NEANIAS
Novel EOSC services for Emerging Atmosphere, Underwater and Space Challenges

Whitepaper: Best practices for service onboarding the EOSC hub

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NEANIAS is a project that comprehensively addresses the 'Prototyping New Innovative Services' challenge set out in the 'Roadmap for EOSC' foreseen actions. It drives the co-design, delivery, and integration into EOSC of innovative thematic services, derived from state-of-the-art research assets and practices in three major sectors: underwater research, atmospheric research and space research. In each sector it engages a diverse set of research and business groups, practices, and technologies and will not only address its community-specific needs but will also enable the transition of the respective community to the EOSC concept and Open Science principles. NEANIAS provides its communities with plentiful resource access, collaboration instruments, and interdisciplinary research mechanisms, which will amplify and broaden each community's research and knowledge generation activities. NEANIAS delivers a rich set of services, designed to be flexible and extensible, able to accommodate the needs of communities beyond their original definition and to adapt to neighbouring cases, fostering reproducibility and re-usability. NEANIAS identifies promising, cutting-edge business cases across several user communities and lays out several concrete exploitation opportunities.

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The European Union (EU) was established in accordance with the Treaty on the European Union (Maastricht). There are currently 27 member states of the European Union. It is based on the European Communities and the member states' cooperation in the fields of Common Foreign and Security Policy and Justice and Home Affairs. The five main institutions of the European Union are the European Parliament, the Council of Ministers, the European Commission, the Court of Justice, and the Court of Auditors (http://europa.eu.int/).

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Abstract

The NEANIAS EU project develops thematic services for EOSC communities in the field of Underwater, Atmospheric and Space research. The integration of the thematic services into the EOSC ecosystem together with the investigation of the possibility of onboarding a number of core services to EOSC as well are among the main project targets to pursue. Furthermore, the reuse of EOSC services for the purposes of NEANIAS services is another key challenge of the project towards EOSC integration.

This white paper presents an overview of the NEANIAS journey towards EOSC integration; from the preparation of an initial integration plan to its realisation through the onboarding of NEANIAS services on EOSC marketplace. The white paper emphasises on experiences gathered, issues encountered and lessons learnt throughout this journey, which may prove helpful to other service providers planning for EOSC onboarding.

1. Introduction

NEANIAS is an EU funded project, which aims to develop and integrate services to EOSC in the field of Underwater, Atmospheric and Space research. The objective of integration is to share these thematic services with scientific researchers of EOSC communities on these fields.

This white paper reports on the accomplishments of NEANIAS activities towards EOSC integration as they were realised by the time of its preparation. It also highlights the difficulties encountered and the solutions adopted in some cases. Good practices and lessons learnt are also presented in this document.

At the time of writing this document, the project has already onboarded eleven (11) thematic services (TRL7 or greater) and three (3) core services (TRL8 and 9) to the EOSC Marketplace.

This white paper has been written based on the current EOSC landscape, which is a continuously evolving environment, and provides up-to-date information as regards several fields related to EOSC integration, such as architecture, application programming interfaces (APIs), onboarding process, access mechanism, federated services and so on.

The structure of this document is as follows: Section 2 makes a general overview of the European Open Science Cloud (EOSC) and its latest developments. Section 3 presents the EOSC onboarding process, the issues and the solutions given, the difficulties and the final achievements of NEANIAS regarding EOSC integration. Section 4 presents good practices, identified by NEANIAS service providers during their efforts for EOSC onboarding, for future help of EOSC-related activities by other service providers. Finally, the conclusions are presented in Section 5.

2. Overview of European Open Science Cloud (EOSC)

The European Open Science Cloud (EOSC) is a European Commission initiative aiming at a trusted, virtual, federated environment in Europe to store, share and re-use digital output from research (publications, data and software) across borders and scientific disciplines. The envisaged infrastructure is established by aggregating services, software, data and other types of scientific outputs from a diverse set of providers.

The EOSC initiative started in 2015, and the first phase of EOSC development finished under a multi-layered, interim governance structure that was active from November 2018 until the end of 2020. In the initial phase of development until the end of 2020, the Commission invested around €320 million to start prototyping the EOSC through project calls in Horizon 2020 - the Commission's research and innovation funding programme.

The EOSC Association is the legal entity established to govern the European Open Science Cloud. It was formed on 29th July 2020 with four founding members and has since grown to over 200 Members and Observers.

EOSC has a "core", the set of services providing the means to discover, share, access and re-use data and services. The initial version of the EOSC core was developed and operated by the EOSC-hub project between 2018 and 2020. The EOSC Portal (https://eosc-portal.eu/) is part of the EOSC core, and during 2021 it was operated and further developed by the EOSC-Enhance project. Now, the developments of the EOSC core (and EOSC ecosystem in general) are being monitored by the EOSC Future project. The EOSC Portal provides a European delivery channel connecting the demand-side and the supply-side of the EOSC and all its stakeholders.

EU countries and countries associated with Horizon 2020, represented in the EOSC Governance Board, agreed unanimously to run the EOSC as a co-programmed European Partnership under Horizon Europe from 2021. Horizon Europe is the Commission's research and innovation funding programme, succeeding Horizon 2020 from 2021. The new governance model agreed with EU countries for the next EOSC implementation phase after 2020 will be tripartite including:

- The EU represented by the Commission
- The European research community represented by the EOSC Association
- EU countries and countries associated with Horizon Europe represented through a Steering Board to be set up in 2021 outside of the EOSC Association

2.1. Current view of the Minimal Viable EOSC

The EOSC Future project is an EU-funded H2020 project which is currently developing an operational platform for the European Open Science Cloud (EOSC) that provides access to integrated research products, services, and infrastructures by consolidating and scaling up the existing EOSC Portal (a gateway to information and resources in EOSC). In turn, EOSC is a key enabler of open science, allowing researchers and research communities to openly and collaboratively share and exploit resources to conduct their research.

Minimal Viable EOSC comprises the core functions that are required to operate the platform and bring added value to researchers. Its main goal is to connect disciplinary infrastructures

and research data to enhance disciplinary, cross-disciplinary and transnational research, leading to new scientific discoveries and new insight for society. It consists of four components as shown in the following figure: EOSC-Core, and subsets of EOSC-Exchange, EOSC Interoperability Framework and EOSC Support Services, that work with the FAIR datasets to be federated via EOSC.
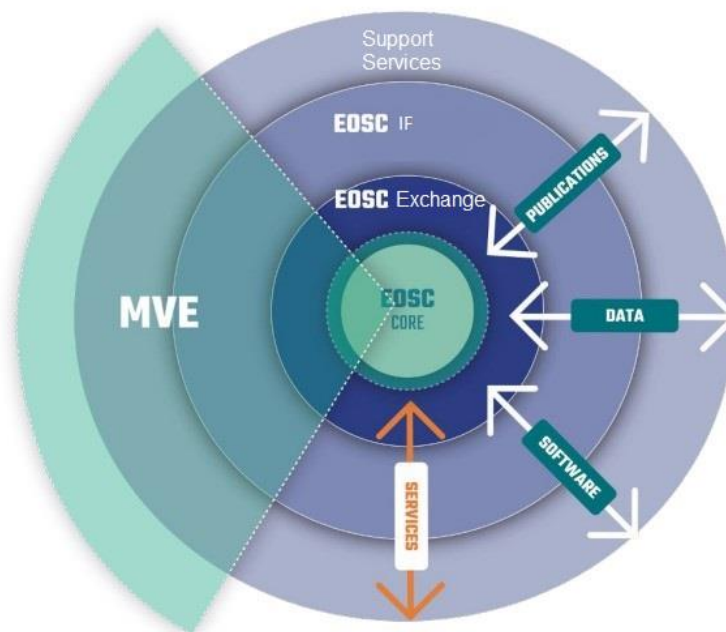

Figure 1: Minimal Viable EOSC

EOSC-Core is a set of internal services that allows EOSC to operate and includes a technical platform to facilitate EOSC operations and non-technical coordination services to support the platform. It is based on FAIR data principles and includes the minimum set of components necessary to provide, share, access and re-use data and services (such as monitoring, AAI, helpdesk etc.).

EOSC-Exchange includes services and data sources onboarded to EOSC by research infrastructures, clusters and projects, serving the needs of one or more research communities as well as the general public and private sector. It consists of a set of disciplinary and horizontal/cross-disciplinary services that make EOSC a rich environment where researchers can easily find and access resources to perform high-impact research. There is no registration fee for participation in EOSC-Exchange as a service provider, but certain technical requirements need to be met.

EOSC Interoperability Framework includes all the overarching standards and guidelines connecting and supporting the interoperability and composability of available resources in the EOSC-Core and EOSC-Exchange, such as Guidelines for Direct Usage (onboarding a provider or a service in order to be compliant with the restrictions of the catalogue), Guidelines for Ticket Redirection, Guidelines for Full Integration with EOSC Helpdesk etc. The EOSC Interoperability Framework is a generic framework that can be used by all entities that are participating in the development and deployment of EOSC, providing a common understanding of the

requirements, challenges and recommendations that they should take into account, as well as a general set of principles on how these recommendations may be addressed.

The EOSC IF is structured according to the four interoperability layers:

- Technical interoperability – is "ability of different information technology systems and software applications to communicate and exchange data"
- Semantic interoperability – is "the ability of computer systems to transmit data with unambiguous, shared meaning"
- Organizational interoperability – is the way in which organizations align their business processes, responsibilities and expectations to achieve commonly agreed and mutually beneficial goals
- Legal interoperability – the data should be reusable, following the FAIR principles

Finally, the **EOSC Support Services layer** is used to describe all the human-centric activities (including monitoring, training, and engagement) which support the operation of the EOSC platform and make EOSC attractive and easy to use.

2.2. EOSC Portal

The EOSC Portal is one of the components of the EOSC core platform; it is the gateway to information and resources in EOSC. The EOSC Portal was officially launched in November 2018 and it is hosted on Cyfronet servers. It was implemented by the eInfraCentral, EOSCpilot, EOSC-hub and OpenAIRE-Advance projects. In 2019 the Portal has been updated and maintained with in-kind contributions by the eInfraCentral, EOSCpilot, EOSC-hub, and OpenAIRE-Advance projects and on the 1st of December 2019, the EOSC Enhance project started with the mandate of bringing forward the developments of the EOSC Portal, running until the end of November 2021. From that day on the EOSC Portal is being maintained and updated by the EOSC Future project.
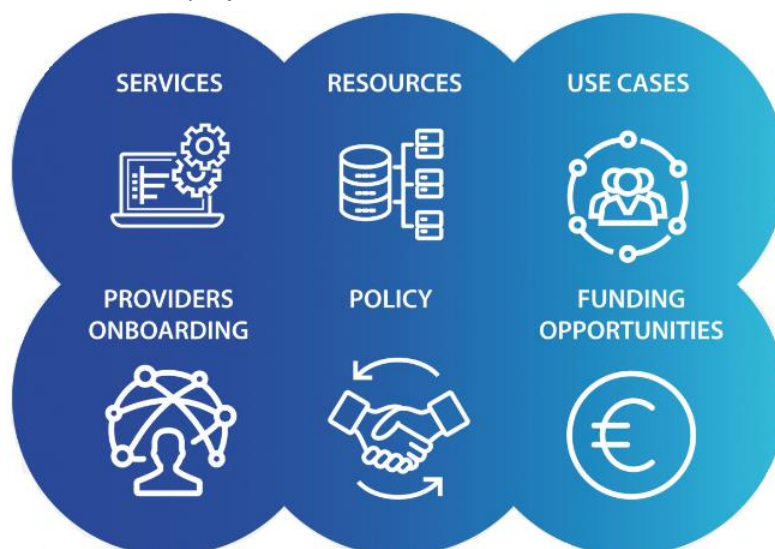

Figure 2: EOSC Portal overview

The EOSC Portal is part of the EOSC implementation roadmap as one of the expected "federating core" services contributing to the implementation of the "Access and interface" action line. It has been conceived to provide a European delivery channel connecting the demand-side and the supply-side of the EOSC and all its stakeholders.

It contains all the information for entering and using the EOSC catalogue both from provider and user prospective. It consists of four main components:

- The portal Home page (https://eosc-portal.eu/)

  It is the landing page of the EOSC Portal, hosting all the relevant information about it, its creation and maintenance. It offers direct entry to the providers (and users in general) documentation page. When visiting EOSC portal home page, users can find example, training material, media cases and detailed documents about using, uploading and updating products of the portal.

- The Providers portal (https://providers.eosc-portal.eu/home)

  This option enables the front-end functionality for the registration of EOSC Providers, organizations entitled to publish their resources via the EOSC Catalogue, and offers them capabilities to onboard and manage EOSC resources. It also offers the Provider dashboard, where representatives from provider organizations have a detailed view on their offerings in the EOSC portal as well as various usage statistics on their resources. Finally, it offers to members of the onboarding team of the EOSC portal the functionality to manage the EOSC portal catalogue entries, i.e., manage the onboarding process of providers that apply to list their resources in the portal, audit on the onboarded resources, etc.

- The Marketplace (https://marketplace.eosc-portal.eu/)

  The Marketplace is the EOSC Portal tool where researchers can discover, order and access the services, analytical tools, data management tools, storage and computing resources they need for their work.

- The helpdesk page (https://eosc-helpdesk.eosc-portal.eu)

  The helpdesk page can be directly accessed by clicking the button Help Desk at the home page. The user is being redirected to Zammad helpdesk environment where any inquiries can be submitted.

2.3. EOSC Service Catalogue

The heart of the EOSC Ecosystem is the EOSC Service Catalogue. It is the repository component offering the necessary programmatic interfaces for the addition, modification, and access to information regarding providers, resources and user activity collected in EOSC portal. Users can browse by scientific domain, resource category or provider and also find helpful material for the right use of the catalogue (if needed). This component offers the underlying storage functionality and the interoperability tools for the programmatic access, registration, manage of providers, services, and catalogues. It also offers the necessary API functionality for the interoperability of service catalogues from individual providers or aggregators (e.g., thematic, or regional catalogues) with the EOSC portal.

The functionality offered by the EOSC Service Catalogue includes:

- For providers
  - Onboarding
  - Management of resources
  - Live usage statistics from the EOSC Providers Portal
  - Email notifications
  - Interaction with EPOT team
- For EPOT team members
  - Onboarding management
  - Auditing and Catalogue management
  - Email digest and interaction with providers
- For other users (funders, EOSC profiles management (vocabularies, schema, etc.)
  - Statistics

One of the major challenges that the EOSC aims to address is the historical lack of Interoperable Online Catalogues of Research Resources that European Researchers could explore across Europe. EOSC Profiles are specifications that define common data models for EOSC entities (Providers, Resources, etc.) and related Code Lists, Taxonomies and Classifications. They contribute to the unified framework for describing and offering EOSC Resources to end-users. In order for EOSC service catalogue to be interoperable with and accessed by more catalogues these requirements must be met.

2.4. Role of NEANIAS (services) in the EOSC Ecosystem

As already mentioned before, EOSC-Exchange is the overall ecosystem of service providers who interact with the EOSC Core. It includes services and data sources onboarded to EOSC catalogue by the research community and makes EOSC a rich environment where researchers can easily find and access resources to perform high-impact research.

One of the major goals of the NEANIAS catalogue was to onboard a lot of its services to the EOSC Ecosystem. This intent was denoted through the very early steps of the project and the goal was achieved by onboarding and updating 14 services (11 thematic and 3 core), thus benefiting both catalogues.

From NEANIAS aspect, uploading resources to a European fast-growing catalogue will make those resources available and accessible long after the end of NEANIAS project. The research community will be able to search, order and use those services, as they will continue to be updated, through EOSC catalogue.

The impact is also remarkable for the EOSC catalogue. Even though there are much more services uploaded on EOSC catalogue, the quality of the ones deriving from NEANIAS, could make the EOSC ecosystem more appealing to the users. The already uploaded services are spread across the three thematic axes of the NEANIAS catalogue: Atmosphere, Space and Underwater and offer a great amount of data on those sectors, allowing researchers to find, access, reuse and combine results with other services.

Finally, NEANIAS was one of the first catalogues to make use of the EOSC Interoperability guidelines and use the available APIs to upload and synchronize resources with the EOSC catalogue. Now, the user of NEANIAS catalogue has the option to update its products only on NEANIAS catalogue or on both NEANIAS and EOSC. The update pop-up window of NEANIAS catalogue has been modified to provide this option. If the latter is selected, the user has to

provide a personalized token (issued by EOSC catalogue, unique for every e-mail, with validity of 1 hour), so as to confirm its administrative rights on both catalogues. This procedure, though, cannot be used for registering products for the first time on EOSC catalogue. The products must be already uploaded and approved by the EPOT team and only then they could be synchronized and be update simultaneously. Through this activity, NEANIAS achieved to adapt to evolving technical specifications (EOSC Profiles and APIs), new procedures and service management guidelines, thus aiding with detection of technical errors, gaps, and opportunities for other thematic and regional catalogues, which would also like to adopt to the EOSC Interoperability Framework. EOSC procedures were further refined and any misconceptions occurred were diminished. More details on the steps followed and the lessons learnt from this activity are provided in the next sections.

3.   Onboarding services to EOSC

3.1.   EOSC onboarding process

EOSC poses the following requirements, aka. 'Rules of Participation' (RoP), on services in order to be eligible for onboarding:

- The service is accessible to users outside its original community.
- The service is described through a common template focused on value proposition and functional capabilities.
- At least one service instance is running in a production environment available to the user community.
- Publish Research data which is Findable, Accessible, Interoperable and Reusable.
- Release notes and sufficient documentation are available.
- Helpdesk channels are available for support, bug reporting and requirements gathering.

The onboarding process [1] is the process that an EOSC Provider must follow to register the Provider and its Resources in the EOSC Portal Registry. The Registry provides EOSC System Users with a list of live/ready-to-use descriptions of EOSC Resources offered by the EOSC System. Every entry of the EOSC Registry must comply with and be described and updated following the EOSC Portal Interoperability Framework which includes, among others the EOSC Profiles, the EOSC Rules of Participation (RoP) and the EOSC Portal Application Programming Interface (APIs) methods for the automatic provisioning and synchronisation of information between Providers' systems and the EOSC Portal.

Until very recently (August 2022), EOSC Portal was using the EOSC Portal Onboarding Process (EPOP) v3.00, developed by EOSC Enhance. EPOP v3.00 specified only the onboarding of Providers and their Resources, and was organised in 3 distinct Phases (further implemented in 10 Stages):

- Phase A: An Authorised Representative of a Provider registers him/herself into the EOSC Portal.
- Phase B: The Authorised and Authenticated Representative of a Provider onboards (and updates) the Provider.
- Phase C: The Authorised and Authenticated Representative of a Provider onboards (and updates) the Resources offered by the Provider.

EPOP v3.00 was followed by NEANIAS service providers for the onboarding of their services on EOSC.

The EOSC onboarding process v4.00, which enhanced EPOP v3.00 based on Requests for Changes received and adopted by EOSC Enhance, although similar to EPOP v3.00 introduces some new features such as:

- The Ordering Capability (additional onboarding Phase).
- The onboarding of trusted Multi-Provider Regional and Thematic Portals (MPRTP) (additional distinct EPOP to cover cases where the Requestor is not the owner of the Resources but rather an aggregator, broker or of other similar roles).

This way, EPOP v4.00 consists of 5 distinct Phases:

- Phase 1: An Authorised Representative of a Provider (ARP) registers into the EOSC Portal.
- Phase 2: The Authorised and Authenticated Representative of a Provider (AARP) onboards the Provider (organisation).
- Phase 3: The AARP onboards the Resources offered by the Provider.
- Phase 4: The AARP onboards the Options/Offerings of a Resource offered by the Provider.
- Phase 5: The AARP and the EPOT maintain the quality of the Profiles.

Application for onboarding a new provider should be done by the Authorised Representative of the Provider (AARP), who at this point has simple user rights in the catalogue. The new provider will not be visible and listed to the catalogue until approval by the EOSC Portal Onboarding Team (EPOT). If not rejected, the newly applied provider will become activated and visible to the catalogue. Then, the user who onboarded the provider will be listed in the administrator tab and have augmented access functionality. From that point on the administrator can make changes to the provider's entry, add more administrators or even delete the provider.

Once the provider has been onboarded, the population of the catalogue with services of that provider can begin. The AARP should select the method to onboard resources (via the Web Interface or via the API) upload their new resource and wait until approval from the EPOT team, so as the resource to become visible in the catalogue.

The EPOT will create a Review and Feedback Report. Upon the request of the Provider the EPOT can provide best practices, feedback, and consultation to Provider.

In simple terms, for onboarding a service to the EOSC portal, the service provider shall first identify the person, who will assume all tasks related to the registration of the provider on EOSC, and thus will act as the Authorised Representative of the Provider in what EOSC is concerned. It is advised that this person assumes a technical role related to the service(s) to be onboarded in order to be familiar with the information that will be needed, but also be in close collaboration with the management of the provider so as to be able to address issues that require management approval. The representative of the provider, after being properly authenticated on EOSC portal, needs to fill-in some information on the provider's organization in order to register the provider on EOSC. When this information, which comprises the Provider Profile on EOSC, is reviewed and validated by the EOSC Portal Onboarding Team, the representative of the provider may continue with onboarding Resources (i.e. Services) on

EOSC, by completing another standardized form called Resource Profile. The Resource Profile covers more detailed information which enables the EOSC Portal Onboarding Team to determine that the service fulfils all requirements of the 'Rules of Participation' in addition to information needed to populate the EOSC Service Portfolio entry corresponding to the new service. The Resource Profile is a longer form, requesting information about a service in the following categories (fields marked with an asterisk are mandatory):

- Basic Information (*): ID (assigned upon creation-NOT changeable), Name (*), Abbreviation (*), Resource Organization (*), Resource Providers, Webpage (*)
- Marketing Information (*): Description (*), Tagline (*), Logo (*), Multimedia, Use Cases
- Classification Information (*): Scientific Domain and Subdomain (*), Category and Subcategory (*), Target Users (*), Access Type and Mode, Tags
- Availability Information (*): Geographical (*) and Language (*) Availability
- Resource Location Information: Geographic Location a service is hosted or deployed (including the data processed by the service).
- Contact Information (*):
  - Main Contact/Resource Owner and Public Contact (*): Name, Email, Phone, Position, Organization
  - Public Contacts (*)
  - Helpdesk Emai (*) l, Security Contact Email (*)
- Maturity Information (*): Technology Readiness Level (*), Life Cycle Status, Certifications, Standards, Open-Source Technologies, Version, Last Update, Change Log
- Dependencies Information: Required Resources, Related Resources, Related Platforms, Catalogue
- Attribution Information: Funding Body, Funding Program, Grant/Project Name
- Management Information: Helpdesk Page, User Manual, Terms Of Use, Privacy Policy, Access Policy, Resource Level, Training Information, Status Monitoring, Maintenance
- Order Information (*): Order Type (*), Order
- Financial Information: Payment Model, Pricing

The procedure described above is part of the applied profile of the EOSC catalogue (profile version 4.00). Profiles on the EOSC Portal are updated by Providers and periodically audited by the EPOT team.

3.2. NEANIAS experiences with EOSC onboarding

3.2.1. The NEANIAS journey towards EOSC integration

The NEANIAS consortium had set a very ambitious although specific and measurable target towards EOSC integration from the very beginning: to onboard nine (9) thematic services to EOSC; 3 services from each sector (Underwater, Atmospheric and Space research). In order to achieve this target, which also constitutes a project KPI, NEANIAS developed the initial version of its **EOSC integration plan** [2] quite early in the project (Month 9), which, after reviewing and comparing integration approaches, procedures, and relevant services discovered as part of the EOSC landscape monitoring activities, introduced the NEANIAS strategy for EOSC integration.

The entire integration plan was developed in a way that could enable the achievement of three (3) fundamental goals defined since the beginning of the project:

1. Publish NEANIAS thematic services in EOSC. Consider the publishing of additional NEANIAS services in EOSC in a future stage.
2. Integrate NEANIAS services (thematic and core) with relevant EOSC services, where we see value of the integration (e.g. to enhance our operations, to deliver more features to users).
3. Develop the NEANIAS IT Service Management System gradually, and in an EOSC compatible way.

An agile approach, based on successive development cycles bringing NEANIAS services from very basic EOSC integration with minimal functionalities to more complex EOSC integration with advanced capabilities, was followed in the effort of achieving the above goals.

A fundamental part of the EOSC integration plan of NEANIAS was the reuse of and integration with EOSC services. After investigating the needs of NEANIAS thematic services, NEANIAS initially targeted EOSC services for integrating with in the following areas:

- EOSC portal

- Authentication and authorization

- Monitoring

- Accounting

- Helpdesk

- Data Management Planning

- Data Catalogue

The EOSC integration plan was being monitored throughout the project, and was assessed and fine-tuned near the middle of the project duration (Month 22) [4] in order to take into consideration good practices and issues encountered during the EOSC onboarding of the first NEANIAS services as well as changes in the EOSC landscape. Two additional project deliverables [5][6] formally reported on the accomplishments of NEANIAS activities towards EOSC integration, thus enabling NEANIAS consortium to have a clear insight on achievements and plan corrective actions where needed.

Another key factor during EOSC integration efforts was the development of the **NEANIAS catalogue portal** (https://catalogue.neanias.eu/), which is the main entry point for NEANIAS services and resources, in parallel with the development of the NEANIAS services themselves. The catalogue portal served as a test bed for NEANIAS service providers, initially by helping them understand how to model their services and then by enabling them to start formulating a service management culture within their organisations.

Last but not least, the setup of **an IT Service Management** for NEANIAS purposes was put very high in the project priorities, mainly due to the large number of services expected to be developed and the complexity of integrations planned, both internal (i.e. among different NEANIAS services) and external (e.g. with EOSC services). The NEANIAS service management system [3] defined the set of policies, objectives, processes, procedures and tools, etc.,

required to support the design, development and delivery of NEANIAS services. The establishment of the NEANIAS service management system ensured that the entire lifecycle of NEANIAS services is governed by specific rules, which in turn ensured that the services were developed and operated in a consistent manner. NEANIAS chose to develop an IT Service Management System of its own, which is nevertheless compatible with the EOSC one.

The NEANIAS SMS is supported by the following tools:

- The NEANIAS catalogue portal, which provides the interface to service providers to register and describe their services, presents information about the services that NEANIAS provides to users, enables service ordering, and provides the interface to users for submitting incidents and service requests, complaints, requirements about services, etc.
- The NEANIAS service management IT system[1], which monitors the lifecycle of incidents and service requests, complaints, changes, etc.
- The NEANIAS wiki, which stores information about the processes of the NEANIAS service management system.

The above tools are complemented by own tools of the thematic/core service providers, which focus on the more technical aspects of service management (e.g. performance monitoring, logging, event management, capacity management etc.).

3.2.2. Issues encountered and solutions given

Throughout the journey of onboarding NEANIAS services to the EOSC marketplace, despite the overall positive experience, some issues were encountered, and solutions had to be given upon the appearance of each difficulty.

First was the **identification of the Authorized Representative of Provider** (ARP). Although this should be something very easy to address, most of the service providers, especially during the beginning of the onboarding, faced some difficulties and delays in identifying and authorizing a person to act as the "Representative of the Provider" in what EOSC is concerned. This was more evident with service providers belonging to the research and academic sectors than with providers having a private company status, and was due to the organization and the internal procedures these providers had to follow (e.g. submit a recommendation to the BoD in order to get a decision). After the first 2-3 cases where this issue occurred, we advised, under NEANIAS WP8 facilitation, all NEANIAS service providers to identify their EOSC representatives as soon as possible, even way before they start onboarding their services on EOSC.

In addition to the above, we soon identified **the need to have non-IT personnel involved in the onboarding process**, something that was not initially foreseen. Resource profiles requirements associated, for example, with the Provider Manager, the Resource (service) owner and the resource contacts weren't always obvious for the technical personnel of the providers to complete or it was even out of their jurisdiction. The same difficulty was encountered with the preparation of access policies, privacy policies and terms of use for each

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[1] The NEANIAS service management IT system implements a workflow-type functionality on a ticketing software platform (redmine).

service, which on one hand require specific expertise and on the other need to be approved by the provider's management. In order to overcome this issue, we gave specific guidance to service providers as to how they could identify what to complete in the resource profiles. As regards policies and terms of use, we prepared relevant templates, in collaboration with legal persons with appropriate experience, and provided guidance to NEANIAS service providers on their adoption and "customisation" to the needs and the characteristics of their services.

In some cases, **a service was provided by multiple providers** (a lead provider and other supporting ones). In order to associate all providers to a service on EOSC portal, it is necessary for all providers to be registered on it. Although reasonable, this could delay the onboarding of a service, although it might be ready and fully operational, until all providers supporting it were registered on EOSC (which would also require all of them to define their Authorised Representative as discussed above). In order to avoid this situation, we chose to ignore the association of the 2nd provider with a service and proceed with onboarding the service. When and if the 2nd provider got registered on EOSC portal, proper correction was made.

Furthermore, a difficulty we encountered during the onboarding process was relevant to the **EOSC onboarding of multiple providers and services directly from the NEANIAS service catalogue**. Although NEANIAS services were modelled according to EOSC Profiles (v3.00 at that time) and we had developed the relevant catalogue API for facilitating the integration with EOSC, due to restrictions of the EOSC onboarding process, this API could not be used for the initial registration of a service provider to EOSC or the onboarding of the first service of this provider. This resulted on having to manually fill-in the provider and the service information from the NEANIAS service catalogue to the EOSC portal. However, the API was used later on (i.e. after the initial onboarding) for synchronising the information about NEANIAS services between the NEANIAS Catalogue with the EOSC Portal.

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Finally, regarding service ordering, after investigating the options provided by EOSC Order management, we chose to develop our own ordering mechanism on the NEANIAS service management IT system in order to achieve greater flexibility on granting/customising access to NEANIAS services. Additional to this ordering mechanism, we would also like to have a **pay-for-use ordering** option, which is currently investigated by service providers outside of NEANIAS project.

3.2.3. Final achievements regarding EOSC onboarding

Based on the NEANIAS plan for EOSC integration [2], following the EOSC onboarding process (see section 3.1) and after overcoming the issues presented in section 3.2.2, the NEANIAS project managed to onboard:

- eleven (11) thematic services (TRL7 or greater) and
- three (3) core services (TRL8 and 9)

to EOSC marketplace, thus exceeding its initial target to onboard nine (9) thematic services to EOSC.

More specifically, the following NEANIAS **thematic** services are available on EOSC Marketplace:

Table 1: NEANIAS thematic services on EOSC Marketplace

Thematic area	Service name	Lead provider	EOSC URL
UNDERWATER	Bathymetry Mapping from Acoustic Data	TELEDYNE	https://marketplace.eosc-portal.eu/services/uw-bat
	Seafloor Mosaicing from Optical Data	CORONIS	https://marketplace.eosc-portal.eu/services/uw-mos
	Seabed Classification from Multispectral, Multibeam Data	ATHENA	https://marketplace.eosc-portal.eu/services/uw-map
ATMOSPHERE	Greenhouse Gases Flux Density Monitoring	ATHENA	https://marketplace.eosc-portal.eu/services/atmo-flud
	Monitor atmospheric Perturbations and Components in Active Tectonic Regions / *Atmo-Stress*	ATHENA	https://marketplace.eosc-portal.eu/services/atmo-stress
	Air Quality Estimation, Monitoring and Forecasting	UBIWHERE	https://marketplace.eosc-portal.eu/services/atmo-4cast
SPACE	FAIR Data Management and Visualization for Complex Data and Metadata		
	SPACE-VIS ViaLactea Service	INAF	https://marketplace.eosc-portal.eu/services/space-vis-vialactea-service
	SPACE-VIS ADN Service	ALTEC	https://marketplace.eosc-portal.eu/services/space-vis-adn-service
	ADAM-SPACE	MEEO	https://marketplace.eosc-portal.eu/services/adam-space
	Structure detection on large map images with		

Thematic area	Service name	Lead provider	EOSC URL
	machine learning techniques		
	SPACE-ML CAESAR service	INAF	https://marketplace.eosc-portal.eu/services/space-ml-caesar-service
	SPACE-ML LSE service	UNIMIB	https://marketplace.eosc-portal.eu/services/latent-space-explorer

Additionally, the following NEANIAS **core** services have onboarded EOSC:

Table 2: NEANIAS core services on EOSC Marketplace

Service name	Lead Provider	EOSC URL
Artificial Intelligence services		
Data Exploration Service (ADAM Platform)	MEEO	https://marketplace.eosc-portal.eu/services/adam-platform
Distributed Multi-GPU training of large ML models using Horovod	SZTAKI	https://marketplace.eosc-portal.eu/services/distributed-deep-learning-by-horovod
Visualisation services		
Framework for Visual Discovery (VD) / *VD-Maps*	CORONIS	https://marketplace.eosc-portal.eu/services/vd-maps

4.   Good practices & Lessons learnt

From the beginning of the NEANIAS project, one of our main goals was the direct registration and onboarding of some of the catalogue products (providers and services) to the EOSC catalogue. The process was both interesting and educational, and the lessons learnt could be useful for future use, even by other interested parties.

The most important fact to take into consideration is to start organizing for this integration ahead of time; onboarding to a third-party catalogue could be a time-consuming procedure. In our case (as discussed in section 3.2.2) we encountered some difficulties with identifying the administrative representative of each provider, or even the other parties necessary for completing the procedure. Additionally, requirements, originating from the EOSC catalogue structure (such as providing Terms of Use and Privacy Policy documents), had to be met, causing delays in the onboarding of some NEANIAS services.

Even though the process of onboarding and synchronizing NEANIAS services to EOSC was challenging, the benefits obtained by that are multiple. NEANIAS services onboarded to EOSC have become available to an expanded group of users (simple users, researchers, universities etc.) and could continue evolving even after the end of the NEANIAS project.

4.1. Service modelling

Different service catalogues (e.g. EOSC catalogue, NEANIAS catalogue, other third-party catalogues) usually do not have the same format, validations and requirements, a fact that poses extra difficulty during their integration, if the latter has not been planned from the beginning. In order to make it as simple as possible, NEANIAS has developed and populated its own service catalogue before EOSC onboarding, and chose to follow a service model that adopts the EOSC one, namely EOSC Profiles (v3.00 at that time). This way, when the time for NEANIAS services to onboard EOSC came, service providers had already all the information in place on the NEANIAS catalogue and could copy it (due to the EOSC restrictions with the catalogue API, as discussed in 3.2.2) on EOSC marketplace forms.

Now that EOSC Resource Profiles moved to v4.00, we chose to evolve NEANIAS catalogue structure in order to adopt the changes proposed by EOSC in the new version, thus further ensuring our compatibility with EOSC developments.

4.2. Service owners and contacts

Our experience with the onboarding process and the operation of the services revealed that service providers should be careful on the selection of the owners and contacts of their services. Selecting a member of the upper management of a large organization as the contact person or the helpdesk contact for a service is not a good idea. Similarly, a mere technical resource is not a suitable candidate to fill in a management role, such as the role of the service owner. A more balanced approach could be to select a person from the management of the provider (at an appropriate level according to the size and internal organization of the provider) as the service owner, and people that support the operation of the service as helpdesk and security contacts, as well as service administrators as far as NEANIAS/ EOSC catalogue is concerned. Furthermore, the use of personal e-mail accounts as helpdesk/ security contacts for a service is discouraged in order to avoid issues due to changes of personnel fulfilling these roles.

4.3. Integrations with core services

4.3.1. EOSC Portal

The first integration with EOSC core services is the one with EOSC Portal / Service Catalogue, which is already presented in §2.2 and §2.3. Through this integration NEANIAS services are listed in the respective directory and can be located and consumed by EOSC users.

More specifically, a prototype implementation of the integration of the NEANIAS catalogue portal with the EOSC one through the EOSC API has been completed. Through this integration, changes on services on the NEANIAS catalogue portal are propagated to the EOSC

marketplace. In the next period we will work more for the full integration with the EOSC APIs. Additional details on this integration are presented in section 4.7.

4.3.2. EGI – Argo Monitoring Service

The EGI e-infrastructure federation provides service monitoring service in EOSC (http://argoeu.github.io/index.html) based on the ARGO system. This ARGO-based Service collects service status results from monitoring engine(s) and delivers status results and/or monthly availability (A) and reliability (R) statistics of distributed services. Both the status results and A/R statistics are presented through a Web UI, with the possibility for users to drill-down from the availability of a site to individual services, to individual test results that contributed to overall reliability/availability of the service. Argo is capable also to send notifications to the service admins in case of a failure/warning on one of the services monitored.

ARGO Service Monitoring keeps an eye on the performance of IT services and quickly detects issues and helps the providers resolve them. With Service Monitoring service providers can get:

- the activation of monitoring for their services with minimal effort
- a ready-to-use user interface
- automated reporting tools

Within the context of NEANIAS, the integration with the EGI-Argo monitoring service has been pursued from early stages of the project. For this reason and to pilot the integration, we relied on ARGO to monitor, from their early releases, two of our core services, the NEANIAS AAI and our Data Sharing Service (DaShaS). The list of monitored services expanded in parallel to the wider availability and maturity of the NEANIAS offerings. The benefits and insight the ARGO service provided were recognized to the extent that we considered a NEANIAS service integration with ARGO to be part of our base line requirements before a service was published to be made available in the EOSC catalogue of services.

In cooperation with the EGI-ARGO support team, we took advantage of the multi-environment support offered and initially created a development / staging configuration for our project (https://neanias.ui.devel.argo.grnet.gr/neanias/CORE) through which we had the opportunity to validate our monitoring approach and streamline the processes to define the monitored services, the validations performed and the lifetime and upgrade procedure management. After the successful configuration, the migration to the production grade monitoring setup (https://neanias.ui.argo.grnet.gr/) was straightforward and assisted by the ARGO support team.

Some key benefits and takeaways from our integration journey can be highlighted by the following:

- **Monitoring from the outside**: Although NEANIAS offers a monitoring service that is configured, deployed, and managed within the project, offering valuable findings, having the ability to employ an external monitoring service gave us the opportunity to monitor our services as an agent external to our infrastructure. As an example of what this approach has to offer, it is straightforward to understand how this approach can assist in cases such as connectivity issues outside from our data center network.
- **Complementary monitoring**: The opportunity to employ an internal NEANIAS Monitoring service which is complemented by an external, properly maintained and

supported one, such as ARGO, has multiplied our confidence in the ability to provide services of high quality and availability to our user-base.

- **Ease of integration**: Although the ARGO system offers a wide range of monitoring capabilities and integration options, it offers also a straightforward bootstrapping process for simple http based checks which we made use for the NEANIAS setup. Though configuration ingestion mechanisms require simple automation integrations, the service catalogue, service information, monitored endpoints and lifetime and upgrade events are easily ingested in the system.
- **Validated SMS with external flows**: Several of our Service Management System (SMS) processes had the opportunity to be validated not just with in-house procedures but also with external pipelines. The release processes were updated to include third party service updates and ensure that our service users could receive on-time notifications and updates on our service availability.
- **Downtime & Upgrade:** The scheduled maintenance and upgrade definition process and the ingestion paths of the information to the ARGO system, has allowed us to build a common approach which, in line with our Service Management System, ensured that the complex and reuse-driven dependency network of the NEANIAS services could identify affected service from scheduled downtime and feed both the internal and external monitoring services.
- **Catalogue Integration:** Expanding over the monitoring, alerting and reporting capabilities offered by the ARGO service, it was decided to seek further integrations. To this end, the NEANIAS Catalogue service has made use of the APIs offered by ARGO and has included in the service listing an indication on the current status of each service for the user's information.

In addition to monitoring the liveliness and expected behavior of our services, two main metrics that are produced by the ARGO monitoring service and we take under consideration while evaluating our NEANIAS Key Performance Indicators (KPIs) are:

- Availability – Service Availability is the fraction of time a service was in the UP Period during the known interval in a given period.
- Reliability – Service Reliability is the ratio of the time interval a service was UP over the time interval it was supposed (scheduled) to be UP in the given period.

4.3.3. EGI – Check-in

Within the context of the NEANIAS AAI service, the goal of expanding the user-base but also facilitating the EOSC research community to use the NEANIAS services easily and securely, was pursued by enabling authentication and registration to the NEANIAS catalogue of users, principals that are authenticated through external identity providers. One of the main participants of the NEANIAS identity federation includes EGI Check-in. The integration with EGI Check-In brings the NEANIAS services closer to the EOSC user base providing more streamlined access from the EOSC portal catalogue of services.

Although EGI Check-in is not an EOSC core component it essentially acts in an equivalent manner for NEANIAS services. EGI Check-in is a proxy service that operates as a central hub to connect federated Identity Providers (IdPs) with EGI service providers. Check-in allows users

to select their preferred IdP so that they can access and use EGI services in a uniform and easy way. As some of its main characteristics, the service:

- Enables multiple federated authentication sources using different technologies
- Federated in eduGAIN as a service provider, publishing REFEDS RnS[2] and Sirtfi[3] compliance
- User registration portal to allow accounts-linking
- Combines user attributes originating from various authoritative sources (IdPs and attribute provider services) and delivers them to the connected EGI service providers transparently.
- Increased productivity and security.

Check-in enables single sign-on to services through eduGAIN and other identity providers. Users without institutional accounts can access services through social media or other external accounts, including Google, Facebook, LinkedIn or ORCID. Both SAML- and OpenID Connect-based services can be integrated with Check-in with very little effort to enable users to authenticate with their own credentials. As an authentication service Check-in will:

- Enable eduGAIN identity providers
- Enable social media credentials
- Enable X.509 certificate credentials
- Enable users to link their accounts

The registration process for a Service Provider integration with the EGI Check-In is straightforward and well documented. The initial set of information imposes minimal overhead, assuming a starting point of high service maturity level, compatible with the profile information maintained within NEANIAS for its user catalogue. This information includes:

- Name of the service
- Short description of the service
- Site (URL) for localized information about the service
- Contact information including Helpdesk/Support, Administrative, Technical, Security/incident response
- Service Privacy statement
- Logo URL
- Country of the service
- Compliance with the EGI Policies and the GÉANT Data Protection Code of Conduct

The integration process includes registration for separate instances of EGI Check-in:

- Development: This is where an integrating service can test new features that are not available in production yet
- Demo: The demo instance allows for testing authentication and authorization through the academic and social Identity Providers connected to Check-in without affecting the production Check-in service and has identical functionality to the production instance
- Production: The production instance is the final goal of integration

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[2] https://refeds.org/
[3] https://aarc-project.eu/policies/sirtfi/

This separation and categorization of instances was also aligned with the NEANIAS approach of the AAI and testing realms defined for the release process of our services. For this purpose, the NEANIAS development realm was used to integrate with the Check-in Demo instance, while, after the validation, the production realm was registered with the Check-in production instance.

The available scopes that can be requested for a logged-in user include: openid, voperson_id, email, profile, offline_access, eduperson_entitlement, eduperson_scoped_affiliation, eduperson_unique_id, aarc, orcid. Out of these, the NEANIAS integration included:

- openid, voperson_id – The User's Community Identifier is a globally unique, opaque, persistent and non-reassignable identifier identifying the user.
- Email – The user's email address.
- Profile – Including the Display Name, Given Name, Family Name, Username of the user.
- eduperson_entitlement – Describing the resource or child-resource a user is allowed to access, optionally specifying certain actions the user is entitled to perform.

To maintain the relation and profile information for properties shared from the Check-in service to the NEANIAS AAI, an explicit mapper pipeline was introduced so that voperson_id and entitlements are stored as user attributes within the NEANIAS AAI. As it is envisioned that multiple, linked, credentials from federated identities could be utilized at some point, the user stub entry created within NEANIAS AAI receives its own identifying subject id and the relation to EGI Check-in is kept as one of the federated links to this identity.

Though the successful integration with the EGI Check-in service, we did not only manage to expand and streamline our user access and onboarding process, but we also validated that our Service Management System processes that applied for these cases can uniformly be applied across federated identity provider registrations and ensured that our internal AAI client registration process is inline with the one that Check-in has developed, evolved and applied over the course of its usage.

In parallel to the work performed on integrating to the EGI Check-in service, we are monitoring the evolution of the EOSC AAI Federation which would enable the NEANIAS AAI to connect as an Infrastructure Proxy (SAML Service Provider) through a SAML IDP federation, as is described in the AARC / EOSC AAI architecture[4]. We are actively monitoring the work performed on this front, especially the forked parallel evolution of the "EOSC keycloak"[5] work and how that work is pushed back to the main line of development of the official keycloak[6] distribution, as this technology is enabling the NEANIAS AAI.

4.3.4. Zenodo

Among the stepping-stones for bridging NEANIAS with the EOSC ecosystem is the integration with Zenodo. The reason is that Zenodo delivers mechanisms that satisfy several priorities set by NEANIAS technical management, including discovery, storage (or linking), publication and formalization of description of research artifacts as well as association with formal Persistent Identifiers (DOIs).

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[4] https://aarc-project.eu/wp-content/uploads/2019/05/AARC2-DJRA1.4_v2-FINAL.pdf

[5] https://github.com/eosc-kc/keycloak

[6] https://github.com/keycloak/keycloak

Apart from the strategic, but not obligatory for thematic services, directive for exploitation of Zenodo service offerings, NEANIAS took a few more steps into integrating services with it:

- Strongly supported the integration of OpenDMP system, which is behind the OpenAIRE Argos service in integrating with Zenodo. The particular integration, which is mainly implemented in the context of OpenAIRE Nexus project, targeted several Zenodo API offerings, including the publication/deposition of data, PID issuing and discovery of datasets. NEANIAS contribution rested mainly in contributing to problem solving and minor usage aspects refinements, both driven by NEANIAS usage of the platform.
- Designed a multi-part mechanism for facilitating the integration of NEANIAS services and storage management platform with Zenodo, named Zenodo Bridge, vastly reducing the steps and flow for the thematic service providers that opt for publishing data to Zenodo. Zenodo Bridge undertakes the task to contact Zenodo's API, address authentication challenges and pick data and descriptions from client service's space and push those to Zenodo. The client service provider needs to form metadata in a compliant manner and instruct the Zenodo Bridge into locating the data on NEANIAS/service storage space and provide minimal information on how those data and metadata will be published. Zenodo Bridge is itself a service providing a combination of API and UI of its own, to address the challenges of Zenodo integration on behalf of the client service.

The effect of the integration performed is shown to be beneficial both for Zenodo and NEANIAS. On one hand NEANIAS benefits from residing on a proven, well-established service that brings research products onto the FAIR data ecosystem without investing the corresponding effort required for building such a solution from scratch or adapting an existing one. On the other hand Zenodo benefits in more than one ways: (a) new scientific communities are brought closer to Zenodo's offering for research artifact publishing both manually or through services' integration and (b) a new toolkit for integrating the widely used platform of NextCloud with Zenodo is made available to the public.

4.3.5. EGI Resources

As already mentioned in this document, the NEANIAS applied and got accepted at the EGI ACE call, thus gaining access to EGI coordinated resources, specifically from CESNET. This is helpful for all EOSC services as it resolved the issue of "where" the service is deployed and provides access to standardized EGI resources across all EGI-participating infrastructure providers across Europe.

Said resources ranged from "standard" OpenStack VMs to access to a managed Kubernetes cluster, which is one of the first across Europe.

With OpenStack, our issues were mostly to iron out the details with regards to access to GPU resources that NEANIAS services required mostly for Machine Learning workloads. Thus, one needs to ensure that the VM flavors provided by the infrastructure provider match the required ones.

However, the managed Kubernetes cluster proved more difficult to onboard for a variety of reasons, mostly stemming from the fact that we were moving from an own managed, private cluster, to an externally managed one.

The first issue was that the managed cluster did not allow execution of root-based containers, which makes sense for a managed cluster but not so much for our private one. The key takeaway here is to prepare for such public-cluster scenarios ahead of time, even though you may be deploying at a private cluster, as this will ease such transitions.

The second one was a security concern, as the initial approach for onboarding the NEANIAS project was to treat it as a single entity, which resulted in NEANIAS service providers gaining access to each other services, something that was not possible in our private cluster. Thankfully, because the managed cluster from CESNET is based on the Rancher offering, and Rancher provides one level of abstraction above namespaces called "projects", down the road we switched to using Rancher projects and resolved this issue as well. The key takeaway here is to ensure that privacy can also be preserved even **within** an EU project, as multiple partners are involved.

Finally, while in our private cluster we had the ability to deploy any solution we chose for horizontal concerns such as log collection, this was not the case in the managed cluster. CESNET provided a solution for log aggregation that is using a different technology stack than the one that the NEANIAS project had selected, and thus a custom solution was required to be developed and deployed by the NEANIAS service providers. The key takeaway from this case is that one has to think of the complete deployment, including any vertical concerns (logs, backups, etc.) before committing to an infrastructure provider's offerings.

4.4. Establishment of helpdesk/service management system

To assist and support the end users of the NEANIAS offered services, a ticketing system is made available, acting as the entry point for service consumers to report issues, incidents and requests in a structured fashion as presented in Deliverable D8.2 "EOSC Service Model" [3]. More specifically, the NEANIAS SMS is developed based on the same service management framework as the EOSC one, i.e. FitSM [7], with ISO/IEC 20000-1:2018 extensions [8] (where/if needed), utilising also ITIL guidance [9] as best practice. This way, we aimed on one hand to be compliant with the EOSC service management system and on the other hand to establish a more tailored-made SMS, which would better serve the needs of NEANIAS services. Additionally, we aimed to have increased control on the SMS, so that we could adjust it more easily and quickly to future developments of the services and needs of the providers of NEANIAS services.

The Redmine platform was selected for the development of the NEANIAS SMS [10] and for the Wiki which provides the documentation of the whole system. The procedures defined in Deliverable D8.2 were implemented in Redmine workflows and documented in Redmine Wiki. Additional procedures are also implemented for the external users like access request, and general questions. Furthermore, the internal request and the maintenance workflow were also implemented for internal service management. The NEANIAS SMS is integrated with the NEANIAS Catalogue and the EOSC Marketplace with dedicated links for ticket submission to the corresponding service with prefilled fields as well.

4.5. Preparation of Terms of Use / Access & Privacy Policies

Terms of Use and Access & Privacy Policy documents are not mandatory for the onboarding of services to the NEANIAS catalogue, although making them mandatory was among EOSC plans since Q4 2021. In any case, as it is a good service management practice which also could yield benefits regarding service transparency, attractiveness and sustainability, we chose to commit project resources in developing such documents for all NEANIAS services. To this end, Terms of Use[7] and Privacy Policy "templates" were developed, which were then adjusted to the specific characteristics of each service by the respective service provider, under the guidance and support of experienced project resources in the subject. This way, on one hand we saved resources from multiple providers working in the same area, and on the other hand we achieved homogeneity and managed to have all NEANIAS services adhering to the same general principles which reflect the overall principles of the NEANIAS project.

4.6. Service ordering with computing resources provided by the user

After investigating the expectations of the NEANIAS providers concerning order management via EOSC, we concluded that NEANIAS services are/should be accessible in EOSC in one or more of the following ways:

1. Open access: The service does not need user authentication/authorisation and can be accessed via redirection from the EOSC Marketplace (MP). All currently onboarded NEANIAS services use this option.

2. Ordering: The service requires an access order from the user. This order is generated by the EOSC MP and sent to the NEANIAS provider who can enable access and approve the order in the MP. The NEANIAS SMS already describes this process, but there is no service yet using it.

3. Ordering with computing resources provided by the user: In this option the user must make a compute allocation in EOSC before submitting the NEANIAS order and include the allocation endpoint in the NEANIAS order. The details are developed in collaboration with the EGI-ACE project (see below).

4. Pay-for-use ordering: This option was assessed the conclusion was that this will not be elaborated further in NEANIAS. The providers who need this option should register their service with a 'demonstration access' level in EOSC. More complex access has to be negotiated bilaterally with the user outside EOSC/NEANIAS.

For option 3 above, we assessed the offering of the EOSC Compute Platform provided by EGI-ACE project (https://www.egi.eu/projects/egi-ace/) and found it a suitable platform to scale out the NEANIAS services that require external hosting/execution environments. Using the EGI-ACE Open Call mechanism (https://www.egi.eu/projects/egi-ace/call-for-use-cases) NEANIAS submitted an application to EGI-ACE before the 15th of December 2021 deadline, requesting cloud resources (CPU, GPU, storage) to setup and validate two use cases in the EOSC Compute Platform:

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[7] Access Policy is included in the Terms of Use of each service.

1. Scale out compute intensive NEANIAS thematic services to EGI-ACE cloud/Kubernetes resources. The successful validation of this use case would open a new service delivery model for NEANIAS thematic service providers: Their users would have to request compute allocations from the EOSC Compute Platform, and 'bring these allocations' to the thematic service providers who would connect these to their service to serve that individual user.

2. Hosting NEANIAS thematic services in EGI-ACE cloud/Kubernetes resources. The successful validation of this use case would open a new sustainability model for thematic service providers: The thematic service providers could make arrangements with EOSC Compute Platform providers for the hosting of the NEANIAS services beyond the NEANIAS lifetime, and delivering the services as a collaborative effort of NEANIAS and EOSC Compute Platform providers.

The NEANIAS application was accepted by EGI-ACE, and at the time of writing we have got access to the EGI-ACE resources, reached some first service setups, and are working on the validation of the setups for all NEANIAS services in scope. At the end, we will update the NEANIAS delivery model in EOSC (incl. user guides), and sustainability models.

4.7. Implementing the EOSC Interoperability Framework

NEANIAS catalogue must be aligned with the guidelines of the EOSC Interoperability Framework (section 2.1), so as to be interoperable with the EOSC catalogue.

EOSC offers a set of API calls in order to populate and update its catalogue. These calls are open and known to all partners and can be used once the terms and conditions of participation are met. Onboarding of a new provider or resource to the EOSC catalogue could be done by any user, but only after approval by the EOSC Portal Onboarding Team (EPOT) the procedure will be finalized and the new product will be visible to the catalogue. Changes after this first step can only be made by the designated administrator of each product (information denoted upon its original submission).

Every user that wishes to upload its products to the EOSC catalogue can have access to this information and use the well descriptive documents to follow the procedures. That was the normal process which was used at the early steps of onboarding the NEANIAS catalogue products (providers and resources) to the EOSC catalogue. Users would register their products and after approval they could update them or delete them at the respective product form. This procedure is still valid, but an additional improvement has been implemented to the NEANIAS catalogue, so as to update the data of a provider or resource at both catalogues (NEANIAS and EOSC) simultaneously, the **auto-update feature**. Now, the representatives of each product (administrative users) can update the information at the NEANIAS endpoint (submission form) and when clicking "submit", choose whether to update the data only on NEANIAS or on both catalogues.

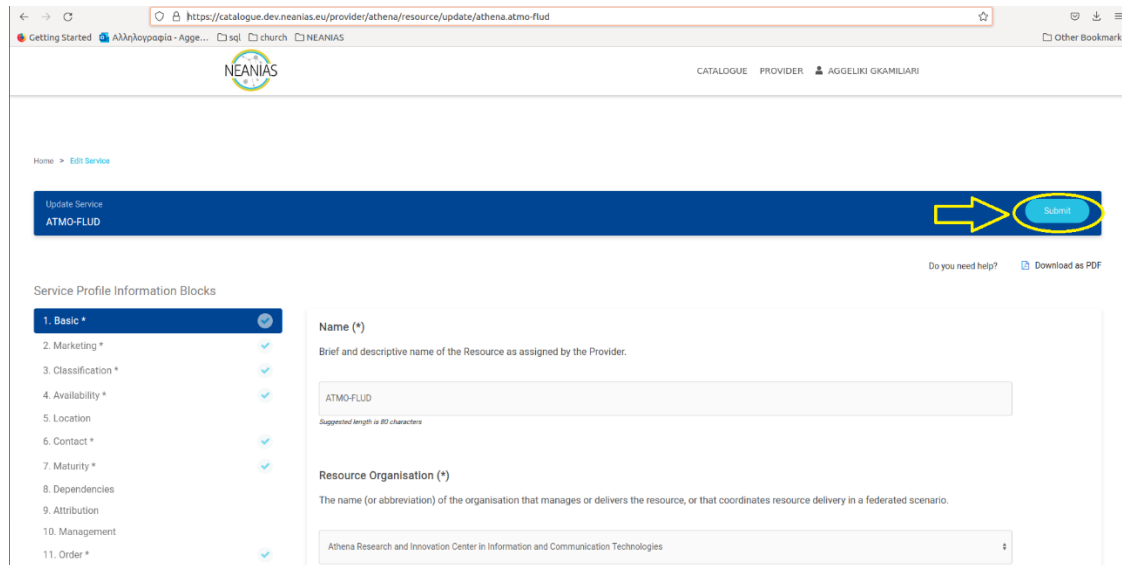Whitepaper: Best practices for service onboarding the EOSC hub

Figure 3: Service administration page on NEANIAS catalogue

A pop-up window appears, giving the user the option to update only NEANIAS catalogue, or both NEANIAS and EOSC.
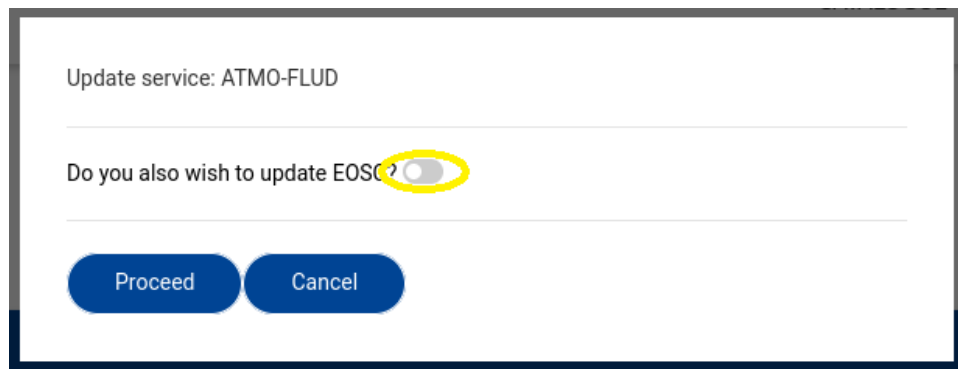

Figure 4: Option to update service information on both NEANIAS and EOSC catalogues

If the latter is selected, they must provide a specific for each user token, related to the e-mail with the use of which it was published. Take into consideration that the administrative user e-mail and the token publication e-mail must be the same for the auto-update to work.
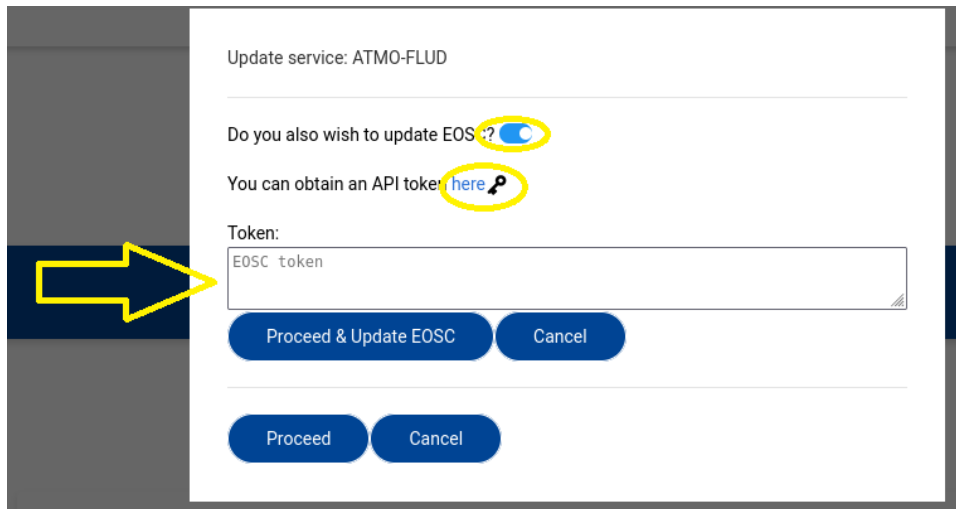
Figure 5: Providing access token for updating service information on EOSC Marketplace

After authorization, the user's access token becomes visible and it can be provided to the textbox of the pop up window of the update.
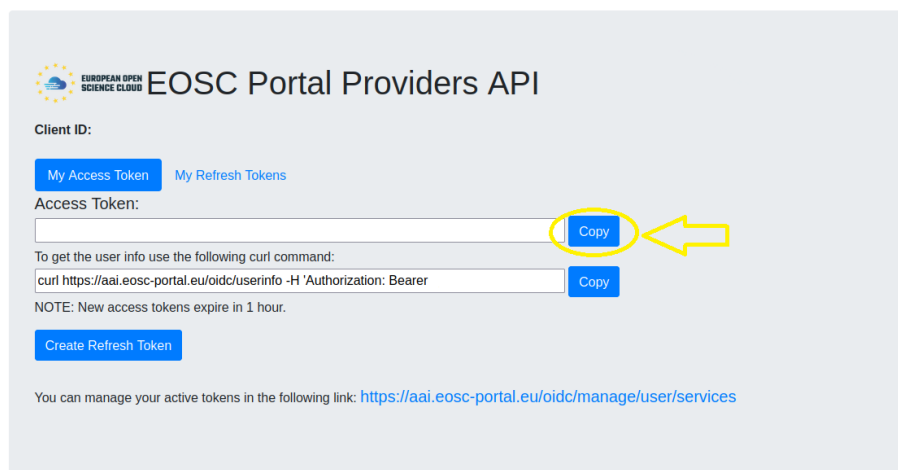

Figure 6: Retrieval of the user's access token for updating service information on EOSC Marketplace

5. Conclusions

The overall experience of NEANIAS service providers from EOSC onboarding process was positive and the collaboration with the EOSC Portal Onboarding Team was pretty smooth; minor issues identified during service onboarding were quickly addressed, also creating a "known-issues" list, which other NEANIAS service providers could consult in order to avoid the same issues and speed up the onboarding of their services to EOSC.

Planning for EOSC integration from the very beginning of the project contributed to the creation of an "EOSC integration by design" approach within NEANIAS. All thematic services were designed and developed in such a way that could fit to the characteristics of EOSC and address the needs of EOSC users.

Decisions made within NEANIAS consortium to develop a catalogue of NEANIAS services compliant with the requirements of the EOSC one, commit resources on monitoring the constantly evolving EOSC landscape, and establish an "EOSC onboarding observatory" under WP8 further facilitated the onboarding process.

At the technical level, integrations with EOSC services enabled the reuse of existing services, thus further promoting open science. The service management system proved to be a valuable tool for supporting the operation of NEANIAS services, and created a standardized approach for responding to unexpected events and/ or user requests. Finally, the integration with the EOSC catalogue API relieved NEANIAS service providers from having to manually update service information on two different systems; the NEANIAS catalogue and the EOSC one.

Overall, the careful and timely planning and execution of NEANIAS activities towards EOSC integration resulted to a significant number of NEANIAS services being available on EOSC marketplace; currently eleven (11) thematic services and three (3) core services from nine (9) different service providers can be accessed through EOSC.

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List of Acronyms

Acronym	Description
AAI	Authentication and Authorization Infrastructure
AARP	Authorised and Authenticated Representative of a Provider
API	Application Programming Interface
ARP	Authorised Representative of a Provider
EOSC	European Open Science Cloud
EPOP	EOSC Portal Onboarding Process
EPOT	EOSC Portal Onboarding Team
FAIR	Findability, Accessibility, Interoperability, Reusability
IF	Interoperability Framework
KPI	Key Performance Indicator
MP	Marketplace
SMS	Service Management System
TRL	Technology Readiness Level
AAI	Authentication and Authorization Infrastructure