridge between different infrastructure pieces, providing a great opportunity for EGI.

5 APPENDICES

5.1 A. Report on the Implementation of the EGI-ACE Strategic Priorities

In EGI-ACE Deliverable D2.2 "EGI-ACE Strategic Plan"[13], 6 strategic priorities to maximise the project outcome and long-term effects were presented. They were described in terms of issues to be addressed, priorities for action, desired outcome of the action and practical initiatives to be put in place. Also, for each initiative, we described the related action, the owners (both leaders 'L' and contributors 'C'), the main target audience (based on the classification of EGI-ACE D2.6), the expected results and the status. This section provides an update on the identified priorities with the final results that were obtained.

5.1.1 PR1: Promote the value proposition of the EOSC Compute Platform

Area

Compute Platform

Issue

The EOSC Compute Platform is a new concept promoted by the EGI-ACE project and it is not yet captured in the EOSC SRIA or other official documents about the EOSC. Also, many EOSC users or providers do not yet understand the value of it.

Strategic priority

Promote the value proposition of the EOSC Compute Platform so that it is recognised as a distinctive EOSC element and valued by both service providers and users.

Desired outcome

Current and potential EOSC users and providers have easy access to the EOSC Compute Platform information, they understand the value of it and support its continuation. Also, official EOSC documents include the EOSC Compute Platform.

Initiatives

Action & Owner	Target audience	Expected result	Results
Prepare a short policy brief about the EOSC Compute Platform and submit it to the relevant entities	EOSC Task Forces (especially FinSust), EOSC-A, EOSC Future, EC	The identified target audience is aware of the concept and value of the EOSC Compute Platform and	- Contribution to EOSC Future D2.9 (Dec 2021) - Impact report submitted to the EC (Mar 2022) - Feedback to EC on EOSC procurement (Jun 2022) - EGI-ACE Impact Report (Jun 2023)

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		support its continuation	
The EOSC Compute Platform values are clearly explained via the communications and engagement campaigns and channels L: EGI-ACE T2.3 C: EGI-ACE T2.4	Researchers, international projects, EOSC Governance	The website is improved with the ECP value proposition clearly explained; communications campaigns clearly highlight the value of	- Website section on ECP updated (Apr 2022) - EGI-ACE Impact Report (Jun 2023)
Newly approved Horizon Europe projects are monitored and relevant actions that can benefit from EOSC services are reached out to promote the use of the EGI-ACE services L: EGI-ACE T2.3 C: EGI-ACE T2.4	Upcoming HE projects that can benefit from EOSC services	All coordinators of approved projects are aware of the EGI-ACE services and part of them submit applications for use cases	- Mailing list campaign organised (Q1/2022) - Some applications for use cases generated

5.1.2 PR2: Develop processes/procedures to expand the EOSC Compute Platform

Area

Compute Platform

Issue

The EOSC Compute Platform started as a project-based initiative where providers were pre-selected during the preparation phase of the project. There is not yet a set of defined rules explaining how new providers and services can join, and how the EOSC Compute Platform membership and the EGI membership relate to each other.

Strategic priority

Develop open and transparent processes and procedures for new providers and new services to join the EOSC Compute Platform. Also, define the requirements to be part of the

EOSC Compute Platform (both technical and policy related) and its relationship with the EGI Federation governance and affiliation.

Desired outcome

Current and potential providers have a clear understanding of how to join the ECP and how it differs from the EOSC Onboarding. The relationship between the EOSC Compute Platform and EGI membership and portfolio is well articulated and presented in relevant communication materials.

Initiatives

Action & Owner	Target audience	Expected result	Results
Define open processes and procedures to join the EOSC Compute Platform L: EGI-ACE T2.2 C: EGI-ACE WP7	Service and content providers for research	Definition of processes and procedures to join the EOSC Compute Platform	We have documentations on how to join the EGI infrastructure either as as supplier of an EGI-owned service, as provider of an instance of an EGI-owned service, as provider of a new service, as software supplier: https://docs.egi.eu/providers/
Clarify how being part of the EGI Federation relates to being part of the EOSC Compute Platform L: EGI-ACE PMB C: EGI-ACE Executive Board	Service and content providers for research, EGI Council	Policy document clarifying the terms of participation in the EGI Federation vs the EOSC Compute Platform	The evolved EOSC architecture has compute services within the 'Horizontal services' layer of EOSC, and a segment of this will be procured by the EC into the 'European EOSC Node' in Lot 2. Other EOSC Nodes (e.g. national) are expected to also have horizontal services of their own, and expect to link directly into the EOSC Core (and not into the Managed Compute services of the European EOSC Node). While the term "EOSC Compute Platform" is not adopted in the EOSC architecture, the elements are present.

5.1.3 PR3: Develop and sustain the researcher support network of the EOSC Compute Platform

Area

Compute Platform

Issue

The EGI-ACE project has bootstrapped an initial support network for the EOSC Compute Platform. This helps new users to be guided on the best way to use and combine services from the EOSC Compute Platform. On the other hand, these structures have different levels of maturity, and their level of expertise needs to be expanded as the platform evolves.

Strategic priority

Develop and sustain the researcher support network of the EOSC Compute Platform and link it with emerging EOSC user support networks.

Desired outcome

- There is an active support team in every country that participates in EGI-ACE to serve new users' and providers' joining requests.
- The EGI-ACE network of providers is known and used by other thematic support networks for compute-related consultancy.

Initiatives

Action & Owner	Target audience	Expected result	Results
Run internal training for the supporters within the consortium and for newly joining service providers so they can become professional in serving users and providers L: EGI-ACE T2.3	Supporters from service and content providers part of EGI-ACE	Improved skill and know-how in personnel part of the EGI-ACE service and content providers	- Shepherds' handbook was prepared: https://documents.egi.eu/document/3866 - Various training events and workshops for shepherds and use case submitters
Promote the value of research support networks within EOSC and link the EOSC Compute Platform network with those	EOSC Governance, EOSC Task Forces (especially FinSust)	EOSC funders recognize and increase support for the research support networks	- Contribution to EOSC Future D2.9 - Feedback to MAR survey for 2023-2024 and 2025-2027

Action & Owner	Target audience	Expected result	Results
L: EGI-ACE SFG C: EGI-ACE PMB, EGI-ACE T2.4			- Added in the final recommendations part of EGI-ACE D2.10

5.1.4 PR4: Sustain the EOSC Compute Platform after EGI-ACE

Area

Compute Platform

Issue

The EOSC Compute Platform is a project-based initiative currently supported via the Virtual Access funding mechanism. Without institutional mandate or viable business model, providers will cease to offer their services after the end of the project. Also, there is a demand for including further types of services in the EOSC Compute Platform (e.g., edge computing, HPC) for which additional funding would be needed.

Strategic priority

Seek support for sustaining and scale out the delivery of the EOSC Compute Platform after the end of EGI-ACE.

Desired outcome

The EC recognises the value of the ECP as an element of the EOSC and contributes to its delivery for the benefits of research. Also, the EOSC Steering Board representing the MSs/ACs support it as part of the in-kind contributions to the EOSC initiative.

Initiatives

Action & Owner	Target audience	Expected result	Results
The EOSC Compute Platform is promoted as a scenario within the EOSC Task Force on Financial Models L: EGI-ACE SFG C: EGI-ACE PMB	EOSC FinSust TF	The report from the EOSC TF includes scenarios compatible with the EOSC Compute Platform	- The TF worked on scenarios across 3 sub-groups: EOSC Core, EOSC Exchange, Federation of Data - The TF recommended that some horizontal "essential" services to be centrally funded
The EOSC Compute Platform is promoted towards the EOSC	EOSC Partnership	The EOSC SRIA and related MAR recognize the value of the	- Replied to two EOSC MAR consultations; the second reply is added in this document as annex

Partnership for support in the context of the Multi Annual Roadmap L: EGI-ACE SFG C: EGI-ACE PMB		EOSC Compute Platform	

5.1.5 PR5: Contribute to the development of a data space reference model

Area

Data Spaces

Issue

There is no distilled learning from building Data spaces and processing tools that could be reused by other initiatives. There is no sustainability plan for the EGI-ACE data spaces and processing tools beyond the project.

Strategic priority

Contribute to the development of a data space/processing tool reference model and support the definition of related financial and sustainability models. Build partnerships with relevant data space initiatives to uptake and evolve the EGI-ACE data spaces and their approach.

Desired outcome

The most successful data spaces and processing tools can access new funding opportunities after the end of EGI-ACE. The EGI-ACE expertise and reference model is used beyond the project for the building of Data spaces.

Initiatives

Action & Owner	Target audience	Expected result	Results
Provide leadership to the research community in identifying and targeting upcoming calls about Data Spaces in the HE and Digital Europe programmes. These calls can fund the continued development and	Service, technology, and content providers related to Data Spaces and EOSC ECP	Project proposals are prepared, submitted, awarded to support the further development of Data Spaces on top of the EOSC ECP	- Various EC project proposals were prepared, in agreement with the EGI Executive Board and Council - One proposal was accepted focusing on a data space for open scientific data from environmental sciences, capitalising on the technologies and operational approaches from EGI-ACE

delivery of data spaces on top of the EOSC Compute Platform L: EGI Foundation Project Management Office C: EGI Project Advisory Committee			
Liaise with emerging and existing Data Space initiatives for future collaboration and the exchange of approaches and technologies L: EGI-ACE T2.2 C: EGI-ACE WP5	Initiatives or groups working on Data Spaces	Mapping of data spaces initiatives and identification of opportunities	- Key initiatives were engaged and some were invited at the EGI Conference[14] as keynote speakers and participants in data spaces sessions - It is recognised also that the scope of data spaces in the past 2 years moved towards facilitating exchange of data (non necessarily open) between stakeholders that operate independently; this is a different area than the one played by EGI-ACE Data Spaces where the focus was to enable data access from groups of data providers who already have trust among them, and because the project focused on the computing (with big data) instead of access/download
Develop a data space reference model and implementation	Initiatives or groups working on Data Spaces	Document describing a data space reference	- During the project, wider Data Spaces initiatives produced relevant contributions in this area[15]

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[14] See EGI Conference 2023 program (https://indico.egi.eu/event/6071/overview), in particular the session "Making Space for Data" (https://indico.egi.eu/event/6071/sessions/5036/#20230622)
[15] International Data SpacesInternational Data Spaces,
https://internationaldataspaces.org/offers/reference-architecture/ and Data Spaces Business

		model and implementation guidelines	- EGI-ACE re-focused on influencing wider initiatives, more than leading an own proposal, also in consideration with the available effort to conduct the work
guidelines useful for developing financial models to be submitted to the related EOSC Task Force L: EGI-ACE T2.2 C: EGI-ACE WP5			- EGI-ACE experts are contributing to the EOSC Future Position Paper on Data Spaces (Note: the EOSC Future project is extended, so experience from EGI-ACE will be fed into this work)

5.1.6 PR6: Contribute to the development of the EOSC Interoperability Framework including Data Spaces

Area

Data Spaces

Issue

The 13, and the other emerging data spaces of EGI-ACE solved data, application and compute interoperability and exploitation in their individual domains. At the same time, the level of interoperability among them is low.

Strategic priority

Contribute to the development of the EOSC Interoperability Framework, to the "Data Spaces Technical Framework" that will be created through the Digital Europe (DE) Work Programme, and to other relevant initiatives that work towards a single, European Data space.

Desired outcome

Alliance - Technical Convergence (Discussion Document) https://internationaldataspaces.org/wp-content/uploads/dlm_uploads/Data-Spaces-Business-Alliance-Technical-Convergence.pdf

Data spaces evolve within Europe without becoming data/application silos, using the EGI-ACE implementation approaches and tools in collaboration with industry and other academic solutions.

Initiatives

Action & Owner	Target audience	Expected result	Results
Capture lessons learned, best practices about Data space interoperability and bring this as input in the relevant EOSC task forces and other initiatives that work on Data spaces interoperability L: EGI-ACE T2.2 C: EGI-ACE WP5	EOSC Task Forces, Data Spaces initiatives	Document about lessons learned on data spaces interoperability	- The general scope of data spaces in the Digital Europe projects has shifted in 2022-23 to facilitate trusted exchange of data between untrusted parties. This is different from the use cases that EGI-ACE operated with therefore there was no possibility to significantly influence the broader DS landscape. - EGI-ACE contributed to the EOSC Interoperability Task Force and deployed and integrated the EOSC Data Transfer service between the EOSC Data Sources and Compute resources.
Monitor the Data spaces landscape, identify and lift into EGI-ACE solutions that help the EGI-ACE data spaces be more interoperable with each other and with the broader landscape L: EGI-ACE T2.3 C: EGI-ACE WP5	Data spaces initiatives and projects	Document describing identified and adopted solution for data spaces interoperability	

5.2 B. Feedback to the EOSC Multi-Annual Roadmap

The EOSC Multi-Annual Roadmap (MAR) defines a set of priorities for future investment in EOSC. In March 2023, the EOSC Association launched a consultation to collect feedback on the draft MAR highlighting activities for the period 2025-2027[16]. The final version will be used also to define EOSC priorities for the related Horizon Europe Work Programmes. The EGI-ACE Consortium prepared a reply submitted in early April 2023 that is summarised in this section.

5.2.1 B.1 Feedback to defined priorities and outcomes

Objective 1 - Ensuring Open Science practices and skills are rewarded and taught, becoming the 'new normal':

To broaden the influence of the EOSC, it's important to bring both public and private sectors into the fold. Not only does this align with one of the identified outcomes, but it also allows us to better facilitate access and reuse of essential research components such as data, software, and services across a range of sectors.

In the private sector, it's important to promote the evolution of the EOSC Digital Innovation Hub (DIH). This can be achieved with the help of a cascade funding mechanism which encourages industry-specific use cases.

Turning our attention to the public sector, it would be beneficial to establish an entity such as the "EOSC Competence Centre for Public Administration". This centre would offer focused support to public authorities, aiding them in the implementation of open data practices and fostering a culture of sharing data and services as FAIR (Findable, Accessible, Interoperable, Reusable) assets.

To facilitate the work of this new centre, it would be advantageous to leverage the foundations laid in 2022 by the Data Driven Policy Cluster and the DT-GOVERNANCE-12-2020 project, spearheaded by the DECIDO project.

By adopting these measures, we can anticipate a rise in support for use cases within the industry and public sectors, leading to greater cross-sector adoption of open science outputs. This success will be largely attributed to the concerted efforts of the EOSC DIH, the proposed EOSC Competence Centre for Public Administration, and a robust engagement strategy with data spaces.

Objective 2 – Enable the definition of standards, and the development of tools and services, to allow researchers to find, access, reuse and combine results

Regarding "*European level: The EOSC Interoperability Framework Enables Data and Services Composition*", one of the existing priorities states "The EOSC Interoperability Framework should promote the automated combination of EOSC data and services." However, it's critical that we sustain and progress the EOSC Interoperability Framework over time. This ongoing advancement will aid in facilitating the automated integration of EOSC

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[16] EOSC MAR 2025-2027 Draft V3: https://www.eosc.eu/sria-mar

assets and ensure alignment with SIMPL more effectively. We should encourage active participation of the EOSC community in the SIMPL open-source community. This interaction will be a stepping stone to technical alignment and broader adoption.

The improvements to the EOSC Interoperability Framework (EOSC IF) should be distinctly classified, rather than being nested under "Develop and maintain open interfaces, alignments, crosswalks, and APIs that foster interoperability…". The reasoning behind this is that enhancing the framework itself, separately, will better support automated composition.

The potential outcome is a refined interoperability framework that leads to easy integration of data and services from numerous providers, thereby generating new solutions for data-driven science.

Objective 3 – Establish a sustainable and federated infrastructure enabling open sharing of scientific results:

Regarding "*European level: By the end of 2025 a sustainable EOSC Core should be available & further built on*", priority 3.1.A should extend beyond the testing of new Core capabilities. It ought to include the monitoring and evaluation of the EOSC Core services procured by the EC from 2023-2026, thus extracting lessons from both the procurement process and the implementation. These insights should subsequently be applied to future Core funding rounds.

In response to "*European level: Enhance the EOSC federation model by defining an operational and legal framework*", the range of priority 3.1.B needs expansion. The EOSC should be implemented as a federation, encompassing national, regional, and thematic nodes. These nodes should be integrated in EOSC services portfolio with the EOSC core and horizontal services, in addition to an initial network of European-level research data lakes. This would facilitate the availability of significant research data holdings for EOSC users. The outcome would be the implementation of the EOSC infrastructure as a federation of EOSC nodes, governed by Rules of Participation and an interoperability framework.

Pertaining to "*European level: Utilise and build on existing AAI as provided by AAI Federations*", priority 3.1.D should include the development of AAI solutions and technical support in the EOSC scope. The EOSC should persevere in the co-design, development, and delivery of AAI solutions that build upon existing AAI. We dispute the page 10 statement that 'EOSC should expect that there is no further need', given the ongoing evolution of architecture and technologies in AAI. EOSC needs to actively participate in co-design and co-development. The desired outcome is that EOSC stakeholders become technical innovators in AAI, meeting the requirements of research communities.

Concerning "*National level: Ensure across border AAI infrastructures via the NRENs*", national priority 3.2.M should be reworded to incorporate NGIs as key national contributors to AAI adoption among research communities. An example phrasing could be: "Member states should collaborate with the National Research and Education Networks and NGIs to ensure the AAI is available …"

For "*Institutional level: Support researchers to adopt the data and services federated by EOSC*", point 1.1.B 'Support the development of networks', should be expanded to comprise experts from the providers of key data, software, and processing services that are federated and utilised in EOSC. These experts should be mandated to administer a European-wide programme of open calls to user communities, promoting the active usage of such assets in EOSC. The expected outcome is that EOSC user communities receive effective support to access and utilise EOSC data and services, thus enhancing the impact and adoption of EOSC Exchange services.

5.2.2 B.2 Proposed new outcomes

With regards to changes for priorities in 2025 pertaining to the EOSC MAR, the following new outcomes were proposed:

Objective 1:

● EOSC user communities should receive effective assistance to access and utilise EOSC data and services. This, in turn, would boost the impact and acceptance of EOSC Exchange services.

Objective 2:

● Data and services from diverse providers should be easily amalgamated into innovative solutions for data-driven science.
● Demonstrated use of EOSC Core and Exchange services and resources, thereby providing validation for the EOSC concept by 2025.

Objective 3:

● The EOSC infrastructure should be implemented as a federation of EOSC nodes, underpinned by Rules of Participation and an interoperability framework.
● The EOSC should be established as a European-level federation of essential research data.
● EOSC stakeholders should be technical innovators in AAI, responding effectively to the needs of research communities.
● Every European researcher should have access to compute and storage resources to facilitate their experiments. Furthermore, research collaborations should be able to scale up their infrastructure utilising EOSC resources.

5.2.3 B.3 Proposed call topics for 2025 Work Programme

Here are the revised descriptions of the suggested themes for upcoming Work Programme(s):

● Topic: Enhancing European Networks for EOSC User Support and Training. The focus here is to bolster the development and provision of European networks aimed at aiding and training EOSC users. The primary aim is to simplify the process of identifying, selecting, and adopting services.

- Topic: Establishing a Data Infrastructure with public datasets[17]. This topic seeks to foster the creation of a data infrastructure featuring public datasets, which will aid in the formulation of public policy. The task will involve identifying datasets of broad interest, recognising the necessary services for their analysis and exploitation, and developing an analytics platform to harness them for the enhancement of public policy.
- Topic: Distributed and Cloud Computing Resources for EOSC Researchers. This topic is focused on providing EOSC researchers with distributed and cloud computing resources. These resources will enable researchers to process and analyse data in distributed computing environments via the EOSC Compute Platform.
- Topic: Sustaining Innovation and Delivery Programs in the EOSC Core. We recommend looking into alternate funding schemes that are more accessible for public institutions, such as Framework Program Agreements, for the delivery of these programmes. Current public procurement methods considerably diminish public institutions' chances of participation.
- Topic: Elevating Authentication and Authorisation Services in EOSC. This involves:
  - Promoting consistent adoption of varying levels of assurance in EduGAIN Identity Providers (IdPs), to enhance trust and service access
  - Encouraging the uniform adoption of identity attributes across scientific communities, to facilitate fair access for users from diverse communities
  - Developing an authorisation module for services that take into account EduGAIN levels of assurance and community attributes to accelerate adoption
  - Broadening the acceptance of EduGAIN within European organisations to expand access to EOSC services.

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[17] This topic could also be tailored to create thematic spaces and processing tools towards addressing societal needs