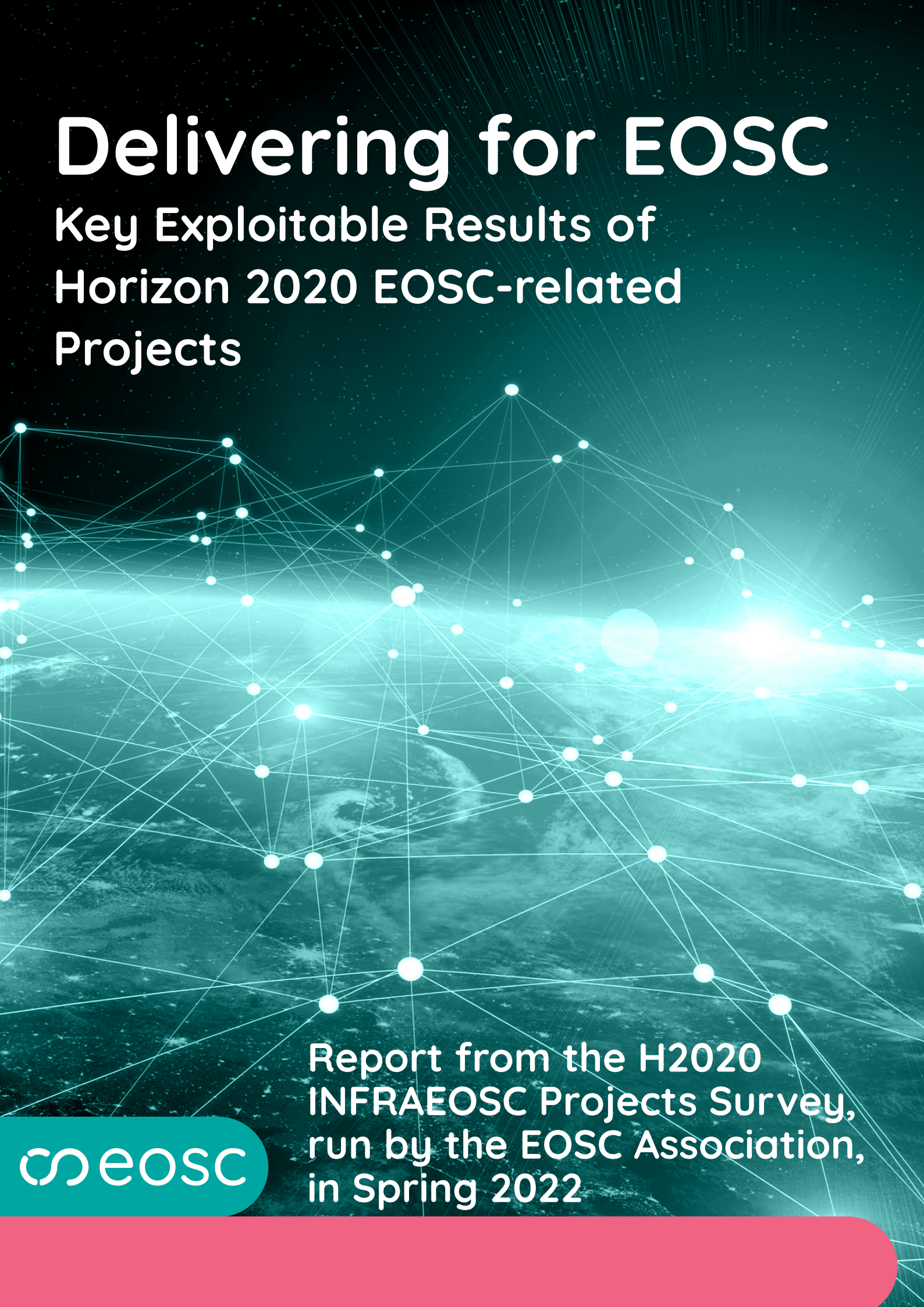

Delivering for EOSC

Key Exploitable Results of Horizon 2020 EOSC-related Projects

Report from the H2020 INFRAEOSC Projects Survey, run by the EOSC Association, in Spring 2022

eosc

This report has been produced by the EOSC Association, in collaboration with Research Data Alliance Association (RDA).

Authors

Ilaria Nardello, Erik-Jan Bos and René Buch - EOSC Association.

Ari Asmi - Research Data Alliance Association (RDA).

Correspondence address:

EOSC Association AISBL, 3 Rue de Luxemburg, Brussels, BE

email: info@eosc.eu

Acknowledgement

The information contained in this document has been provided by EOSC-related projects that have received funding from the European Union's Horizon 2020 (H2020) research and innovation programme, which were still active in spring 2022. The related logos and Grant Agreement numbers are indicated in the document, for each project.

This document has been prepared for publication with the support of the EOSC Future project, which has received funding from the European Union's Horizon 2020 (H2020) research and innovation programme under Grant Agreement no. 101017536

Disclaimer

This document does not represent the opinion of the European Union, and the European Union is not responsible for any use that might be made of its content.

Brussels, November 2022

Table of Contents

1. Executive Summary **3**
2. Introduction **5**
3. Methodology **7**
4. Results of the consultation **8**
4.1 Summary Results 8
4.2 Project-specific descriptions and Key Exploitable Results (KERs) 13
Science Clusters and other Thematic Projects 14
ENVRI-FAIR 14
EOSC-Life 17
ESCAPE 20
ExPaNDS 24
PaNOSC 27
SSHOC 30
Blue-Cloud 35
National/Regional Projects and EOSC Governance 38
EOSC-Nordic 38
EOSC-Pillar 42
EOSC-Synergy 46
FAIRsFAIR 50
NI4OS-Europe 53
EOSC Core and Exchange 57
EOSC Future 57
C-SCALE 60
DICE 64
RELIANCE 67
Prototyping New Innovative Services 72
Cos4Cloud 72
INODE 75
CS3MESH4EOSC 78
NEANIAS 81
TRIPLE 83
ARCHIVER 86
5. Discussion and conclusions **89**
6. Recommendations **91**
7. Annex One – The H2020 EOSC-related Project survey questionnaire **92**
8. Annex Two – Glossary **97**

List of Figures

Figure 1 – Average relevance to the Advisory Group topic, per project, normalised by the number of KERs (N) reported, for each topic 10

List of Tables

Table 1 – List of EOSC Advisory Group (AG) and EOSC Task Forces (TF) 6

Table 2 – List of respondent to the H2020 EOSC-related Projects Survey 8

Table 3 – Number of KERs reported for each category of results 9

Table 4 – Number of KERs reported per Task Forces topic and their relative frequency 11

List of Acronyms

Definitions	Acronyms
Authentication and Authorisation Infrastructure	AAI
EOSC Advisory Group	AG
EOSC Association	EOSC-A
European Commission	EC
European Open Science Cloud	EOSC
European Strategy Forum on Research Infrastructures	ESFRI
EOSC Task Force	TF
Findability Accessibility Interoperability Reusability	FAIR
Horizon 2020	H2020
Horizon Europe	HE
Key Exploitable Results	KERs
Persistent identifier	PID
Research Data Alliance Association	RDA
Research Executive Agency	REA
Rules of Participation	RoP
Strategic Research and Innovation Agenda	SRIA
Technology Readiness Level	TRL
Virtual Reserch Environment	VRE

1. Executive Summary

Policy

The implementation of the European Open Science Cloud (EOSC) began in 2015, with support by the European Commission, coordinating the progressive alignment of the European research community stakeholders.In the current phase of implementation (2021-2030), the coordination is taking place in the context of the EOSC European co-programmed partnership, agreed between the EOSC Association (EOSC-A) and the European Commission, to reach the objectives set in the EOSC Strategic Research and Innovation Agenda (SRIA), which is co-developed with the entire EOSC community.

European Commission (EC) Horizon Projects

The European Commission's Horizon 2020 and Horizon Europe (HE) grant projects are key elements for the implementation of EOSC and for the development of the EOSC ecosystem. They are part of the mechanism by which standards, services and tools are produced to support the sustainable and federated infrastructure for the sharing of scientific results (as openly as possible) known as the European Open Science Cloud. In the spirit of the EOSC ambition to multiply the potential impact of research data for science, education and innovation, the EOSC Association surveyed the still-running Horizon 2020 (H2020) EOSC-related projects, in the spring of 2022. The purpose of the consultation was to capture each project's Key Exploitable Results (KERs), with the ultimate goal of establishing a continuum between the sunsetting H2020 projects and the new Horizon Europe projects supporting the implementation of EOSC.

The EOSC Association survey of the EOSC-related H2020 projects

A questionnaire was prepared by the EOSC Association in collaboration with the Research Data Alliance Association (RDA). It was distributed as a survey to the projects who were listed as EOSC-relevant by the EC-mandated European Research Executive Agency (REA), and who where still active in the spring of 2022. The survey ran between 11th March and 13th June 2022. The questionnaire meant to capture details on various aspects of the projects' implementation, including the description of up to six EOSC-related KERs, which detailed their level of maturity, provisions for sustainability, further development plans and outstanding needs. The survey also captured the projects' provisions for the internationalisation of their products and their expectations relative to the EOSC Association.

The survey collected responses from 22 projects, which reported a total of 119 KERs, covering mainly technical and policy harmonisation efforts, virtual research environments, discovery/access platforms, training resources, knowledge centres and validation tools.

Status of the Horizon 2020 project KERs

With few exceptions, most KERs were beyond the demonstration phase, and had already been adopted by a broad reference community, as would be expected from projects in their final stages of implementation.

Most of the projects surveyed provided detailed sustainability and exploitation plans, which gives a general indication of the maturity level of the projects' implementation and of the exploitability of each KER. The products developed by the so-called Science Cluster projects, in particular, appear well-grounded in the European Strategy Forum on Research Infrastructures (ESFRI) Research Infrastructure ecosystem, which provides a robust environment and a user community to cultivate their further use and development. Other projects have already been granted a path to sustain their KERs

through awards for new research projects. A handful of the project KERs would benefit from further development to improve their potential to be more widely used, particularly with respect to international collaborations and collaboration among projects. Training resources, which are a major KER in almost all projects, often lack a clear and standardised channel for discovery and use.

The RDA is often mentioned as a key counterpart for supporting the internationalisation ambitions of the project consortia, and could certainly play a role in the overall sustainability of the KERs.

Collaboration with industry partners also appears typically under-represented. Even when such collaboration is indicated as beneficial for the KER's sustainability, a clear plan to achieve industry engagement is missing.

The role of the EOSC Association as a provider of sustainability measures is often recognised by the survey respondents, especially in its role as an advocate for new funding schemes or funding-support measures. The Association is also seen as a potential clearinghouse for the dissemination of project results, with a view toward stimulating wider adoption or further development of the KERs.

The EOSC Association Task Forces as a main stakeholder in receipt of this report

The EOSC Association has established five Advisory Groups (AGs) to provide an "umbrella" for a set of 13 Task Forces that address key areas of the EOSC implementation. These Task Forces are a major stakeholder in receipt of this report. They systematically liaise with EOSC projects to offer feedback on project developments, and provide input to the EOSC Partnership's Strategic Research and Innovation Agenda, the SRIA. The Task Forces are well-positioned to identify gaps in the implementation plan for EOSC and areas for investment.

The KERs identified in this survey of Horizon 2020 EOSC-related projects show strong correlations to the EOSC Advisory Group (AG) topics, with maximum relevance for "Technical challenges in EOSC" and "Implementation of EOSC"; high relevance for "Metadata and data quality"; and satisfactory relevance for the AG topics "Research careers and curricula" and "Sustaining the EOSC". All of the areas covered by the 13 Task Forces are represented, with a level distribution of KERs across the various Task Forces topics.

Role of the EOSC Association

The EOSC Association will continue to reinforce its role of bringing the various initiatives together and to provide collaborative environments to foster increased communication among EOSC-related EU projects. Through initiatives like "Vademecum: A Handbook for Effective Collaboration within the EOSC Co-Programmed Partnership"; and the EOSC Forum online collaboration platform, the EOSC Association aims to proliferate opportunities for inter-project exchange to achieve "one EOSC", a critical mass of coordination that keeps everyone on the same page, working toward the same objectives. In particular, this cross-pollination of ideas will be useful in defining gaps in EOSC's implementation, which can be brought to bear on the SRIA agenda updates.

The EOSC Associaiton encourages all Horizon projects to exploit the communcationa and dissemination pathways that are being produced, to their fullest extent, and to actively engage in the creation of a culture of collaboration, knowledge exchange, exportability, quality production and re- use, that will realise the fundamentals of EOSC

2. Introduction

Policies

The implementation of the EOSC began in 2015, with support by the European Commission, coordinating the progressive alignment of the European research community stakeholders. In the initial phase of implementation (2018-2020), the European Commission invested around €250 million to prototype components of the EOSC through calls for projects under Horizon 2020. The European Commission also launched an interim EOSC Governance to prepare the strategic orientations for the EOSC implementation post-2020.

In the current phase of implementation (2021-2030), the coordination is taking place in the context of the EOSC European co-programmed partnership, agreed between the EOSC Association and the European Commission, which was launched at the Research and Innovation Days 2021. The EOSC Partnership shall co-invest at least €1 billion (including both in-kind and financial contributions), to reach the objectives set in the EOSC Strategic Research and Innovation Agenda (SRIA), which is co-developed with the entire EOSC community. According to the "European strategy for data"[1], the EOSC "science, research and innovation data space" will articulate with the other European sectoral data spaces. This phase is steered by the new EOSC tripartite governance, involving: the European Union represented by the European Commission; the participating countries represented in the EOSC Steering Board and the research community represented by the EOSC Association.

Horizon Projects

The European Commission began providing financial support to implement the EOSC by means of projects under the EU "Horizon 2020" Framework Programme for Research and Innovation, in 2018. The EC Horizon projects are thus key elements for the implementation of EOSC and for the development of the EOSC ecosystem, producing standards, services and tools that are envisaged to support a sustainable and federated infrastructure for sharing of scientific results, as openly as possible.

The financial support action by means of projects continues with the new Horizon Europe (HE) Framework Programme for Research and Innovation, covering the period 2021-2027. At the time of writing, nine projects[2] have been awarded already, with the HE programme.

The H2020 EOSC-related Projects Survey by the EOSC Association

In the spirit of the EOSC ambition to multiply the potential impact of research data for science, education and innovation, the EOSC Association carried out a broad consultation of the still-running H2020 EOSC-related projects in the spring of 2022. The objective was to capture the main results from these projects and ultimately establish a continuum between H2020 and the new HE projects related to the European Open Science Cloud (EOSC).

The H2020 EOSC-related projects survey was also a means to understand the needs of the project consortia in terms of supportive measures for communication, dissemination, exchanges within the community, internationalisation and exploitability of their main products, and to receive the research community's views on their expectations of the role of the Association.

The EOSC Task Forces

The EOSC Association Advisory Groups are a structure to allow Association members and other experts to help steer the implementation of EOSC. Each Advisory Group liaises to the EOSC Association via its chair being one representative of the Association's Board of Directors.

The EOSC Advisory Groups provide an essential "umbrella" for a set of Task Forces that address key areas of the EOSC implementation. They liaise with EOSC projects to offer feedback on developments, as well as input to SRIA on the identified strategic gaps and areas for investment. An open call was held to define the membership of the Task Forces, which resulted in several hundred members of the community offering their expertise as volunteers to shape the future direction of EOSC.

1 EC COM(2020) 66 final: "COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS A European strategy for data"

2 FAIR IMPACT; Skills4EOSC; EOSC Focus; FAIRCORE4EOSC; FAIR_EASE; EuroScoenceGateway; RAISE; AI4EOSC; EOSC4Cancer

Advisory groups	Task Forces	
AG 1 Implementation of EOSC		TF 1.1 PID policy and implementation
		TF 1.2 Researcher engagement and adoption
		TF 1.3 Rules of Participation (RoP) compliance monitoring
AG 2 Metadata and Data QUality		TF 2.1 FAIR metrics and data quality
		TF 2.2 Semantic interoperability
AG 3 Research Careers and Curricula		TF 3. 1 Data stewardship curricula and career paths
		TF 3.2 Research careers, recognition and credit
		TF 3.3 Upskilling countries to engage in EOSC
AG 4 Technical challenges on EOSC		TF 4.1 AAI Architecture
		TF 4.2 Infrastructures for quality research software
		TF 4.3 Technical interoperability of data and services
AG 5 Sustaining EOSC		TF 5.1 Financial Sustainability
		TF 5.2 Long-term data preservation

Table 1 – List of EOSC Advisory Group (AG) and EOSC Task Forces (TF)

The involvement of the EOSC Task Forces in digesting the results of this H2020 projects survey report is necessary to achieve the objectives of the endeavour. They are a main stakeholder for receipt of this report.

3. Methodology

Upon consultation with the EC-mandated European Research Executive Agency (REA), the EOSC Association received a list of still running H2020 projects and their contact points, in the spring of 2022. An invitation from the Association was extended to all of them to participate in this monitoring exercise.

A survey questionnaire (Annex one for fuller details) was prepared by the EOSC Association in consultation with Research Data Alliance (RDA), covering various aspects of the project implementation and mainly addressing the following descriptions:

- **Key Exploitable Results (KERs)** Up to six EOSC-related Key Exploitable Results (KERs).
- **KER Maturity** In order to assess the exploitability of the listed results, the respondents were requested to self-evaluate the maturity of each of the reported KERs, in terms of either:
  - Technology Readiness Level[3] (TRL), or:
  - Referring to the following categories of product maturity:
    - Concept, plan, or demonstrator, needing additional work (in or out of the project team) to be directly usable in most contexts (EXPLOITABILITY LEVEL 1).
    - Prototype service, limited community practice, specific technology for limited field, usable in its current form, but would benefit from additional work to be generalised or more widely usable (EXPLOITABILITY LEVEL 2).
    - Operational service, accepted community standard, widely used technology, fully usable by target audiences, and mature for use in other parts of EOSC, if relevant (EXPLOITABILITY LEVEL 3).
- **Relevance to EOSC Advisory Groups and Task Forces** In order to map the potential relations of the projects' results and to facilitate the integration of their outcome into future initiatives, e.g. through the work of the EOSC Task Forces or new Horizon Europe projects, the surveyed projects were asked to indicate in which of the EOSC Advisory Group domains (eosc.eu/advisory-groups) their output would contribute. The relevance would be on a scale from 1 (minimum relevance) to 5 (maximum relevance).
- **Sustainability and exploitation plans** With a view to support the projects in sustaining their output and providing measures to increase their visibility, uptake and further development, the EOSC Association asked them to describe their views on the KERs sustainability after the project end, whether an exploitation plan was in place, and what kind of resources would be needed, or already aligned, to sustain these outputs, e.g., in terms of storage, IT services, helpdesk, updates, etc.
- **Expectations from the Association** The projects were asked to voice their expectations on the role of the EOSC Association
- **Internationalisation needs and provisions** With the collaboration of RDA, and with the scope to prioritise future actions and identify potential targets, the projects were asked which of the results reported would benefit from additional efforts for standardisation, or activities/ initiatives to create international harmonisation, and whether the project partners could be interested in the future to participate in such actions.

After having run a pilot phase, with the support of three of the involved projects, a familiarisation online meeting was held, on the 11th March 2022, where all the projects were invited. The survey was launched on the same day and was open for 8 weeks.

The survey collected responses from 22 projects and closed on the 13th June 2022. The analysis of the information was conducted by the EOSC Association, in collaboration with RDA. Preliminary summary results were conveyed in various appointments, including the EOSC Association General Assembly #3, in April 2022. A validation exercise was run with each project, in October 2022, through which the respondents could review and approve the project-specific information that would be communicated in this report.

The results of the survey are articulated in the next section (4.0), organised in two main sub-sections:

- **"Summary results"** (section 4.1), containing an overview of the results received and summary statistics, and:
- **"Project-specific descriptions and Key Exploitable Results (KERs)"** (section4.2), articulated over the following thematic areas:
  - Science Clusters and other Thematic Projects.
  - National/Regional Projects and EOSC Governance.
  - EOSC Core and Exchange.
  - Prototyping New Innovative Services.

3 https://ec.europa.eu/research/participants/data/ref/h2020/other/wp/2018-2020/annexes/h2020-wp1820-annex-g-trl_en.pdf

4. Results of the consultation

This section presents both the summary results (section 4.1) as well as the results per project (section 4.2), mainly grouped by project call name and call topic.

4.1 Summary Results

Respondents N.=22

Call name	Topic	Project Name	2018	2019	2020	2021	2022	2023
H2020-INFRAEOSC-2018-2	INFRAEOSC-04-2018 - Connecting ESFRI infrastructures through Cluster projects	ENVRI-FAIR		✖	✖	✖	✖	✖
		EOSC-Life		✖	✖	✖	✖	✖
		ESCAPE		✖	✖	✖	✖	✖
		PaNOSC	✖	✖	✖	✖	✖	
		SSHOC		✖	✖	✖	✖	✖
H2020-INFRAEOSC-2018-3	INFRAEOSC-05-2018-2019 - Support to the EOSC Governance	EOSC-Nordic		✖	✖	✖	✖	
		EOSC-Pillar		✖	✖	✖	✖	
		EOSC-synergy		✖	✖	✖	✖	
		ExPaNDS		✖	✖	✖	✖	✖
		NI4OS-Europe		✖	✖	✖	✖	✖
H2020-INFRAEOSC-2018-4	INFRAEOSC-05-2018-2019 - Support to the EOSC Governance	FAIRsFAIR		✖	✖	✖	✖	
H2020-INFRAEOSC-2019-1	INFRAEOSC-02-2019 - Prototyping new innovative services	COS4CLOUD		✖	✖	✖	✖	✖
		CS3MESH4EOSC			✖	✖	✖	✖
		INODE		✖	✖	✖	✖	✖
		NEANIAS		✖	✖	✖	✖	
		TRIPLE		✖	✖	✖	✖	✖
H2020-INFRAEOSC-2020-2	INFRAEOSC-07-2020 - Increasing the service over of the EOSC Portal	C-SCALE				✖	✖	✖
H2020-INFRAEOSC-2020-2	INFRAEOSC-07-2020 - Increasing the service over of the EOSC Portal	RELIANCE				✖	✖	✖
BG-07-2019-2020	BG-07-2019-2020 - The Future of Seas and Oceans Flagship Initiative	Blue Cloud		✖	✖	✖	✖	✖

Call name	Topic	Project Name	2018	2019	2020	2021	2022	2023
H2020-INFRAEOSC-2020-2	INFRAEOSC-03-2020 - Integration and consolidation of the existing pan-European access mechanism to public research infrastructures and commercial services through the EOSC Portal	EOSC Future				✖	✖	✖
H2020-ICT-2018-2	ICT-34-2018-2019 - Pre-Commercial Procurement open	Archiver		✖	✖	✖	✖	
H2020-ICT-2014-1	ICT-09-2014 - Tools and Methods for Software Development	DICE				✖	✖	✖

Table 2 – List of respondent to the H2020 EOSC-related Projects Survey

Number and category of KERs

The respondents were asked to report a maximum of six most important outputs (deliverables, standards, policy templates, tools, infrastructure, services, etc.) which are referred to as Key Exploitable Results (KERs) and which could be directly usable for the EOSC development in the current and next phases of the EOSC initiative. The KERs were expected to have any of the following aspects:

- Connected to the EOSC interoperability framework.
- Directly usable by EOSC TASK FORCES in their work.
- Having high disciplinary or multidisciplinary importance to engage major user communities in the EOSC.
- Of direct use to EOSC user communities in their engagement to EOSC.
- Contributing towards achieving the SRIA[4] objectives and an operational EOSC infrastructure.

In total, 119 KERs were reported by the projects, with an average of 5,4 KERs per project. The KERs were categorised according to seven possible classes of results, as shown in Table 3.

Technical harmonisation (metadata, interoperability, guidance, etc. on technical aspects of data/services) included 24 KERs, as many as the KERs classified as Virtual Research Environment (VRE) products; 17 KERs were about policy harmonisation measures; 15 KERs provided training resources and materials; 11 KERs were establishing a reference knowledge centre; only three KERs were about providing Authentication and Authorisation Infrastructure (AAI); 12 KERs which did not fit any of the previos categories were classified as Validation Tools or Other Resources.

KER Category	N KERs
Technical Harmonisation: Metadata, interoperability, guidance, etc. on technical aspects of data/services.	24
Policy Harmonisation: Agreements, policies, etc. on data/service.	17
Discovery/Access platform: Virtual platform to find/access data/service.	13
Virtual Reserch Environment (VRE): Virtual research environment - including Virtual management environments for infrastructure - these are online services running for researchers or organisations.	24
Training Resource: Training materials, guidelines, codes of practices.	15
Knowledge Centre: Structured collection of information for various applications.	11
Authentication and Authorization Infrastructure (AAI): Most AAI solutions.	3
Validation Tool or Other: Any results which could not be described by the above categories.	12

Table 3 – Number of KERs reported for each category of results

Maturity of KERs

KER maturity was reported by the projects in a mix of the various formats available, i.e. either as TRL values, or as maturity categories or with a verbose description. With the assumption that the higher the maturity of a result, the more likely the same result would be usable in the short term; and: in order to put the various evaluations on a same (comparable) scale, these values or descriptions were translated into three main "Exploitability Levels":

- Exploitability level 1: Concept, plan, or demonstrator (corresponding to: category A; or: TRL 1-3).
- Exploitability level 2: Prototype (corresponding to: category B; or: TRL 4-6).
- Exploitability level 3: Operational (corresponding to: category C; or: TRL 7-9).

4 https://eosc.eu/sria

The situation is detailed for each KER, in the next section of this report.

With a few exceptions, most KERs fall under the Exploitability Levels 2 and 3, i.e.: beyond the demonstration phase and already in use by the reference community. In other words, while some of the KERs still require some work to improve their potential to be taken up, most of the KERs are fully developed and adopted by a broad reference community. This is expected for projects in their final stages of implementation.

KER relevance to the EOSC Advisory Groups and Task Forces

In order to map the potential relations of the projects' results and to facilitate the integration of their outcome into future initiatives, e.g. through the work of the EOSC Task Forces or new Horizon Europe projects, the surveyed projects were asked to indicate which of the EOSC Advisory Group domains (https://eosc.eu/advisory-groups) their output would contribute. The relevance was measured on a scale from 1 (minimum relevance) to 5 (maximum relevance).

A summary of the average relevance to the EOSC Advisory Groups (AGs), per project, normalised by the number of KERs (N) reported for each topic, is provided below (Fig. 1). The details are provided per KER in the next section of this report. It is evident that the presented KERs are related in good measure to all the AG topics, and that the maximum relevance is for AG4 – Technical challenges in EOSC and AG1 – Implementation of EOSC, with average relevance values close to 4; slightly less overall relevance is towards the AG2 – Topic metadata and data quality; while, the topics AG3 – Research carreers and Curricula and AG5 – Sustaining the EOSC are around an average relevance value of 3,5.

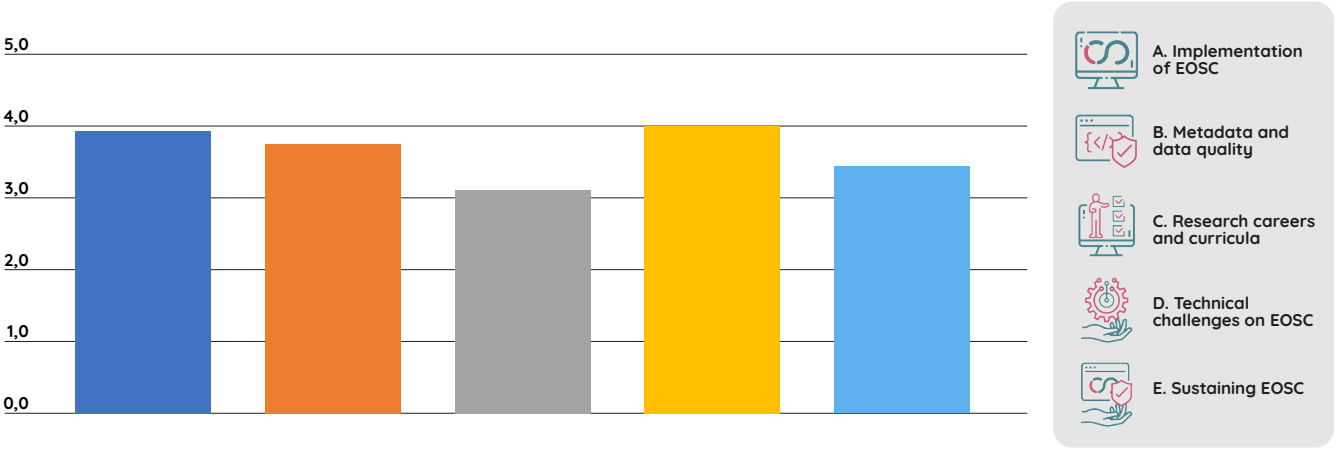

Figure 1 – Average relevance to the Advisory Group topic, per project, normalised by the number of KERs (N) reported, for each topic

At the level of the Task Forces (Table 4), the number of KERs declared as relevant is higher (>10%) for TF 1.2 – Researcher engagement and adoption (10,1%); TF 2.1 – FAIR metrics and data quality (10,1%); TF 4.3 – Technical interoperability of data and services (12,2%). Many KERs (between 7-10%) are for: TF 2.2 – Semantic interoperability (9,2%); TF 4.2 – Infrastructures for quality research software (8,9%); TF 3.2 – Research careers, recognition and credit (7,2%) and TF 3.3 – Upskilling countries to engage in EOSC (7,1%). The other TF categories are less frequently reported (>7%): TF 5.2 – Long-term data preservation (6,8%) ; TF 1.1 – PID policy and implementation (6,7%); TF 1.3 – Rules of Participation (RoP) compliance monitoring (6,0%); TF 4.1 – AAI Architecture (5,8%); TF 3.1 – Data stewardship curricula and career paths (4,3%).

Advisory Groups	Task Forces		Number of KERs reported	Frequency of the reported KERs
AG 1 Implementation of EOSC		TF 1.1 PID policy and implementation	48	6,7%
		TF 1.2 Researcher engagement and adoption	73	10,1%
		TF 1.3 Rules of Participation (RoP) compliance monitoring	43	5,0%
AG 2 Metadata and Data QUality		TF 2.1 FAIR metrics and data quality	73	10,1%
		TF 2.2 Semantic interoperability	66	9,2%
AG 3 Research Careers and Curricula		TF 3. 1 Data stewardship curricula and career paths	31	4,3%
		TF 3.2 Research careers, recognition and credit	52	7,2%
		TF 3.3 Upskilling countries to engage in EOSC	51	7,1%
AG 4 Technical challenges on EOSC		TF 4.1 AAI Architecture	42	5,8%
		TF 4.2 Infrastructures for quality research software	64	8,9%
		TF 4.3 Technical interoperability of data and services	88	12,2%
AG 5 Sustaining EOSC		TF 5.1 Financial Sustainability	40	5,5%
		TF 5.2 Long-term data preservation	49	6,8

Table 4 – Number of KERs reported per Task Forces topic and their relative frequency

KER Sustainability

The projects often listed detailed sustainability and exploitation plans, which shows the general maturity of the project implementation. The KERs developed by the Science Cluster projects, in particular, appear well grounded in the ESFRI Research Infrastructure ecosystem, which provides a wide environment for their further use and development, and a large user community. Other projects have already been granted a path for sustaining their KERs through new research projects. The role of the EOSC Association as provider of sustainability measures is often described, especially as advocates for new funding schemes or funding-support measures, and for dissemination of the projects results. The RDA is also often mentioned as a key counterpart for supporting the internationalisation ambitions by the project consortia, which would certainly play a role in the overall sustainability of the KERs. On the other hand, industry engagement is typically under-represented in the provided plans.

As the details of this information are KER-specific, a full description of the envisaged sustainability measures is provided for each KER, in the next section.

Internationalisation capacity of KERs

Many of the KERs have been listed with some level of international collaboration. In particularl, science cluster projects seem to have considered such internationalisation, while many good examples of already established practices exist, and even considering these aspects already in the project design phase, such as is the case of FAIRsFAIR.

The results show that there are many challenges on the way of international collaboration for KERs, mostly around timing and resources. Most projects seem to have underestimated the time and effort for such activities during the project preparation, and the level of internationalisation is then left to an after-project phase, to be addressed by the user communities, or the organisations responsible for the sustainability of the results, which may lack the necessary resources at the end of the project. The risk for these cases is to reduce the impact of the KERs, especially when considering the potential for cross-fertilisation. From the point-of-view of the tools recommended to achieve internationalisation of the results, the use of RDA is mentioned very widely, particularly by the projects with wider user domains (e.g. the Science Cluster projects), and the ones concentrated on the policy and technical harmonisation. However, many other pathways are also mentioned, particularly on highly specific-domain areas, where specialised existing international networks can be more efficient to reach the target audiences needed for this kind of engagement.

A particular need for international collaboration and collaboration between projects is clearly visible in the accessibility, documentation and publication of training resources, which are a major KER in almost all projects involved, and do not have proper and standardised channels for discovery and use.

Collaboration with industry partners was indicated as beneficial for a number of KERs. However, no clear indication was given on how this could be achieved. The next phase of EOSC implementation which focuses on widening from public to private stakeholders could be beneficial here.

The role of the EOSC Association

The projects articulated the community's expectations on the EOSC Association role, with detail. The main actions expected regard supporting the communication and dissemination activities of the projects. The suggestions (quoting from the survey) include:

- Define branding guidelines for services which are considered part of EOSC.
- Organise events and networking opportunities for the user community of EOSC to share needs and solutions.
- Help find and exploit the many results being provided by numerous EOSC projects.
- Provide free resources for hosting EOSC related projects e.g. software, project home pages etc.".

It is quite evident that the Association is also expected to support the projects' sustainability as an advocate for the continuation of relevant project actions and encouraging the interactions among the projects and, more generally, among the community members and with public funding stakeholders.

- Support dissemination and outreach towards stakeholders and potential users of the services.
- Share opportunities for sustaining EOSC services.
- Support EOSC projects to share expected/achieved results and outputs, so as to enhance the identification of synergies and potential collaboration.

Other activities mentioned by the projects that are expected by the EOSC Association regard the technical implementation of EOSC and its services. Suggestions received include:

- Map the landscape of EOSC activities.
- Support activities around recognition of researchers contributions to Open Science.
- Support finding solutions to technical challenges for the core services.
- Provide clear guidelines for how to contribute services and data to the EOSC.
- Endorse existing solutions as EOSC standards to encourage uptake and collaboration.

The community also expressed inspirational vision statements for the Association and its role within the community, such as:

- "The EOSC Association's role is the custodian of the EOSC therefore it should define the EOSC, its architecture and influence its implementation, with a clear definition of EOSC and its core services".
- "The EOSC Association is a neutral, community-oriented broker that drives the development of a coherent EOSC vision, strategic plan and business model, with value propositions for the different individual actors".

4.2 Project-specific descriptions and Key Exploitable Results (KERs)

ENVRI-FAIR

ENVironmental Research Infrastructures building Fair services Accessible for society, Innovation and Research – ENVRI-FAIR

Grant agreement ID: 824068

DOI: 10.3030/824068

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 18.997.878,75

EU contribution: € 18.997.878,75

Start date: 1 January 2019

End date: 30 June 2023

Coordinated by: Forschungszentrum Jülich Gmbh.

Brief description of the project: The EU-funded ENVRI-FAIR project aims to advance the findability, accessibility, interoperability and reusability (FAIRness) of harmonised and easy-to-use data and services from the contributing environmental research infrastructures and connect them to the emerging European Open Science Cloud (EOSC).

Fields of science:
Natural Sciences > Environmental Sciences.
Natural Sciences > Biological Sciences > Ecology > Ecosystems.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures.

Topic(s): INFRAEOSC-04-2018 - Connecting ESFRI infrastructures through Cluster projects.

Sub call: H2020-INFRAEOSC-2018-2

Funding Scheme: RIA - Research and Innovation action.

Website: envri.eu/home-envri-fair

Cordis: cordis.europa.eu/project/id/824068

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓	✓				✓
	1.2 Researcher Engagement and Adoption						
	1.3 Rules of Participation Compliance Monitoring						✓
AG 2	2.1 FAIR Metrics and Data Quality	✓				✓	✓
	2.2 Semantic Interoperability	✓				✓	
AG 3	3.1 Data Stewardship Curricula and Career Paths						
	3.2 Research Careers, Recognition, and Credit						
	3.3 Upskilling Countries to Engage in EOSC			✓			
AG 4	4.1 AAI Architecture					✓	
	4.2 Infrastructure for Quality Research Software						
	4.3 Technical Interoperability of Data and Services	✓	✓			✓	
AG 5	5.1 Financial Sustainability						
	5.2 Long-term Data Preservation	✓				✓	

AG1: Implementation of EOSC | AG2: Metadata and data quality | AG3: Research careers and curricula
AG4: Technical challenges on EOSC | AG5: Sustaining EOSC

ENVRI1 - ENVRI Catalogue of Services

Category: Knowledge Centre.

Description: We are preparing the ENVRI Catalogue of services (to be integrated in ENVRI-Hub) to expose thematic data services and tools from the environmental Research Infrastructures catalogues to the EOSC Catalogue of Services.

Link: doi.org/10.5281/zenodo.4024173

Maturity: TRL3 (present), TRL 7 -8 by the end of the project when ENVRI-Hub, which will include the ENVRI Catalogue of services, will be functional, as a continuously developing resource.

Exploitability: Operational service.

Sustainability: The ENVRI Catalogue of services will be functional at the end of the project. It will be delivered as a continuously developing resource, maintained by the contributing Research Infrastructures.

Internationalisation: EENVRI Catalogue of services: The further development of the Catalogue is expected to benefit from RDA-related activities concerning the development of an Interoperability Framework for describing observable properties, focusing on environmental sciences. This conceptual framework will foster interoperability between cross-domain terminologies by providing a common method to systematically express or represent observable properties, thus paving the way for seamless terminology alignment see RDA I-ADOPT WG which is directed by ENVRI experts.

ENVRI2 - ENVRI Knowledge Base

Category: Knowledge Centre.

Description: The cluster-level ENVRI Knowledge Base (to be integrated into the ENVRI-Hub) is being built in order to share technical practices, identify common data and service requirements and design patterns, and facilitate search and analysis of existing Research Infrastructures solutions for interoperability challenges that are shared among environmental Research Infrastructures.

Link: doi.org/10.5281/zenodo.4311047

Maturity: TRL 8-9 The initial version of the ENVRI Knowledge Base is online (search.envri.eu). However, this is and will be a work in progress. We follow a co-design and iterative development strategy. We aim to update the knowledge content and search functionality continuously. In addition, we plan to engage the knowledge curators from research infrastructures to customise the indexing pipeline, control the quality, recommend additional knowledge sources, and improve the efficiency of the knowledge base management.

Exploitability: Operational service.

Sustainability: This service will be provided by the ENVRI community as part of the ENVRI-Hub. As for the ENVRI Catalogue of services, the ENVRI Knowledge Base maintenance and operation as an EOSC-based service needs continuous resources, which requires clarification of the remuneration of its service provision via EOSC.

Internationalisation: ENVRI Knowledge Base: This service is mainly targeting Research Infrastructures operators and developers. Internationalisation and standardisation needs have not been identified yet.

ENVRI3 - ENVRI Training Catalogue

Category: Training Resource.

Description: The ENVRI Training Catalogue (trainingcatalogue.envri.eu) has been designed and implemented to facilitate findability, sharing and reuse of educational resources on FAIR data management and the Training Portal (training.envri.eu).

Links:

doi.org/10.5281/zenodo.5052426

trainingcatalogue.envri.eu

training.envri.eu

Maturity: TRL 9 ENVRI Training catalogue (trainingcatalogue.envri.eu) is operable, but it will need continuous updates even after the end of the project.

Exploitability: Operational service

Sustainability: This service will be provided by the ENVRI community as part of the ENVRI-Hub. As for the ENVRI Catalogue of services, the ENVRI Training Catalogue maintenance and operation as EOSC-based service needs continuous resources, which requires clarification of the remuneration of its service provision via EOSC.

Internationalisation: ENVRI Training Catalogue: ENVRI-FAIR has developed a Learning Environment, consisting of three components: a catalogue for learning resources, a community learning platform, and an underlying repository for curating materials. The catalogue, based on the international IEEE standard for learning resources, is exposing FAIR training services that facilitate the findability (for both human and machine processes) and the reuse of the materials. The catalogue implementation and the underlying metadata model have received much attention from outside of ENVRI, including from the FAIRsFAIR and EOSC Future projects as well as the Research Data Alliance interest group on education and training on handling research data. Collaboration with these stakeholders is planned, or already ongoing.

ENVRI4 - FAIR Implementation Profiles (FIP wizard tool)

Category: Policy Harmonisation.

Description: In collaboration with the GO FAIR Foundation, the FAIR Implementation Profiles (FIP wizard tool) has been developed, which allows the evaluation of the implementation status of FAIR data practices at individual environmental Research Infrastructure levels. The FIP Tool, named FIP wizard, will become publicly available as one of the services provided by the ENVRI-Hub.

Links:

- fip-wizard.readthedocs.io/en/latest/about/about.html
- https://docs.google.com/spreadsheets/d/1yx8r2St6ha-lmQtg02FvwU8nB21uWiTOM8tLIgJ70oE/edit?usp=sharing
- doi.org/10.1007/978-3-030-65847-2_13

Maturity: The FIP Tool (now at TRL6), named FIP Wizard, will become publicly available at the end of the project at TRL8 as one of the services provided by the ENVRI-Hub.

Exploitability: Prototype.

Sustainability: It is intended to provide the FIP Wizard in fully operational mode via the GO FAIR Foundation which is now leading the development and implementation. Sustained operation is expected from the GO FAIR Foundation, but this may require discussion with EOSC.

Internationalisation: FIP Wizard: The FIP Wizard is a tool to facilitate the capture of data in the FAIR Implementation Profils prompting communities to explicitly declare their FAIR enabling resources used and their implementation status. These profiles can then be stored and published as nano publications. The tool can be deployed wherever the user wants, and further development driven by user needs is expected during the deployment of the tool.

ENVRI5 - Common metadata schema

Category: Technical Harmonisation.

Description: A common metadata schema to be used by all environmental RIs is being developed, based on the metadata standard DCAT-AP for the exchange of open data. This metadata standard will allow the ingestion of RI metadata into the ENVRI Catalogue of Services (see KER1) and enable the search across all RIs by the ENVRI-Hub search functionality.

Link: doi.org/10.5281/zenodo.4061702

Maturity: The common metadata schema is under development and has been implemented at the ENV RIs within the lifetime of the project. The metadata schema is expected to reach operationality within the ENVRI cluster (TRL7). Application beyond the ENVRI community is beyond the scope of the project.

Exploitability: Operational service.

Sustainability: Common metadata schema: The metadata schema is expected to reach operationality within the ENVRI cluster and is sustained by the participating RIs. Application outside of the ENVRI community is beyond the scope of the project and requires further resources, including the involvement of RDA.

Internationalisation: Common metadata schema: The further development and broader application of the metadata standard applied in the ENVRI cluster will certainly benefit from the respective activities in RDA, in which many ENVRI actors are already involved see, e.g., the Metadata Standards Catalogue WG which will produce a machine-actionable catalogue of metadata standards submitted by all RDA WGs, or the Research Metadata.

ENVRI6 - Policy framework in the ENVRI domain

Category: Policy Harmonisation.

Description: Within ENVRI-FAIR, a policy framework for the entire community of ENV RIs will be developed and implemented by the end of the project. This policy is aligned with EOSC Rules of Participation.

Link: zenodo.org/record/3961475

Maturity: The final policy document for the ENVRI-FAIR common service catalogue provides the policy framework for the development and integration of the ENVRI-FAIR services with the European Open Science Cloud (EOSC).

Exploitability: Prototype.

Sustainability: ENVRI Policy Framework: The framework has been developed and implemented at the participating RIs. The broader application of the developed Policy Framework is considered beneficial for EOSC, but this effort requires additional support on the European Commission level and by RDA.

Internationalisation: ENVRI Policy Framework: The framework has been developed for the ENV RIs, but its broader application, including other scientific domains, requires support from RDA.

EOSC-Life

Providing an open collaborative space for digital biology in Europe – EOSC-Life

Grant agreement ID: 824087

DOI: 10.3030/824087

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 26.145.996,25

EU contribution: € 26.145.996,25

Start date: 1 March 2019

End date: 31 August 2023

Coordinated by: European Molecular Biology Laboratory.

Brief description of the project: The EU-funded EOSC-Life project aims to implement interdisciplinary workflows and create an open, digital and collaborative space for life science research that will publish FAIR data and a catalogue of services for the management, storage and reuse of data in the European Open Science Cloud (EOSC).

Fields of science:
Natural Sciences > Computer and Information Sciences > Data Science.
Natural Sciences > Biological Sciences.
Natural Sciences > Medical Sciences.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures

Topic(s): INFRAEOSC-04-2018 - Connecting ESFRI infrastructures through Cluster projects.

Sub call: H2020-INFRAEOSC-2018-2

Funding Scheme: RIA - Research and Innovation action.

Website: eosc-life.eu

Cordis: cordis.europa.eu/project/id/824087

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓	✓	✓	✓	✓	✓
	1.2 Researcher Engagement and Adoption	✓	✓	✓	✓	✓	✓
	1.3 Rules of Participation Compliance Monitoring	✓	✓	✓	✓	✓	✓
AG 2	2.1 FAIR Metrics and Data Quality	✓	✓	✓	✓	✓	✓
	2.2 Semantic Interoperability	✓	✓	✓	✓	✓	✓
AG 3	3.1 Data Stewardship Curricula and Career Paths	✓	✓	✓	✓	✓	✓
	3.2 Research Careers, Recognition, and Credit	✓	✓	✓	✓	✓	✓
	3.3 Upskilling Countries to Engage in EOSC	✓	✓	✓	✓	✓	✓
AG 4	4.1 AAI Architecture	✓	✓	✓	✓	✓	✓
	4.2 Infrastructure for Quality Research Software	✓	✓	✓	✓	✓	✓
	4.3 Technical Interoperability of Data and Services	✓	✓	✓	✓	✓	✓
AG 5	5.1 Financial Sustainability	✓	✓	✓	✓	✓	✓
	5.2 Long-term Data Preservation	✓	✓	✓	✓	✓	✓

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 Life science data in EOSC

Category: Discovery/Access Platform.

Description: Establish EOSC-Life by publishing FAIR life science data resources for cloud use.

Links:

fairsharing.org/3513
zenodo.org/record/4483694
covid19dataportal.org
doi.org/10.5281/zenodo.5519121

Maturity:

TRL C: Fully operational (in production) and in use by research infrastructure facilities:

1. FAIRSharing.
2. COVID 19 Data Portal.
3. Common Provenance Model.

TRL B: Development to launch:

1. Clinical Trial Data repository (doi.org/10.5281/zenodo.5519121) – TRL B: awaiting data agreements for the next steps.
2. Sensitive data toolkit (zenodo.org/record/4483694).

Exploitability: Concept, plan, or demonstrator.

Sustainability: See KER #2 Life-science toolkits in EOSC.

Internationalisation: Research Data Management: Well-developed actions/solutions with EOSC-Life and ELIXIR-CONVERGE (rdmkit.elixir-europe.org) including other LS RI discussed with NIH as part of open science mandates and tools. Outside Europe FAIRsharing, and RDMKit are widely used in the United States community. In addition, FAIRsharing is part of NIH-funded consortia.

KER #2 Life-science toolkits in EOSC

Category: Discovery/Access platform, Authentication and Authorisation Infrastructure (AAI).

Description: Create an eco-system of innovative life-science tools in EOSC:

EOSC-Life Tools Collaboratory and the key services/standards: RO-Crate, Workflowhub.eu, workflow execution (WfExS, SCHeMa), monitoring (Life Monitor), reporting (OpenEBench), provenance (Common Provenance Model) and workflow submissions for regulatory sciences (BioCompute Objects), Scipion and Galaxy.

Harmonised metadata specifications for computational tools and workflows, and presented them via Schema.org and Bioschemas.org.

Links:

Workflowhub.eu
Schema.org
Bioschemas.org
RO-Crate
Galaxy
Scipion

Maturity: TRL C: Fully operational (in production) and in use by research infrastructure facilities (all above).

Exploitability: Operational service.

Sustainability:

ELIXIR leads:

1. Life science data catalog (fairsharing.org/3513): Recognise FAIRsharing.org as EOSC component with EOSC Core funding, each RI maintains records.
2. COVID-19 Data Portal (covid19dataportal.org): Discuss/agree partnership with HERA needs long-term funding.
3. LS Login, a common AAI system for life science RI – launched in production (see lifescience-ri.eu/ls-login.html): ELIXIR leads sustainability (part of ELIXIR programme) recognise as EOSC component with EOSC Core funding.

ECRIN leads:

1. Sensitive data toolkit (zenodo.org/record/4483694): Maintain via RI collaboration and future projects.
2. Clinical Trial Data repository (doi.org/10.5281/zenodo.5519121): Discuss/agree partnership with HERA needs long-term funding.

BBMRI leads:

1. Common Provenance Model (ISO 23494-2): ISO published, community adoption needs future action.

ELIXIR leads with Euro-BioImaging and Instruct:

1. The EOSC-Life Tools Collaboratory and the key services/standards: RO-Crate, Workflowhub.eu, workflow execution (WfExS, SCHeMa), monitoring (Life Monitor), reporting (OpenEBench), provenance (Common Provenance Model) and workflow submissions for regulatory sciences (BioCompute Objects), Scipion and Galaxy: Recognise EOSC-Life Tools Collaborator as EOSC component with EOSC Core funding.

ELIXIR leads with OpenAIRE partnership:

1. EOSC-Life has developed and harmonised metadata specifications for computational tools and workflows, and presented them via Schema.org and Bioschemas.org: Drive further adoption via future EOSC (topical and generic) projects.

Instruct leads:

1. ARIA user and facility management system (see instruct-eric.eu/help/about-aria): Maintained within INSTRUCT. Recognise as EOSC component and fund via EOSC Core.

Euro-BioImaging/Instruct leads:

1. Procedures, guidance documents and templates for future EOSC Open Calls: Bring forward into future call-driven cluster projects, maintained via inter-RI MoU.

Internationalisation: Tools Collaboratory: Galaxy (usegalaxy.eu) is part of a global network, supported by EOSC-Life and actively developed globally. Other services (RO-Crate, workflowhub.eu, etc) discussed with US/Australian BioCommons.

KER #3

Category: Authentication and Authorisation Infrastructure (AAI), Policy Harmonisation.

Description: Key results for EOSC-Life Objective 3: Enable ground-breaking data-driven research in Europe by connecting life scientists to EOSC:

1. Procedures, guidance documents and templates for future EOSC Open Calls.
2. ARIA user and facility management system.
3. LS Login – a common AAI system for life science RI – launched/in production.

Links:

instruct-eric.eu/help/about-aria

lifescience-ri.eu/ls-login.html

Maturity:

TRL C: Fully operational (in production) and in use by research infrastructure facilities:

1. Life science data resources integrated into EOSC (fairsharing.org/3513) –used and forms the basis for further catalogues.
2. Extension of COVID-19 Data Portal (covid19dataportal.org/) – TRL C: in production, >100k users.
3. Common Provenance Model (ISO 23494-2) – TRL C: published ISO standard.
4. Procedures, guidance documents and templates for future EOSC Open Calls – TRL C: ready for reuse.

Exploitability: Operational service

Sustainability: See KER #2 Life-science toolkits in EOSC.

Internationalisation: Data standards: LS RI are integrated into global standardisation networks (e.g. global BioImaging, GA4GH, Clinical trial and biobanking standards working group). These standardisation efforts would all benefit from support (e.g. via RDA calls or topical projects).

ESCAPE

European Science Cluster of Astronomy & Particle physics ESFRI research infrastructures – ESCAPE

DOI: 10.3030/824064

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 15.983.301,25

EU contribution: € 15.983.301,25

Start date: 1 February 2019

End date: 31 January 2023

Coordinated by: Centre National De La Recherche Scientifique Cnrs.

Brief description of the project: ESCAPE aims to develop solutions to address the open science and data management challenges shared by ESFRIs facilities as well as other pan-European astronomy and particle physics research infrastructures and establish interoperability within EOSC as an integrated multi-messenger facility for fundamental science.

Fields of science:
Natural Sciences > Computer and Information Sciences > Software.
Natural Sciences > Physical Sciences > Theoretical Physics > Particle Physics.
Natural Sciences > Physical Sciences > Astronomy > Astrophysics.
Natural Sciences > Physical Sciences > Astronomy > Observational Astronomy > Infrared Astronomy.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures.

Topic(s): INFRAEOSC-04-2018 - Connecting ESFRI infrastructures through Cluster projects.

Sub call: H2020-INFRAEOSC-2018-2

Funding Scheme: RIA - Research and Innovation action.

Website: projectescape.eu

Cordis: cordis.europa.eu/project/id/824064

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓	✓		✓		
	1.2 Researcher Engagement and Adoption		✓	✓	✓		
	1.3 Rules of Participation Compliance Monitoring		✓		✓		
AG 2	2.1 FAIR Metrics and Data Quality		✓		✓		
	2.2 Semantic Interoperability		✓		✓		
AG 3	3.1 Data Stewardship Curricula and Career Paths		✓		✓		
	3.2 Research Careers, Recognition, and Credit		✓		✓		
	3.3 Upskilling Countries to Engage in EOSC	✓	✓		✓		
AG 4	4.1 AAI Architecture	✓	✓		✓		
	4.2 Infrastructure for Quality Research Software		✓	✓	✓		
	4.3 Technical Interoperability of Data and Services	✓	✓	✓	✓		
AG 5	5.1 Financial Sustainability	✓	✓		✓		
	5.2 Long-term Data Preservation	✓	✓	✓	✓		

AG1: Implementation of EOSC | AG2: Metadata and data quality | AG3: Research careers and curricula
AG4: Technical challenges on EOSC | AG5: Sustaining EOSC

KER#1 ESCAPEDIOS - DataStorage/Management/Transfer/Access system

Category: Virtual Research Environment (VRE).

Description: ESCAPE DIOS prototyped a full Data Storage, Data Management, Data Transfer and Data Access system under a common AAI framework for distributed scientific computing. DIOS is based on proven technologies fostering flexibility for further integration with ESFRIs/RIs and resource-providing infrastructures.

Link: projectescape.eu/services/data-infrastructure-open-science-dios

Maturity: The current ESCAPE DIOS prototype is a fully working system and able to cater for current workflows and pipelines from particle physics, astrophysics and radio-astronomy, ranging from data acquisition from remote sources to end-user analysis. The DIOS building blocks can be considered to fill different service needs in the EOSC. Many of the component tools that comprise the DIOS data management infrastructure are fully operational in production for many years and are thus TRL 8. Other components developed in ESCAPE are at TRL 7 or category B.

Exploitability: Operational service.

Sustainability: The key Data Management components in the DIOS infrastructure have been already adopted by some (ESFRI) RIs in production and some others are in the process of evaluating their usage for the starting phase of their projects. The sustainability of the model is also ensured by the common interest among the participating parties to pursue a collaboration to continue developing and integrating the DIOS model for a broad range of communities, three aspects have been identified: The Data Management System, the Notebook/Analysis Facilities/Analysis Platforms integration and the common AAI with token-based authentication. The continued development and support of the DIOS tools will be assured in the new ESCAPE Collaboration, and the tools all onboarded to EOSC via the OSSR.

Internationalisation: The DIOS tools and infrastructure are the intended data management platforms of several of the ESCAPE RIs, which are all international (global) collaborations. The individual components that are deployed as DIOS have been contributed through several of those collaborations as well as the ESCAPE project. The underlying AAI, which follows the AARC blueprint, used in the EOSC AAI federation, is also an international standard and agreement.

KER #2 ESCAPE OSSR - catalogue for digital scientific products

Category: Discovery/Access Platform.

Description: ESCAPE OSSR developed a catalogue for digital scientific products (mainly software and services) including a complete meta-data standard, best practices in the software lifecycle and integration of the system of development platforms, archiving solutions and landing pages for users.

Link: projectescape.eu/services/open-source-scientific-software-and-service-repository-ossr

Maturity: The OSSR is in TRL7 or category B. The framework (python library) and metadata description are under finalisation as of 2022 and will be completed by the end of the project (01/2023). It will be ready to be operational by then. The rules of participation and meta-data standards will be subject to evolution.

Exploitability: Operational service.

Sustainability: The technical part of the OSSR (python library, metadata and rules of participation definitions) are maintained as an open-source software project. One development goal of the working group was the sustainability of the service with little effort. The major needs are for human resources:

- The maintenance of the library and definitions as well as the curation process for technical resources.
- The further operation of a development platform (currently operated by CNRS) and the teaching efforts for open-source software custodians.
- The continuation of the onboarding activities as well as a helpdesk for OSSR (currently by ESCAPE).
- The continuation of the Zenodo service (by CERN).

The further operation is part of the ESCAPE Collaboration agreement where the major partners of the project signed to further this service on a best-effort basis. The OSSR itself will be connected to the EOSC marketplace.

Internationalisation: Several activities about sustainable open science software are currently in operation and planned (within RDA which is worldwide, the EOSC task force on Quality Research Software). A harmonisation of the efforts - standardisation of metadata, best practices and the sustainability of the necessary technical infrastructure - is necessary and several partners are involved and are strongly interested in continuing and strengthening the participation with appropriate funding schemes.

KER #3 ESCAPE CEVO interoperability standards for IVOA approved astronomical data services

Category: Technical Harmonisation.

Description: ESCAPE CEVO has developed interoperability standards for astronomical data services that have been approved by the International Virtual Observatory Alliance (IVOA) and have been implemented in operational services. These standards have been developed based on the needs of ESFRIs with a methodology of combining data-sharing expertise into partnerships with the ESFRIs. The standards have wide applicability in the international astronomy community and potential for interdisciplinary interoperability. Specific examples include the IVOA MOC 2.0 interoperability standard for sky- and temporal-coverage of astronomy data sets, and the IVOA Provenance Data Model 1.0.

Link: projectescape.eu/services/virtual-observatory-vo

Maturity: The IVOA-approved interoperability standards supported by ESCAPE fall into category C as accepted community standards, with reference implementations (as required by the IVOA process). IVOA standards are implemented in ESFRI and RI services with different maturity levels from TRL 9 to TRL 7. The progress of the ESCAPE work to support the development and use of common standards will be reported in ESCAPE D4.8 (09/22). The ESCAPE project has built capacity in ESFRIs and RIs for the development and implementation of common standards and has maintained European coordination of the development of standards to meet scientific needs. Further maturation is expected beyond the end of the project and will benefit from the continuation of the ESCAPE cluster collaboration. The Virtual Observatory Registry system is mature at TRL 9 and ESCAPE has fostered its inclusion in EUDAT B2FIND as a path to be included in the EOSC portal, which requires further work as the EOSC portal onboarding evolves. Further work will be required beyond the end of the project to ensure that the IVOA standards are included in the EOSC Interoperability Framework.

Exploitability: Operational service.

Sustainability: The interoperability standards that have been developed in ESCAPE (and approved by IVOA) are maintained on the permanent IVOA repository of technical specifications. These standards are also registered in the Astrophysics Data System (ADS) with assigned bibcode IDs, and the standards are also deposited in the FAIRSharing repository where DOIs are assigned. The management of the standards is under the responsibility of IVOA which relies on continued community participation for the maintenance and updates that will be required for scientific and technical evolutions.

Internationalisation: ESCAPE is bringing international astronomical resources (in the Virtual Observatory registry) into EOSC and can be seen as an example of EOSC interfacing with international-level systems. The IVOA standards are approved at the international level with well-established governance, procedures and guidelines for participation that can serve as an example of setting up and operating an international interoperability framework. There is also potential for interdisciplinary use of IVOA standards (or derivatives) for example the potential use of MOC 2.0 in fields that concern the use of spherical coordinate systems (e.g. planetary surfaces, earth science) and time coverage systems.

KER #4 ESAP - Science Platform for service offering integration

Category: Virtual Research Environment (VRE).

Description: ESCAPE ESAP provides a reusable toolkit for integrating diverse service offerings to provide a coherent "science platform" environment which can be customised to the needs of particular research infrastructures or communities. It connects with the services and tools developed in ESCAPE WPs 2 (DIOS), 3 (OSSR), 4 (CEVO) and 6 (ECO) to provide a unified view of the ESCAPE ecosystem, and is also extensible to provide interoperability with a wide range of customized and off-the-shelf services in use within the wider scientific community. ESCAPE has also developed a Virtual Research Environment that offers a single point of entry to the integrated tool set.

Link: projectescape.eu/services/esfris-science-analysis-platform-esap

Maturity: Core ESAP components have reached TRL 7 (category B). Due to the nature of the system, additional services can be integrated through plugins which are available at a range of different TRLs. ESAP is provided as a software toolkit, rather than an operational service; standing up an ESAP instance in a new environment will require some effort to customize it and integrate it with the surrounding services and infrastructure.

Exploitability: Operational service.

Sustainability: ESAP core components are open-source software. They are currently developed and hosted on a code management system at ASTRON, the Netherlands Institute for Radio Astronomy. ASTRON will continue to host them indefinitely, certainly beyond the end of the ESCAPE project. Migration to other common platforms (GitHub, GitLab) should the ASTRON system become unavailable would be straightforward.

Continued development beyond the end of the ESCAPE project will be driven by users: we expect ESAP components to see wide application across a variety of ESFRIs and related establishments, and they will drive development as an open-source project. This may be moderated by a future ESCAPE collaboration agreement.

The ESAP Zooniverse shopping basket will remain integrated

with the Zooniverse citizen science platform with minimal maintenance requirements.

The ESAP tools and components will be onboarded into OSSR and hence the EOSC marketplace.

Internationalisation: ESAP has been developed by an international team, drawing on effort, expertise, and input from research infrastructures across Europe. Test deployments have been made across the continent. In the future, we hope to explore opportunities for international federation of ESAP instances and services.

KER #5 Training Materials for OS practices and user community engagement

Category: Training Resource.

Description: ESCAPE has developed training materials for different target audiences including scientific researchers, data providers, software code developers, and research infrastructures. These materials are valuable reusable resources for the support of open science practices in the disciplines covered by ESCAPE and also more generally for the implementation of EOSC, and the engagement with user communities. The ESCAPE initiatives in Citizen Science also strengthen community engagement, both through broadening the community to interested scientists and citizens, but also through the use of Citizen Science as a research tool itself.

Link:

Sustainability: The sustainability of the materials and tools developed in ESCAPE is assured through their inclusion in the OSSR, and the anticipated onboarding of them into the EOSC marketplace to make them available for a broader community.

Internationalisation: The training materials have been used in schools and workshops that have had significant international participation, both online and in person. The Citizen Science initiatives have been used by volunteers worldwide.

ExPaNDS

EOSC Photon and Neutron Data Services – ExPaNDS

Grant agreement ID: 857641

DOI: 10.3030/857641

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 5.998.103,75

EU contribution: € 5.998.103,75

Start date: 1 September 2019

End date: 28 February 2023

Coordinated by: Deutsches Elektronen- Synchrotron, Desy.

Brief description of the project: The EU-funded ExPaNDS project aims to make the majority of large-scale photon and neutron research infrastructures' scientific data open, following FAIR principles and harmonising their data catalogues and data analysis services through the EOSC to enable the storage, management, analysis and reuse of this data.

Fields of science:
Natural Sciences > Computer and Information Sciences > Data Science.
Natural Sciences > Computer and Information Sciences > Knowledge Engineering > Ontology.
Social Sciences > Sociology > Governance.
Natural Sciences > Physical Sciences > Theoretical Physics > Particle Physics > Photons.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures.

Topic(s): INFRAEOSC-05-2018-2019 - Support to the EOSC Governance.

Sub call: H2020-INFRAEOSC-2018-3

Funding Scheme: RIA - Research and Innovation action.

Website: expands.eu

Cordis: cordis.europa.eu/project/id/857641

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓		✓		✓	✓
	1.2 Researcher Engagement and Adoption	✓		✓	✓	✓	✓
	1.3 Rules of Participation Compliance Monitoring					✓	
AG 2	2.1 FAIR Metrics and Data Quality	✓	✓	✓	✓		✓
	2.2 Semantic Interoperability	✓	✓	✓	✓		✓
AG 3	3.1 Data Stewardship Curricula and Career Paths	✓				✓	✓
	3.2 Research Careers, Recognition, and Credit	✓				✓	✓
	3.3 Upskilling Countries to Engage in EOSC	✓			✓	✓	
AG 4	4.1 AAI Architecture	✓		✓	✓	✓	✓
	4.2 Infrastructure for Quality Research Software	✓		✓	✓	✓	✓
	4.3 Technical Interoperability of Data and Services	✓	✓	✓	✓	✓	✓
AG 5	5.1 Financial Sustainability	✓	✓	✓	✓	✓	
	5.2 Long-term Data Preservation	✓		✓			

AG1: Implementation of EOSC | AG2: Metadata and data quality | AG3: Research careers and curricula
AG4: Technical challenges on EOSC | AG5: Sustaining EOSC

KER #1 Policy harmonisation and self-assessment of FAIR in photon & neutron science

Category: Policy Harmonisation.

Description: Building and documenting a consensus on FAIR-compliant Data Policies at the ExPaNDS research infrastructures including mechanisms for self-assessment.

Maturity: Current TRL: 5.

The first iteration has been established and reviewed by the stakeholder. The final version incorporates this feedback. The self-evaluation mechanisms will be released by the end of the project. We anticipate early adopters during the project's lifetime.

Expected TRL: Targeting 9 but depends on management decisions of the different facilities on which ExPaNDS doesn't have much influence.

Exploitability: Prototype.

Sustainability: ExPaNDS supported its partner facilities in creating customised versions of data policies depending on their special needs. It is expected that those agreed policies will be integrated into the daily workflow of domain and beamline scientists.

Internationalisation: As FAIR Policies are of cross-scientific interest, ExPaNDS would benefit from a closer collaboration with similar initiatives in other scientific fields, such as RDA.

KER #2 Ontology of techniques in photon & neutron science

Category: Technical Harmonisation.

Description: Steering the definition of an ontology for scientific techniques, with a focus on Photon and Neutron facilities used for faceted search of datasets in catalogues, classification of learning material and supporting self-defining data files (e.g. NeXus file format).

Maturity: Current TRL: 6.

Ontologies have been established and published. Software tools to use faceted searches have been written and will be deployed by the end of the project. The ontology keywords are available on the training platform, however, currently lack the hierarchical search.

Expected TRL: 9.

Exploitability: Prototype.

Sustainability: Building a community-driven support model possibly using the NIAC (NeXus International Advisory Committee) steering board as an example.

Internationalisation: Ontologies are also of cross-scientific interest. ExPaNDS would benefit from a closer collaboration with similar initiatives in other scientific fields, such as RDA.

KER #3 portable VISA

Category: Virtual Research Environment (VRE).

Description: Enhancing VISA's portability, allowing it to be deployed at ExPaNDS's facilities and integrated with their diverse cloud technologies.

Maturity: Current TRL: 6.

The VISA software is already in production at ILL. Prototype deployments are available at the different RI's which use a variety of cloud technologies. An adapter framework for local infrastructure is being worked on.

Expected TRL: 9.

Exploitability: Prototype.

Sustainability: ILL is continuing the core part of VISA as this is their production portal. Each facility will maintain the corresponding adapters to interface VISA with local services. For most facilities, the VISA portal is a strategic component, so sustainability is guaranteed by their individual contribution.

Internationalisation: VISA is based on Cloud and ICT industry standards, which essentially guarantees interoperability by definition.

KER #4 PaN workflow engines

Category: Virtual Research Environment (VRE).

Description: Demonstrating the portability of scientific workflows, by providing common access mechanisms and analysis pipelines at multiple RIs, using modern cloud technologies like Virtual Machines, containers and Jupyter Notebooks.

Maturity: Current TRL: 5.

Target pipelines have been identified. Work is ongoing demonstrating their portability.

Expected TRL: 9.

Exploitability: Prototype.

Sustainability: Portability of scientific workflows and applications is a key objective for all PaN facilities to attract users, foster scientific output and with that increase their visibility. Consequently, the standardisation effort will be picked up by LEAPS and LENS IT working groups.

Internationalisation: The final objective is to base the project's workflows on established industry standards. However, as

some facilities are hosting sciences beyond ExPaNDS, better coordination between different sciences would be of benefit to the corresponding service providers.

KER #5 TeSS e-learning platform In PaN

Category: Training Resource.

Description: Evaluating and adapting ELIXIR's TeSS e-learning platform to ExPaNDS requirements and deploying it as a central service at one of the project's facilities.

Maturity: Current TRL: 7.

The TeSS system has been successfully customised and deployed. Content has been added and activities have been established to support facilities in contributing content.

Expected TRL: 9.

Exploitability: Prototype.

Sustainability: HZDR has agreed to host the service beyond the project's lifetime. LEAPS and LENS are involved in providing new material and ensuring it receives suitable visibility.

Internationalisation: There is no known standard for training platforms, however, the project's decision to use the ELIXIR TeSS training platform and the Moodle system provides a larger science community with an established environment.

KER #6 Enhancing the visibility of FAIR data within the EOSC Marketplace and other services

Category: Discovery/Access platform, Technical Harmonisation.

Description: Facilitating RI adoption of standard catalogue software (SciCat and ICAT), enhancing the visibility of FAIR data within services such as B2FIND, OpenAIRE and the EOSC Marketplace.

Maturity: Current TRL: 3-9.

As catalogues require deep integration into the infrastructure of the facilities, the project can only advise and support the adoption of standard solutions. Facilities are at different states of adoption. Blueprint documents for the adoption and their integration of SciCat and ICAT into the global PaN search infrastructure (e.g. B2find and OpenAire) are provided. This has been validated at some of our facilities, running those services in production.

Expected TRL: 9.

Exploitability: Prototype.

Sustainability: SciCat and ICat are established products with proven support models. The support for the PaN-search API has been integrated into upstream catalogue software (ICAT and SciCat) and will be maintained through their support model. The OAI-PMH is an established protocol, maintained by the Open Archives Initiative Organisation.

Internationalisation: ExPaNDS is consolidating efforts and focusing on two implementations of catalogues services. However, as most scientific domains are using their very specific catalogues, the project implemented the established domain-agnostic OAI-PMH API and designed an ExPaNDS-specific search API which might be of interest to other sciences too.

PaNOSC

Photon and Neutron Open Science Cloud – PaNOSC

Grant agreement ID: 823852

DOI: 10.3030/823852

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 11.953.516,99

EU contribution: € 11.953.516,99

Start date: 1 December 2018

End date: 30 November 2022

Coordinated by: European Synchrotron Radiation Facility.

Brief description of the project: The PaNOSC project brings together six strategic European research infrastructures to develop open science strategies and solutions in the area of photon and neutron FAIR data policy, data management, data services and tools, such as data storage, analysis and simulation.

Fields of science:

Natural Sciences > Computer and Information Sciences >Data Science.
Natural Sciences > Computer and Information Sciences > Software.
Natural Sciences > Computer and Information Sciences > Computer Security >Access Control.
Natural Sciences > Physical Sciences >Theoretical Physics > Particle Physics > Photons.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures.

Topic(s): INFRAEOSC-04-2018 - Connecting ESFRI infrastructures through Cluster projects.

Sub call: H2020-INFRAEOSC-2018-2

Funding Scheme: RIA - Research and Innovation action.

Website: panosc.eu

Cordis: cordis.europa.eu/project/id/823852

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓	✓			✓	
	1.2 Researcher Engagement and Adoption	✓	✓	✓		✓	
	1.3 Rules of Participation Compliance Monitoring			✓	✓		✓
AG 2	2.1 FAIR Metrics and Data Quality	✓	✓				✓
	2.2 Semantic Interoperability	✓	✓				✓
AG 3	3.1 Data Stewardship Curricula and Career Paths	✓				✓	
	3.2 Research Careers, Recognition, and Credit		✓		✓	✓	
	3.3 Upskilling Countries to Engage in EOSC	✓		✓	✓	✓	
AG 4	4.1 AAI Architecture	✓		✓	✓	✓	
	4.2 Infrastructure for Quality Research Software		✓	✓		✓	✓
	4.3 Technical Interoperability of Data and Services		✓	✓	✓	✓	✓
AG 5	5.1 Financial Sustainability	✓	✓			✓	
	5.2 Long-term Data Preservation	✓	✓		✓		

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 FAIR-compliant Data Policy Framework for Research Infrastructures

Category: Policy harmonisation.

Description: PaNOSC FAIR data policy is an update of the PanData Data Policy Framework published in 2010. The PaNdata policy framework has been used as a blueprint for the open data policies of the majority of photon and neutron sources in Europe over the last 10 years. We foresee a similar lifetime for the PaNOSC Data Policy Framework.

Link: doi.org/10.5281/zenodo.3862701

Maturity: FAIR-compliant Data Policies for Research Infrastructures: Accepted community standard. The PaNOSC FAIR policy has been used by all the partners and beyond to adopt or write new FAIR data policies.

Exploitability: Operational service.

Sustainability: Most of the proposed services already have the platforms to ensure their sustainability after the project.

Internationalisation: The PaNOSC FAIR data policy could be the basis for a standard policy for a wide variety of analytical facilities. The RDA or EOSC-A could endorse such standards to help their adoption and ease the task for new facilities.

KER #2 Federated Search API + data portal

Category: Discovery/Access platform.

Description: One of the main objectives of PaNOSC was to provide open data for the EOSC. The federated search API and portal aim to provide an easy way to search for open data across the photon and neutron facilities via a single portal.

Links:

data.panosc.eu

human-organ-atlas.esrf.eu

Maturity: Federated Search API + data portal: TRL7 - system prototype demonstration in an operational environment. The Federated search API and portal are still at the beginning of their life cycle. It exposes all the open data available from the PaN community and makes it easy to search using a powerful scoring algorithm to give useful results. The search API and portal will be the foundation for exposing and finding open data from Europe's photon and neutron facilities by humans and machines.

Exploitability: Operational service.

Sustainability: A recent example of such data is the Human Organ Atlas (human-organ-atlas.esrf.eu) which will provide an atlas of all human organs scanned at the micron level. The codesign methodology will be one of the flagship products of one of the SME involved in the project (SfC). They will exploit it in new projects.

Internationalisation: The federated search API and portal is the first attempt to expose the open data from the PaN community. The goal of PaNOSC is to propose a service which is used by scientists worldwide to find and reuse the data from their facilities. This represents thousands of datasets comprising petabytes of data which could be reused in new publications and applications including machine learning. The portal enables the adoption of standards for publishing, citing and collecting metrics on data reuse. The next step is to extend the portal after PaNOSC so that it covers open data from all PaN facilities in Europe.

KER #3 Remote data analysis platforms (VISA and H5Web)

Category: Virtual Reserch Environment (VRE).

Description: The VISA remote desktop platform is one of the main developments produced by PaNOSC. It was used for remote experiments during the COVID-19 confinement period and for remote data analysis since then. It provides a remote desktop experience which enables desktop sharing between multiple users. It can be deployed on common cloud infrastructure as a general-purpose solution for remote data analysis.

H5Web is a web viewer for HDF5 data files in Jupyter and data portals.

Links:

panosc.eu/services/data-analysis

github.com/silx-kit/h5web

Maturity: VISA+H5Web: TRL9 - actual system proven in an operational environment. VISA will be used by all PaNOSC and ExPaNDS partners and beyond for providing access to cloud resources via a powerful remote desktop for data analysis. H5Web is in production at all PaNOSC sites and is being adopted by a number of other sites including the HDF Group (maintainers of the HDF5 standard).

Exploitability: Operational service.

Sustainability: The training outcomes are supported in EOSC as openly shared products. One of the partners (Open University) also maintains a platform to ensure their sustainability.

Internationalisation: VISA provides a means of accessing data analysis software and scientific data through remote desktops and Jupyter Notebooks but does not dictate which software or environments should be installed. Therefore, standardisation is not really applicable to the VISA platform but could be more generally oriented towards how software packages are installed and how data is accessed within the service. H5Web provides a data viewer for JupyterLab for

HDF5, a binary data format which is used by over a million scientists worldwide in many scientific domains including photon and neutron science, environmental and atmospheric science and AI/ML.

KER #4 UmbrellaId community AAI

Category: Authentication and Authorization Infrastructure (AAI).

Description: The UmbrellaID community AAI is based on the AARC blueprint architecture and is ready for the EOSC AAI federation. PaNOSC is working very closely with GEANT to ensure that UmbrellaID will be one of the first community AAI to form the EOSC AAI federation. The community AAI is used for community services like metadata catalogues, training platforms and software catalogues.

Link: umbrellaid.org/what.html

Maturity: UmbrellaID AAI: TRL8 - system complete and qualified. UmbrellaId is the EOSC AAI ready AAI for the PaN community.

Exploitability: Operational service.

Sustainability: Do it Yourself (DIY) devices are offered as open hardware and software platforms (like Github), ensuring that the products will be available after the project.

Internationalisation: The community AAI so-called UmbrellaID follows the standard AARC blueprint. It is based on the eduTEAMS solution from GÉANT and complies with the standard EOSC AAI. Once the EOSC provides services which accept the EOSC AAI it should logically also accept UmbrellaId AAI for members of the PaN community.

KER #5 Community e-learning platform

Category: Training Resource.

Description: This training and e-learning platform is an updated version of the training platform developed during the H2020 project SINE2020. PaNOSC has joined forces with the ExPaNDS on its training catalogue.

Link: e-learning.pan-training.eu

Maturity: Training platform: TRL9. Actual system is proven in an operational environment. The PaNOSC e-learning platform has a large amount of material for neutrons but is lacking in material for photon sources. Material for photon sources is under development.

Exploitability: Operational service.

Sustainability: The Guidelines on best practices for building citizen observatories will be offered in EOSC and open repositories (such as Zenodo).

Internationalisation: The provided courses can be made FAIR through standardised metadata. Standard training courses on common subjects like FAIR data management could be shared with other providers of training material e.g. FAIRsFAIR.

KER #6 Experiment simulators (VINYL)

Category: Virtual Reserch Environment (VRE).

Description: Simulation of experiments (VINYL which includes SIMEX, McSTAS and OASYS). McSTAS and OASYS are the de facto tools used for designing almost all beamlines world-wide. SIMEX builds on the outcomes of the EUCALL project.

Link: panosc.eu/services/data-analysis-simulation-data-system

Maturity: VINYL: TRL8 and TRL9 for some packages (OASYS + McStasScript). The VINYL simulation platform has enabled the improvement and extension of some of the de facto standard simulation tools in the PaN community (McStas + OASYS are used respectively to design almost all neutron and photon beamlines worldwide). New developments for the FEL community have been pushed ahead with VINYL.

Exploitability: Operational service.

Sustainability: The report on the sustainability strategy for the Cos4Cloud services will be offered in EOSC and open repositories (such as Zenodo).

Internationalisation: The outcomes of WP5 would benefit from the development and adaptation of a formal simulation ontology to enhance even further the accessibility (A) and interoperability (I) in terms of simulation input parameters and simulation output (which may become the source data for subsequent simulations). In a similar way, it could benefit from the development of a common ontology for photon and neutron beamlines and instruments.

SSHOC

Social Sciences & Humanities Open Cloud – SSHOC

Grant agreement ID: 823782

DOI: 10.3030/823782

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 14.493.360,36

EU contribution: € 14.455.594,08

Start date: 1 January 2019

End date: 30 April 2022

Coordinated by: CESSDA ERIC.

Brief description of the project: The EU-funded SSHOC project contributes to the European open science agenda and the realisation of the European Open Science Cloud (EOSC) by creating a social sciences and humanities cloud that can fully encompass infrastructural support for the study of social and cultural phenomena.

Fields of science:
Humanities > Languages and Literature > Linguistics.

Natural Sciences > Biological Sciences > Ecology > Ecosystems Social Sciences.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures.

Topic(s): INFRAEOSC-04-2018 - Connecting ESFRI infrastructures through Cluster projects.

Sub call: H2020-INFRAEOSC-2018-2

Funding Scheme: RIA - Research and Innovation action.

Website: sshopencloud.eu

Cordis: cordis.europa.eu/project/id/823782

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation		✓		✓		
	1.2 Researcher Engagement and Adoption	✓	✓	✓	✓	✓	✓
	1.3 Rules of Participation Compliance Monitoring	✓	✓	✓	✓		
AG 2	2.1 FAIR Metrics and Data Quality			✓			✓
	2.2 Semantic Interoperability	✓		✓	✓		✓
AG 3	3.1 Data Stewardship Curricula and Career Paths		✓			✓	✓
	3.2 Research Careers, Recognition, and Credit	✓	✓	✓		✓	
	3.3 Upskilling Countries to Engage in EOSC	✓				✓	✓
AG 4	4.1 AAI Architecture						
	4.2 Infrastructure for Quality Research Software	✓	✓	✓			✓
	4.3 Technical Interoperability of Data and Services	✓	✓	✓	✓		✓
AG 5	5.1 Financial Sustainability	✓	✓	✓	✓		
	5.2 Long-term Data Preservation				✓		✓

AG1: Implementation of EOSC | AG2: Metadata and data quality | AG3: Research careers and curricula
AG4: Technical challenges on EOSC | AG5: Sustaining EOSC

KER #1 SSH Open Marketplace

Category: Discovery/Access platform.

Description: The Social Sciences and Humanities (SSH) Open Marketplace is one of the entry points in the EOSC for SSH researchers with curated resources (mainly tools, services, training materials and workflows) to support the reusability and combination of research results.

Links:

marketplace.sshopencloud.eu

zenodo.org/record/6394462

Maturity: The SSH Open Marketplace is an operational service in production - TRL 8 - since January 2022. It is onboarded in the EOSC Catalogue & Marketplace. The SSH Open Marketplace reuses community standards and vocabularies to describe its resources and will benefit from community curation to keep its (meta) data up-to-date.

Exploitability: Operational service.

Sustainability: The SSH Open Marketplace is sustained and funded by 3 ERICs - CESSDA, CLARIN and DARIAH - for an initial phase going until Dec. 2023. National nodes of these ERICs are providing the service and its components. An Editorial Board is set up to ensure the day-to-day activities. The exploitation plan for this service is described as part of the SSHOC Exploitation plan, and SSHOC D7.5 can also be consulted for details. The SSH Open Marketplace is also envisioned as a common/shared curation platform for other SSHOC KERs: the SSH Conversion Hub and the Training Discovery Toolkit.

More information on further exploitation can be found in the legacy booklet: zenodo.org/record/6394462

Internationalisation: The SSH Open Marketplace has been developed following Digital Humanities community requirements gathered beyond Europe. See for example, collaboration with Northern American colleagues: dh2020directoriesforum.hcommons.org.

KER #2 Virtual Collection Registry (VCR)

Category: Virtual Reserch Environment (VRE).

Description: The Virtual Collection Registry (VCR) is a service that is directly available to all researchers and allows them to create collections composed of different types of resources hosted by different distributed repositories. Virtual collections are issued a PID and researchers can publish and share virtual collections with their colleagues, independent of discipline.

Link: collections.clarin.eu/public?5

Maturity: The VCR is a mature operational service onboarded in the EOSC Marketplace at TRL8.

Exploitability: Operational service.

Sustainability: The VCR is sustained by CLARIN and a coalition of willing partners. The VCR will be further developed in other EU and national project(s). More information on further exploitation can be found in the legacy booklet: zenodo.org/record/6394462.

Internationalisation: This is partly already done or underway. Standardising and providing access to hosted resources is the main theme for future developments.

KER #3 RESTORE

Category: Virtual Research Environment (VRE).

Description: The RESTORE platform is currently under development (TRL 7) and supports a variety of data formats used in the targeted communities (Heritage Science and Cultural Heritage researchers, professionals, citizen scientists), such as EAC, EAD, TEI, DC, METS, MODS, MAG, ICCD-OA, EDF/TIFF. The developing team adopted CIDOC-CRM as the reference conceptual model, with the aim of making the partners' data machine actionable (i.e.: reusable for computational purposes, and reasoning), but also more accessible and easier to be browsed and communicated in a user-friendly fashion. To do so, the RESTORE project used a significant part of documentary material, selected and revised by domain experts and elaborated with custom tools (i.e.: scripts and parsers for data collection, normalisation and mapping). The expected outcome from the pilot project is that of providing, as also part of the EOSC Platform and Marketplace, the former RESTORE tool as the new "RAISE" (Restore dAta Integration SuitE) service, a tool-pack that will help cultural heritage and heritage science professionals, institutions and researchers to successfully accomplish recovery, integration, accessibility and reuse of multi-format and standardised digital resources, based on FAIR data principles.

Links:

marketplace.sshopencloud.eu/tool-or-service/plyy0d

zenodo.org/record/6394462

Maturity: TRL7.

Exploitability: Operational service.

Sustainability: The RESTORE project proposes a virtuous model for data integration, reuse, and sustainability, good for the contextual representation of data related to intangible and tangible aspects of cultural heritage artefacts. The technical components and custom parsers are fully documented through git service (GOGS) and work for each standardised and validated procedure within the different fields of knowledge. The tool makes use of the SSHOCro (reference

ontology), CIDOC-crm, of open access sources, following FAIR protocols. The Long-Term Sustainability for CH and HS Data is assured by maintenance in the context of the Data Centres already activated and tested by the Italian node of DARIAH infrastructure (DARIAH.it). Those Data Centres are running and are in the stage of final definition.

Within the EOSC context, developing a strategic implementation of the SSHOC data integration suite should enable: the addition of data referencing to the diagnostic operations done on cultural objects considered accessibility of contents and their contextualization reuse outside the context of information generation interoperability between systems semantic interoperability and context preservation.

Internationalisation: The ample range of disciplines covered by the target community (HS and CH) is a testimony of the need of building common protocols and strategies based on existing data and metadata standards, already developed in each scientific discipline, for the reuse and sharing of existing technologies. The project's first objective was to cover the heterogeneous data landscape made of a mix of structured, tabular, unstructured and semi-structured data, towards an interoperable and common set of tools, practices, standard, policies. The pilot use case comprehends both cultural heritage (CH) datasets (documents, texts, works of art, manuscripts, and artefacts) and heritage science (HS) datasets (high-resolution measures and analyses made on artistic objects). To achieve full data integration is a complex subject, for data produced by the community refer to scientific and disciplinary fields that are often following different normative schemas, a complexity which is reflected by use of standards and cataloguing systems that differ in structure and purpose. It was, therefore, necessary to set up a workflow that not only allows the semantisation of data within a single reference domain, but also proposes a shared data processing model, valid for multiple metadata schemes and for multiple standards.

KER #4 Improved Repositories

Category: Discovery/Access platform.

Description: The new ESS Data Portal allows for easier direct access to data/metadata for ESS users (researchers, students, and others). This service allows better data retrieval and more reuse of data through the implementation of FAIR data principles as well as reduced processing costs and less dependence on resource providers.

Surveycodings.org is a free service for survey projects, data archives and researchers measuring and coding socio-economic background variables and more general social science classifications. It provides questionnaires, data collection tools, coding frames, and classifications based on standard statistical classifications for a large number of countries and languages. SurveyCodings covers the following individual and socio-economic variables: industry, occupation, educational attainment, the field of education, religious denominations, social networks, cost of living, and region.

We developed and ran a support program for SSH repositories to guide them in their journey to becoming Trusted Data Repositories (TDR). The support program components are not discipline-specific and can be reused. D8.2 and D8.3.

Links:

- Surveycodings.org
- marketplace.eosc-portal.eu/services/european-social-survey-ess-as-a-service
- marketplace.eosc-portal.eu/services/surveycodings-org
- zenodo.org/record/6394462

Maturity: The ESS Portal is currently onboarded to EOSC as TRL 7 as it is still in Beta planning to upgrade to TRL-8 after analysis and visualisation tools a cumulative data wizard is in place in some weeks' time and after the first ESS10 data will be published in June.

Survey Codings: The services on surveycodings.org aim at obtaining consistent and comparable data by:

- Offering already structured measurement instruments for central socio-economic and more general social science variables for CAWI or CAPI surveys and easy to implement in PAPI too for certain variables.
- Implementing cross-national classifications to permit effective international comparisons.
- Collecting data across samples and/or time points within and between countries
- Saving time in the ex-post harmonization phase of open answers.
- Supplying zoomed insight into key national sectors such as those of education and occupation.

Exploitability: Operational service.

Sustainability: ESS ERIC is a stable infrastructure with long-term commitments to making research data available to users. Data as well as infrastructure is continuously updated on the website, which is already onboarded to the EOSC Portal.

Survey Codings will continue its services for years to come and it will be a partner in funding proposals.

More information on further exploitation can be found in the legacy booklet:

zenodo.org/record/6394462.

Internationalisation: The ESS has fielded in around 30 countries (in Europe including Turkey and Israel). Trusted repositories from WP8: trust support for TDR (or repositories willing to improve their practices and/or become a TDR) has both a universal aspect and an infrastructure-specific aspect. CoreTrustSeal certification is an international certification body. Additional work is needed to create certification or assessment frameworks for repositories that are not TDRs

but e.g. technical service providers for TDRs.

Survey Codings: All ontologies hosted by survey codings are covering 100+ countries and their languages, and meet the standard classification systems, as maintained by the United Nations and the European Union, such as ISCO08 for the classification of occupations, NACE REV2 for the classification of industries, ISCED2011 for the classification of educational categories, and alike.

KER #5 Training discovery toolkit & Trainers Directory

Category: Training Resource.

Description: They are directly usable by EOSC TASK FORCES in their work (Research Careers and Curricula). They have a high disciplinary or multidisciplinary importance to engage major user communities in the EOSC.

They are of direct use to EOSC user communities in their engagement with EOSC.

They contribute towards achieving the SRIA objectives and an operational EOSC infrastructure.

Links:

- training-toolkit.sshopencloud.eu
- sshopencloud.eu/trainers-directory
- lod.sshopencloud.eu

Maturity: As of the beginning of 2022, the SSH Training Community enumerates 172 members covering all SSH disciplines. The main goal is the facilitation of networking and exchange of knowledge between existing and new trainers in the SSH, while also encouraging and fostering collaboration with wider communities (e.g., Community of Practice for training coordinators.

The SSHOC Training Discovery Toolkit contains more than 200 training and learning resources from more than 80 different sources and in a wide range of topics.

The Trainer's Directory will be adopted by the EOSC Future project and will be replicated on the EOSC Portal, this is a work in progress.

The SSHOC LoD is a pilot version of the game, where two chapters of the CESSDA Data Management Expert Guide have been gamified.

Exploitability: Operational service.

Sustainability: Tools, training materials and workflows are available in the SSH Open Marketplace. EOSC Future will work on taking the Trainers' Directory to the EOSC Portal.

More information on further exploitation can be found in the legacy booklet: zenodo.org/record/6394462

KER #6 SSHOC-Created Networks & Communities

Category: Knowledge Centre.

Description: As one of the SSHOC Data Communities, the Ethnic and Migrant Minorities Community built two tools, the EMM Survey Registry (TRL-8) and the EMM Question Data Bank (demonstrator). Both are highly important to their disciplinary field and can be used by the EOSC Task Forces (2.1 FAIR metrics and data quality, 2.2 Semantic interoperability), they engaged researchers and policy makers in the testing and development of their tools, they promote FAIR in their discipline, they implement high metadata standards and give training, to researchers in using and adding to the tools.

- The SSHOC social media community has over 2,600+ connections on Twitter and LinkedIn, they are already directly contributing to the EOSC as sharing updates and inviting members to relevant events. The SSHOC newsletter is received by 600+ subscribers.
- In addition to the EMM Community and the Heritage Sciences with the SSHOC3 RAISE, and the SSH Training Community from SSHOC5, the project brought forward other communities:
  - The SSH Dataverse Community is especially interesting for the technical task forces and has a multi-disciplinary Link: Dataverse Archive in Box Github repo github.com/IQSS/dataverse-docker, SSHOC Weblate weblate-sshoc.cessda.eu.
  - The SSH Vocabulary Commons: is a collaboration of the major SSHOC stakeholder to discuss common recommendations for vocabulary management, and come to an implementation for a federative vocabulary infrastructure.
  - The SSH Trust Support Community: post-project network through the European network of TDR initiated by FAIRsFAIR.
  - The International Secure Data Facility Professionals Network is bringing together international, cross-disciplinary colleagues working in or towards Secure Data Facilities, to share expertise and experiences in making challenging/sensitive data FAIR, discuss relevant areas of work, and to spark collaboration as well as develop new ideas. It can be reached via mailing list: isdfpn@ukdataservice.ac.uk. More information can be found in SSHOC deliverable 5.12 (forthcoming).

Links:

- marketplace.eosc-portal.eu/services/ethnic-and-migrant-minority-survey-registry/details
- github.com/IQSS/dataverse-docker
- weblate-sshoc.cessda.eu
- isdfpn@ukdataservice.ac.uk
- doi.org/10.5281/zenodo.4655994
- doi.org/10.5281/zenodo.6564291

Maturity: The EMM Survey Registry is TRL-8. EMM QDB is a demonstrator.

The SSH Dataverse Community met several times throughout

the SSHOC project lifetime for workshops, and training sessions and produced two tools: the Dataverse Archive in a Box and the Weblate Translation. The Archive in a box is in between B and C, more institutions would need to test and use it to see how stable it is or where work is needed, it is operational and used by institutes. The Weblate translation is in between stages B and C, it is operational but some developments would be needed to automate some functionalities.

The SSH Vocabulary Commons: the existing infrastructure is an instance of the SOKSMOS vocabulary publication software is mature and TRL8, we do envisage extensions, or else a different software, to support a federative vocabulary infrastructure, which does not yet exist.

The Secure Data Facility Professionals Network is an operational service: Terms of Reference and a Steering Group are in place, it is a growing network with an administrative structure and an action plan.

Exploitability: Operational service.

Sustainability:

- EMM Community: Sciences Po currently hosts both the EMM Survey Registry and the EMM Question Data Bank, for the latter, new funding would be needed to build on the demonstrator developed in SSHOC.
- SSH Dataverse Community will be continued in the CESSDA Dataverse Community Group, and the Global Dataverse Community, for the tools: Archive in a box and Weblate will be used and further developed in new projects.
- SSH Vocabulary Commons: current SKOSMOS instance hosted at OEAW which promised to keep this running in the near future. changes to a full federative infrastructure depend on in-kind support by the members.
- SSH Trust Support Community.
- Secure Data Facility Professionals Network: There is an agreement to maintain the network, resources will be needed for upkeep and administrative post(s) (maybe cross-national post(s)), as there is a high demand for the topic.

Internationalisation: The EMM Survey Registry collects international surveys on Ethnic and Migrant Minorities and enriches the metadata that is available for every study in the EMM Question Data Bank, they make surveys available in DDI format.

The Dataverse Software is globally used and developed. Concerning international harmonisation: multilingualism is an area that needs further work. The Dataverse community tools would benefit from the integration of remote-controlled vocabularies. The Vocabulary Commons is very relevant for internationalisation and standardisation ie. it delivers multilingual terminology and builds on standards.

For the Secure Data Facility Professions Network: Standardisation is difficult with national laws in addition to GDPR as there are legal obstacles: sharing data across different legal spaces. Legal advice is needed for safe facilities. Another standardisation needed: Professionalise roles: create guidance and standard ideas of skills for secure data professionals, in recruiting and later in the job. Data disclosure in secure data facilities lies in not so many hands, there is a need for a community of shared norms and practices, and data sharing would benefit from common norms. This community will increase data sharing.

Blue-Cloud

Piloting innovative services for Marine Research & the Blue Economy – Blue-Cloud

Grant agreement ID: 862409

DOI: 10.3030/862409

Funded under: SOCIETAL CHALLENGES - Food security, sustainable agriculture and forestry, marine, maritime and inland water research, and the bioeconomy.

Start date: 1 October 2019

End date: 31 March 2023

Total cost: € 6.783.841,25

EU contribution: € 5.999.520,50

Coordinated by: Trust- IT SRL.

Brief description of the project: Blue-Cloud is the thematic marine EOSC, a collaborative open science platform in support of the EU Mission Ocean. Blue-Cloud innovative core services are deployed through a smart federation of leading European marine data and infrastructures, bringing an unprecedented amount of multidisciplinary data repositories, analytical tools, and computing facilities to the EOSC.

Fields of science: Marine and Ocean Research.

Programme(s):
H2020-EU.3.2. - SOCIETAL CHALLENGES - Food security, sustainable agriculture and forestry, marine, maritime and inland water research, and the bioeconomy.
H2020-EU.3.2.5.1. - Climate change impact on marine ecosystems and maritime economy.

Topic(s): BG-07-2019-2020 - The Future of Seas and Oceans Flagship Initiative.

Sub call: H2020-BG-2019-1

Funding Scheme: IA - Innovation action.

Website: blue-cloud.org

Cordis: cordis.europa.eu/project/id/862409

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓	✓				
	1.2 Researcher Engagement and Adoption	✓	✓				✓
	1.3 Rules of Participation Compliance Monitoring	✓					
AG 2	2.1 FAIR Metrics and Data Quality	✓	✓	✓	✓	✓	✓
	2.2 Semantic Interoperability		✓	✓	✓	✓	
AG 3	3.1 Data Stewardship Curricula and Career Paths						
	3.2 Research Careers, Recognition, and Credit	✓	✓				✓
	3.3 Upskilling Countries to Engage in EOSC	✓	✓	✓			
AG 4	4.1 AAI Architecture	✓		✓			
	4.2 Infrastructure for Quality Research Software	✓				✓	✓
	4.3 Technical Interoperability of Data and Services	✓		✓	✓	✓	
AG 5	5.1 Financial Sustainability	✓					
	5.2 Long-term Data Preservation						

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 Blue-Cloud Virtual Research Environment (VRE)

Category: Virtual Reserch Environment (VRE).

Description: The Blue-Cloud Virtual Research Environment is a cloud-based analytical and publishing framework working as a federation and orchestration of computing platforms and analytical services for constructing, hosting and operating Virtual Labs for specific applications in the marine and ocean domain.

Link: blue-cloud.d4science.org

Maturity: Blue-Cloud VRE: TRL7- The VRE is fully developed and exploited by thousands of users.

Exploitability: Operational service.

Sustainability: The Blue-Cloud VRE realises an operational environment operated by the D4Science infrastructure that CNR is committed to maintain as an operational service for two additional years after the end of the Blue-Cloud funding. Initially, this meant till end 2025; however, considering the recent successful Blue-Cloud 2026 project application, it now concerns a guaranteed operation till the middle of 2028. CNR expects to arrange specific agreements for the operation and maintenance of selected VLabs. For the GRSF, Fisheries Atlas and Aquaculture Atlas Generation there are already arrangements in place between CNR and FAO as a result of the earlier iMarine project. These should enter in the larger umbrella of the services that Blue-Cloud will sustain to promote and operate.

Internationalisation: The Blue-Cloud VRE exploits the D4Science infrastructure that uses the standard OAuth2 (OIDC token for authentication and UMA token for authorization). It already exploits the federated identity delivered by EOSC and several other services including JupyterHub. For accounting, auditing, and quota management there are large spaces for improvements and additional efforts for standardisation would be beneficial to the providers of digital assets.

KER #2 Blue-Cloud catalogue

Category: Virtual Reserch Environment (VRE).

Description: The Blue-Cloud Catalogue features datasets and products resulting from the Blue-Cloud VLabs and provenance metadata on the methods, data sets and workflows used to generate them. Every Catalogue item is accompanied by rich descriptions capturing general attributes to enhance FAIRness: title and creator(s), accessibility properties, technical properties, e.g. size and format, legal and ethical attributes, e.g. whether containing personal data intellectual properties, e.g. licences.

Link: blue-cloud.d4science.org/catalogue-bluecloud

Maturity: Research Object Publishing Service (Blue Cloud catalogue): TRL7.

Exploitability: Operational service.

Sustainability: The Blue-Cloud Catalogue is based on an operational environment operated by the D4Science infrastructure that committed to maintain it operational for two additional years after the end of the project (currently, this implicates till middle of 2028).

Internationalisation: Standardisation for the federation of service catalogues would avoid the duplication of unconnected services description in different catalogues.

KER #3 Blue-Cloud Data Discovery & Access Service

Category: Discovery/access platform.

Description: The Blue-Cloud Data Discovery & Access Service facilitates federated discovery and retrieval of data sets and data products from multiple Blue Data Infrastructures in a common discovery and access interface, both for external users in stand-alone mode, and for users of the Blue-Cloud VRE.

Link: data.blue-cloud.org

Maturity: Blue-Cloud Data Discovery & Access service: TRL7.

Exploitability: Operational service.

Sustainability: The service federates several leading marine and ocean data repositories and builds further on the experiences gained with the SeaDataCloud and ENVRI-FAIR projects. As part of the new EU FAIR-EASE project (start Sept 2022) and Blue-Cloud 2026 (start Jan 2023) the DD&AS will be expanded with additional repositories and its functionality for searching and delivery will be expanded with data subsetting services. This way, its operation is guaranteed already till the end of 2026, while increasing its position in the marine domain.

Internationalisation: The service facilitates the discovery and retrieval of data sets by users. The data sets concern measurement data and derived data products that are managed in Blue Data Infrastructures (BDIs) which are interacting machine-to-machine with the DD&AS to serve federated discovery and access. A common DD&AS interface is provided for the discovery and retrieval of data sets from each of the federated BDIs. The query mechanism has a two-step approach. At the collection level, a common metadata profile following ISO19115 - 19139 metadata standard is generated for each of the federated BDIs by using the DAB brokerage service. This allows the identification of interesting data collections, with free search, spatial and temporal criteria on a common catalogue for all federated BDIs. Users can then drill down per interesting BDI to get more specific data sets at the detail level, adding search criteria, specific to a selected BDI. Finally, users can compose and submit shopping requests for associated data sets, which then can be downloaded from their MyBlueCloud dashboard. This approach allows to add more BDIs and is also fit for adding semantic brokering.

KER #4 Blue-Cloud Virtual Lab for Fisheries data

Category: Virtual Reserch Environment (VRE).

Description: The Virtual Lab on Fisheries data allows users to explore all oceans and regions of the world with the Fisheries Atlas with features ranging from global fisheries maps, statistics and overviews, aggregate records about major world fisheries, and the Global Record on Stocks and Fisheries. This VRE expands on the Virtual Lab for the FAO Tuna Atlas (tuna and billfish catch data): a global vertically integrated toolset that will manage public fisheries statistical data from ingestion, through harmonisation, to publication.

Link: blue-cloud.org/vlabs/global-record-stocks-and-fisheries

Maturity: The lab includes a Fisheries Atlas service with TRL8 and the Global Record of Stocks and Fisheries with TRL 9.

Exploitability: Operational service.

Sustainability: The lab groups together the Fisheries Atlas VLab and the Global Record for Stocks and Fisheries V Lab. Both of these are deployed in the Blue-Cloud VRE on the D4Science infrastructure and accessible through FAO (fao.org). These Blue-Cloud results will remain operational at least for two years after the end of the project (currently, implicating till middle of 2028). Moreover, their maintenance and further development is foreseen in a bilateral agreement between CNR and FAO. Substantial output is already published in a variety of catalogues of fisheries related information and online viewers such as the FAO/IRD Global Tuna Atlas.

Internationalisation: The core facilities of this virtual lab rely on a knowledge base of metadata that is collected and semantically integrated. For this reason, the conceptual backbone of this knowledge base (at least for the Global Record for Stocks and Fisheries virtual Lab) is the ISO 21127:2014 standard CIDOC-CRM ontology as well as its family of extensions (e.g. MarineTLO). Although this is already a major step towards standardisation, there is still much room for improvement, especially as regards to the "linkage" with other metadata standards.

KER #5 Blue-Cloud Virtual Lab for Aquaculture Monitor

Category: Virtual Reserch Environment (VRE).

Description: A tool to produce national aquaculture sector overviews via OGC compliant data services to monitor country aquaculture sector, built on interoperable services where teams can compute and publish reproducible experiments.

Link: blue-cloud.org/vlabs/aquaculture-monitor

Maturity: Aquaculture Monitor - TRL7.

Exploitability: Operational service.

Sustainability: Built on the same Open-Source infrastructure as the Fisheries Lab for the management of geospatial data, the service interacts through ISO/OGC compliant services for the ingestion and publication of two types of Copernicus derived maps enabled through Blue Cloud effort; a service to detect floating mariculture cages using Copernicus S1 imagery, and another to use AI to classify coastal areas using S2 imagery. The geospatial data-flows are covered by Open-Source projects, and can be re-used in any context. The image analytics are based on proprietary software, and require support from a community. The demonstrator was successful in showing how a metadata-driven geospatial data-flow can be enabled in an EU provided e-Infrastructure, and similar data-flows can be replicated in similar contexts.

KER #6 Blue-Cloud Virtual Lab for Zoo and Phytoplankton EOV products

Category: Virtual Reserch Environment (VRE).

Description: The Zoo and Phytoplankton EOV demonstrator provides a description of the current state of the plankton communities and forecasts their evolution, representing valuable information for the modelling, assessment and management of the marine ecosystem.

Link: blue-cloud.org/vlabs/zoo-and-phytoplankton-eov-products

Maturity: Virtual lab on Zoo and Phytoplankton EOV products -TRL 7 Products are finalised and available for users in the VLab. Two of the data products in this Vlab were used during the Blue Cloud Hackathon. Users replicated a jupyter notebook easily with different data sources using the Blue-Cloud Data Discovery & Access service.

Exploitability: Operational service.

Sustainability: The Vlab is hosted in the Blue-Cloud VRE, which will be operational for two additional years after the end of the project (currently, implicating till middle of 2028). During this time the Vlab managers are responsible for their operation and maintenance.

Internationalisation: Virtual lab on Zoo and Phytoplankton EOV products. Scientific products are created using reusable notebooks/scripts in R, Python and Julia. However, for complete reproducibility, the scripts should be stored together with their computational environment (e.g. containerised). This should be stored for archival and be re-launched upon request. As far as we know there are no repositories to store these environments, guidelines on best practices for reproducible research etc.

EOSC-Nordic

EOSC-Nordic

Grant agreement ID: 857652

DOI: 10.3030/857652

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 5.933.475

EU contribution: € 5.933.475

Start date: 1 September 2019

End date: 30 November 2022

Coordinated by: Nordforsk.

Brief description of the project: The EOSC-Nordic project organised initiatives to support and develop open science and open innovation in Denmark, Estonia, Finland, Germany, Iceland, Latvia, Lithuania, Norway, Netherlands, and Sweden and exploit synergies to achieve greater harmonisation in policy and service provision across these countries.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures.

Topic(s): INFRAEOSC-05-2018-2019 - Support to the EOSC Governance.

Sub call: H2020-INFRAEOSC-2018-3

Funding Scheme: RIA - Research and Innovation action.

Website: eosc-nordic.eu

Cordis: cordis.europa.eu/project/id/857652

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation					✓	
	1.2 Researcher Engagement and Adoption					✓	
	1.3 Rules of Participation Compliance Monitoring	✓	✓	✓		✓	
AG 2	2.1 FAIR Metrics and Data Quality					✓	✓
	2.2 Semantic Interoperability				✓	✓	✓
AG 3	3.1 Data Stewardship Curricula and Career Paths					✓	
	3.2 Research Careers, Recognition, and Credit					✓	
	3.3 Upskilling Countries to Engage in EOSC			✓		✓	
AG 4	4.1 AAI Architecture	✓	✓	✓	✓		✓
	4.2 Infrastructure for Quality Research Software	✓	✓	✓			✓
	4.3 Technical Interoperability of Data and Services	✓	✓	✓	✓	✓	✓
AG 5	5.1 Financial Sustainability						
	5.2 Long-term Data Preservation						

AG1: Implementation of EOSC | AG2: Metadata and data quality | AG3: Research careers and curricula
AG4: Technical challenges on EOSC | AG5: Sustaining EOSC

KER #1 Nordic Service Interoperability Framework

Category: Policy Harmonisation.

Description: Nordic Service Interoperability Framework: Analysis and development of interoperability guidelines for service providers based on specific requirements coming from service providers based in the Nordic and Baltic countries.

Links:

- eosc-nordic.eu/eosc-nordic-service-interoperability-framework
- eosc-nordic.eu/kh-material/d3-3-service-interoperability-framework

Maturity: Following EOSC-Nordic Interoperability guidelines is crucial for reducing the complexity of EOSC from the point of view of a researcher.

The work of WP3 has focused on highlighting service interoperability aspects relevant to all services geared towards open science. We are closer to identifying which types of services are expected to comply with which type of interoperability principles. Comparing different types of services using a homogenous set of questions is difficult because of the unique characteristics of the services. In the future, this may be solved by conducting analyses in the context of each service type and/or user base. Such comprehensive evaluations for further development would require high degrees of coordination.

(ref: eosc-nordic.eu/kh-material/d3-3-service-interoperability-framework).

Exploitability: Prototype.

Sustainability: Efforts are being made to bridge the EOSC-Nordic Service Interoperability Framework into the EOSC Future project and the EOSC-A TF on Interoperability (as well as the FAIR-IMPACT project/WP6 on Interoperability).

Internationalisation: The EOSC-Nordic Service Interoperability Framework is ready for European scalability.

KER #2 EOSC-Service-compliance checklist & maturity model

Category: Validation Tool or Other.

Description: Service compliance checklist & maturity model to quickly validate if a service is fit for EOSC.

Links:

- eosc-nordic.eu/kh-material/deliverable-3-1-eosc-service-compliance-checklist-and-maturity-model
- eosc-nordic.eu/eosc-pillar-has-adopted-a-service-maturity-model-developed-by-eosc-nordic-wp3

Maturity: The EOSC-Nordic Service compliance checklist and maturity model describes the compliance checklist devised for assessing services in the Nordic and Baltic region for their fit to the EOSC Rules of Participation and EOSC Future Service model (ref: op.europa.eu/s/w9Sw, eosc-portal.eu/providers-documentation/eosc-provider-portal-inclusion-criteria). It also defines a maturity model that is used for progressing services towards becoming a service part of the EOSC Future Marketplace as well as improving service quality for the services already onboarded in the Marketplace. (ref: eosc-nordic.eu/kh-material/deliverable-3-1-eosc-service-compliance-checklist-and-maturity-model) . The EOSC-Nordic maturity model has also been adopted by the EOSC Pillar project (eosc-nordic.eu/eosc-pillar-has-adopted-a-service-maturity-model-developed-by-eosc-nordic-wp3).

Exploitability: Operational service.

Sustainability: Efforts were made to bridge the EOSC-Nordic Service maturity model into the EOSC Future project as well as the EOSC-A TF on Interoperability.

Internationalisation: The EOSC-Nordic Service maturity model is ready for European scalability and has already been adopted by EOSC-Pillar.

The EOSC-Nordic partners involved (especially ETAIS) would be interested in participating in such actions, potentially facilitated via NeIC in order to catalyse the cross-border and -institutional uptake in the Nordics.

KER #3 Regional EOSC onboarding platform

Category: Knowledge Centre.

Description: The Pre-onboarding platform facilitates the integration and onboarding of services provided by Nordic and Baltic service providers into the EOSC Marketplace. The EOSC-Nordic EOSC onboarding platform has also developed functionalities to onboard HPC services in the EOSC Marketplace and to automatically manage the allocation of the HPC resources requested by a potential user.

Links:

- eosc-nordic.atlassian.net/wiki/spaces/EN/pages/473792558/EOSC-Nordic+Service+Dashboard
- eosc-nordic.eu/knowledge-hub/services

Maturity: The regional service onboarding platform is an already available solution, where all services available for researchers in the Nordics can be accessed and on-boarded to the EOSC-Portal. It is a regional entry point for a Nordic service provider to register or update their service into the list. EOSC-Nordic Services Dashboard offers insights into the situation with EOSC services from the perspective of different stakeholders. These components of EOSC-Nordic are being developed and adjusted according to the evolution of EOSC.

The platform can be accessed via the EOSC-Nordic Knowledge Hub, service section: eosc-nordic.eu/knowledge-hub/services.

Exploitability: Operational service.

Sustainability: Sustainability plans rely on further evolution of EOSC Sustainability model and inclusion of federation aspect into EOSC-A plans for establishing a network of regional and thematic catalogues for services.

Sustainability plans are being made in the Nordics building upon the EOSC-Nordic Coordinator organisation NeIC/ Nordforsk, to run and develop the Nordic Service Dashboard, strengthening the uptake and integration of the Nordic region into a centralised EOSC. ETAIS has committed to maintain the platform for the next 2 years.

Internationalisation: Beyond service onboarding, the EOSC-Nordic regional on-boarding platform interlinks with the EOSC-Nordic Knowledge Hub eosc-nordic.eu/knowledge-hub and local support to provide a window into Nordic services. NeIC would be very interested in future collaborations with EOSC-A in how to set up a collaborative and regional service uptake effort for a truly federated EOSC.

KER #4 Prototype of secure data exchange across organizations

Category: Technical Harmonisation., Policy Harmonisation.

Description: EOSC-Nordic WP3 deployed and evaluated adoption for R&D purposes of secure data exchange platforms deployed in EE and FI for cross organisational services in different countries. X-road based services in FI and EE support federation and inclusion of members from other countries. On the national level, these exchange services serve as a backbone for e-government.

Link: eosc-nordic.eu/feasibility-study-of-implementation-of-x-road-for-research-data-is-now-published

Maturity: A feasibility assessment was conducted in collaboration with a research group at the University of Tartu, that develops an X-Road-based software project GenMed to process genomic data. Software deployment resulted in a situation where an analytical engine in one country was able to request the genomic data from the registry in another country in a safe and efficient way. Thus, adopting X-Road for real-time applications working with sensitive data has good potential in R&D. Service delivery model of X-Road was analysed and compared with that of EOSC.

(ref: eosc-nordic.eu/feasibility-study-of-implementation-of-x-road-for-research-data-is-now-published).

Exploitability: Operational service.

Sustainability: Sustainability according to demand (X-road is an open-source solution used by the public sector and deployed in a number of countries, x-road.global).

Internationalisation: Adopting the X-road-based solution across borders would be of interest to the Nordic infrastructure service providers (especially in Estonia and Finland) as they allow to reuse of existing legal and organizational validations for enabling cross-border sensitive services.

KER #5 FAIR assessment model

Category: Validation Tool or Other.

Description: Semi-automated assessment of FAIR uptake for repositories and datasets.

Maturity: Category B above. The developed FAIR assessment model is still under development and not yet operable as a service but the project is exploring possibilities to develop it into a service.

Exploitability: Operational service.

Sustainability: The automated assessment is not yet operable as a service but the project is exploring possibilities to develop it into service after the project lifetime.

Internationalisation: The automated FAIR assessment model has received a lot of interest and there is potential to collaborate with e.g. FAIR Impact project and EOSC TF FAIR metrics and data quality, and other initiatives that are developing FAIR assessment tools.

Support for FAIR practices adoption: TDRs are a vital component of EOSC. They enable FAIR data and services now and in the long term. FAIRification and certification support for repositories willing to improve their practices and/or become a TDR has both universal aspect and infrastructure-specific aspects. Additional work is needed to create certification or assessment frameworks for repositories that are not TDRs but e.g. technical service providers for TDRs.

KER #6 Proof of Concepts of a Nordic eHealth infrastructure

Category: Technical Harmonisation, Policy Harmonisation.

Description: Proof of Concepts of a Nordic eHealth infrastructure, managing cross-border sensitive data analysis (without actually moving the data out of the countries).

Link: eosc-nordic.eu/eosc-nordic-as-proof-of-concept

Maturity: A Nordic cross-border infrastructure data access model, for Nordic sensitive data has been established. (ref: eosc-nordic.eu/eosc-nordic-as-proof-of-concept)

Exploitability: Prototype.

Sustainability: The results and experience drawn will feed

into the continuous development of a Nordic eHealth Infrastructure, holding potential for scalability at the European level. NeIC is launching the Nordic Forum for sensitive data and infrastructure, where these solutions will be developed further.

Internationalisation: The work around a Nordic eHealth Infrastructure bridges many experts and stakeholders in the Nordics. NeIC has driven many years of development projects (i.e. NeIC Tryggve, NeIC PaRI, NeIC Heilsa, Nordic ELIXIR nodes etc) and has come very far in the area of cross-border sensitive data collaborations. This work is turning the Nordic Commons' vision i.e. a set of recommendations on how to build a cloud infrastructure that allows sharing of medical data across borders in the Nordics.

Building up a Nordic health Infrastructure is something that requires the movement of political forces and economic forces, so it is not something that will ever happen in one single step. EOSC-Nordic, NeIC and Nordforsk and the Nordic sensitive data stakeholders are very interested in collaborating on this work in both European and International partnerships.

EOSC-Pillar

Eosc-Pillar – Coordination and Harmonisation of National Initiatives, Infrastructures and Data services in Central and Western Europe

Grant agreement ID: 857650

DOI: 10.3030/857650

Start date: 1 July 2019

End date: 31 December 2022

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 6.908.465,01

EU contribution: € 6.880.965

Coordinated by: Consortium Garr.

Brief description of the project: The EOSC-Pillar project coordinated and harmonised national open science efforts across Austria, Belgium, France, Germany and Italy, ensuring their contribution and readiness for the implementation of the European Open Science Cloud (EOSC) and investigating the option for them to interfederate at a later stage.

Fields of science:
Natural Sciences > Biological Sciences > Ecology > Ecosystems.
Natural Sciences > Chemical Sciences > Catalysis.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures MAIN PROGRAMME.
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures.

Topic(s): INFRAEOSC-05-2018-2019 - Support to the EOSC Governance.

Sub call: H2020-INFRAEOSC-2018-3

Funding Scheme: RIA - Research and Innovation action.

Website: eosc-pillar.eu

Cordis: cordis.europa.eu/project/id/857650

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation						
	1.2 Researcher Engagement and Adoption	✓		✓	✓	✓	
	1.3 Rules of Participation Compliance Monitoring		✓		✓		
AG 2	2.1 FAIR Metrics and Data Quality	✓					✓
	2.2 Semantic Interoperability						✓
AG 3	3.1 Data Stewardship Curricula and Career Paths			✓			
	3.2 Research Careers, Recognition, and Credit			✓			
	3.3 Upskilling Countries to Engage in EOSC	✓	✓	✓			
AG 4	4.1 AAI Architecture						
	4.2 Infrastructure for Quality Research Software						
	4.3 Technical Interoperability of Data and Services			✓	✓		✓
AG 5	5.1 Financial Sustainability		✓				
	5.2 Long-term Data Preservation						

AG1: Implementation of EOSC | AG2: Metadata and data quality | AG3: Research careers and curricula
AG4: Technical challenges on EOSC | AG5: Sustaining EOSC

KER #1 Eosc-Pillar Legal and Policy Recommendations and Guidelines

Category: Policy Harmonisation.

Description: EOSC-Pillar Recommendations for Legal and Policy Harmonisation of Open and FAIR Science in the EU (doi.org/10.5281/zenodo.6451312), embraces a holistic perspective on both copyright and data protection laws. Thus, encompassing a multi-faceted account of the legislative and non-legislative reforms needed to pave the way toward effective, open, and inclusive research environments in Europe.

EOSC-Pillar Guidelines for Legal Compliance for Researchers (eosc-pillar.eu/legal-compliance-guidelines-researchers-checklist): checklists to help researchers comply with the legal requirements of publishing, sharing and integrating research data. In particular, the challenges raised by IPR, data protection laws, and regulations on non-personal data are addressed. The purpose of the guideline is to promote the implementation of FAIR principles beyond their original scope and to lay down the conditions for the effective realisation of open data and open science policies. The guidelines are valid for all EU member states.

Links: There are two versions of the checklist available for researchers:

- A digital version (doi.org/10.5281/zenodo.6327668) with interactive check boxes that can be ticked off as you progress through the phases.
- A printable version (doi.org/10.5281/zenodo.6327691).
- doi.org/10.5281/zenodo.6451312
- eosc-pillar.eu/news/eosc-pillar-legal-compliance-guidelines-researchers-checklist
- For a more in-depth explanation and background material please refer to the latest version of the Legal and Policy Framework and Federation Blueprint report (DOI: 10.5281/zenodo.5647948).

Maturity: The Guidelines for researchers and stakeholders and Policy recommendations for policymakers are based on a comparative study of a broad range of legislative and non-legislative aspects relating to both the EU and the national regulatory landscapes of the five EOSC-Pillar Countries (Austria, Belgium, France, Germany, Italy). They have been designed following a threefold focus on copyright, personal data protection, and non-personal data protection. The assumption that these three legal sectors and to a certain extent licensing, represent the regulatory pillars of OS and OA infrastructures, practices and envisioned future has, indeed, proved true by the significance of the data collected across the in-depth study. Both the Guidelines and the Recommendations are final outcomes of the EOSC-Pillar project and they are ready-to-use by European researchers and policymakers. Nevertheless, they could be a starting point for developing discipline-specific guidelines. The study of legal mapping can also be extended to other European countries to try to solve the gaps that prevent the circulation of data and research products between the different member states. The Guidelines and the Recommendations could be adopted at the National level, and the Italian version (doi.org/10.5281/zenodo.7152093)was developed and is promoted by ICDI, the Italian Mandated organisation. This is why we hope that the EOSC A Steering Board can disseminate the work among the Member States. TRL is not applicable.

Exploitability: Operational service.

Sustainability: The Legal and Policy Recommendations Guidelines will be maintained as well as the project's website, after the end of the project.

Internationalisation: Research Infrastructures, universities and researchers would benefit by using them since they find concrete recommendations in the management of research data and, more generally, research outputs. By leveraging regulatory flexibilities and taking into account legitimate restrictions to access, the recommendation/guidelines aim at guiding researchers in the management of research data and, more generally, research outputs, and promoting best practices to achieve accessibility, findability and interoperability of research data in view of reuse, open access of published products, and the removal of unnecessary restrictions, facilitating the convergences of national solutions. Further work could be developed in collaboration with the research disciplines to reflect the specific needs and workflows of the researchers in each sector.

KER #2 PoC for the Dashboard to measure EOSC readiness

Category: Policy Harmonisation.

Description: Identification of a set of indicators to measure EOSC readiness for MS and development of a dashboard solution, that would integrate data harvested from trusted open data sources automatically with the information provided manually by delegates from the MS, and facilitate the semi-automated evaluation of EOSC readiness against indicators.

Link: eoscsecretariat.eu/cocreating-eosc/consultancy-design-and-poc-platform-monitoring

Maturity: PoC for the Dashboard to measure EOSC readiness is a prototype service. It has been realised thanks to the collaboration between the EOSC Landscape WG and the INFRAEOSC-05 project's landscaping task force coordinated by the EOSC-Pillar coordinator, GARR. The project was funded by the EOSC Secretariat co-creation campaign and ran from February to September 2021. Alongside the first 18 indicators and the dashboard, the project provided recommendations on how to progress in the short, medium and long term. The PoC has been presented to EOSC Future to develop the EOSC Observatory. Possible re-use is undergoing by National

Mandated organisations.

Exploitability: Prototype.

Sustainability: PoC for the Dashboard to measure EOSC readiness was maintained by EOSC Secretariat.

Internationalisation: The discussion around the first group of the first 18 indicators, the platform and the workflows to gather information was well communicated and shared within the EOSC Community and EOSC Future for the development of the Observatory. Future actions need to be addressed to test to ensure flexible solutions to update and develop new indicators and to involve testers among the NOSCIs/ Mandated Organisations to test and tune the semi-automatic solutions to gather and visualise data.

KER #3 The EOSC-Pillar RDM Training and support catalogue

Category: Training Resource.

Description: The EOSC-Pillar RDM Training and support catalogue is a collection of online searchable resources for Data Stewardship and Research Data Management support. It includes training materials, but it also includes day-to-day, operational and readily available resources that can be used by data stewards to support researchers.

Link: eosc-pillar.d4science.org/web/eoscpillartrainingandsupport

Maturity: The catalogue is an operational service. From the service functionality and operation point of view: (a) it is fully functional and the functionalities have proven to be effective in several scenarios, and (b) it is operated by relying on the support of the D4Science service provider. From the content perspective, it is under continuous development, i.e., new material can be added at any time and the metadata characterising the published material can be revised to improve the interoperability with homologous catalogues.

Exploitability: Operational service.

Sustainability: The catalogue will be maintained in operational status for at least two years after the end of the project thanks to an agreement with the D4Science service provider. This period will be used to decide on a long-term exploitation and sustainability plan and strategy.

Moreover, the training catalogue will be maintained in operation by ICDI, and used within the context of the Skills4EOSC project (101058527).

Internationalisation: The catalogue has been designed to be interoperable with other homologous catalogues and to facilitate the discoverability of its contents from third-party data discovery services. Having standard / shared approaches for describing, characterising and making available training material (by tracking provenance and preserving attribution) facilitates their dissemination and diffusion.

KER #4 The Italian National Service Catalogue

Category: Knowledge Centre.

Description: The Italian National Service Catalogue is a collection of Service Providers and Services representing the service offering aggregated by the Italian Computing and Data Infrastructure (ICDI) initiative. It is designed to be interoperable with the overall EOSC Service Catalogue.

Link: eosc-pillar.d4science.org/web/eoscpillaritserviceregistry

Maturity: The Catalogue is an operational service. From the service functionality and operation point of view: (a) it is fully functional and the functionalities have proven to be effective in several scenarios, and (b) it is operated by relying on the support of the D4Science service provider. From the content perspective, it is under continuous development, i.e., new providers and services can be added at any time (according to the policies governing it) and the metadata characterising the published material can be revised to improve the interoperability with homologous catalogues (namely, the EOSC Service Catalogue).

Exploitability: Operational service.

Sustainability: The Catalogue will be maintained in operational status for at least two years after the end of the project thanks to an agreement with the D4Science service provider. The exploitation and sustainability plan and strategy will be discussed in the context of the Italian Computing and Data Infrastructure (ICDI) initiative.

Internationalisation: The Catalogue was designed to be interoperable with other homologous catalogues, in particular the EOSC Service Catalogue. Having standard / shared approaches for describing, characterising and making available service descriptions facilitates their dissemination and reuse.

KER #5 Ambassadors Programme

Category: Knowledge Centre.

Description: Communication materials (poster, flyers, videos and podcast) to raise awareness of EOSC addressed to organisations and researchers.

Link: eosc-pillar.eu/ambassadors-programme

Maturity: All the materials, translated into different national languages, are available on the EOSC-Pillar website for re-use. Further products will be elaborated on until the end of the project. Collaborations are ongoing with other European projects of the EOSC family - such as EOSC Future - and

organisations and universities in several member countries, to communicate and involve research centres and researchers in the development of EOSC. TRL is not applicable.

Exploitability: Operational service.

Sustainability: The Programme will be maintained as well as the project's website, after the end of the project.

Internationalisation: The material is easily adaptable for the purposes of EOSC communication to different research communities, both nationally and in Europe. It can be collected and made available to all EOSC-A participants to present in their communities the vision of EOSC, the benefits it offers and how people and institutions can participate.

KER #6 The Federated FAIR Data Space

Category: Discovery/Access Platform.

Description: The Federated FAIR Data Space (F2DS) is a family of services supporting the development of a unified data space out of datasets stored in existing and heterogeneous repositories and data sources. It comprises: (i) a Metadata Repository (built by the FAIR Data Point technology) equipped with a dataset onboarding mechanism enacted to collect, transform and enrich datasets metadata from an existing data source into FAIR compliant datasets descriptions; (ii) a Data Catalogue enacting to seamlessly discover and access the dataset's metadata collected into the Metadata repository; (iii) a semantic enrichment helper enacting to develop a knowledge base of ontologies and semantic concepts and offering facilities for selecting semantic concepts from the knowledge base. A Virtual Research Environment (eosc-pillar.d4science.org/web/eoscpillarresdatactlg) has been deployed to showcase the set of tools.

Link: eosc-pillar.d4science.org/web/eoscpillarresdatactlg

Exploitability: Prototype.

Maturity: The F2DS as a whole is a prototype service with some components being under development while others being based on consolidated technology and operational services (e.g., the data catalogue is based on the same technology, service and service provider underlying the catalogues described above). From the content perspective datasets collected and metadata characterising them are evolving.

Sustainability: The F2DS consists of both (i) open-source software that can be deployed thus to create new instances, and (ii) services in operation. Regarding the services offered by D4Science (namely, the data catalogue and the accompanying Virtual Research Environment) there is an agreement for maintaining them up and running for at least two years after the end of the project. However, these services have content-related dependencies on the Metadata Repository component instance, i.e., some catalogue items are collected from this service instance.

Internationalisation: The F2DS relies on DCAT W3C standard for exposing the metadata of the integrated datasets both in the Metadata Repository and in the Data Catalogue. Regarding the feeding of the data space: (i) the Metadata Repository counts on per data source mappings for both the harvesting protocol and the metadata transformation, (ii) the Data Catalogue counts on an open array of harvesters including DCAT, OAI-PMH, and CSW.

EOSC-Synergy

European Open Science Cloud – Expanding Capacities by building Capabilities – EOSC-synergy

Grant agreement ID: 857647

DOI: 10.3030/857647

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 5.584.006,25

EU contribution: € 5.584.006,25

Start date: 1 September 2019

End date: 31 October 2022

Coordinated by: Agencia Estatal Consejo Superior De Investigaciones Cientificas.

Brief description of the project: The EU funded the project EOSC-synergy contributed to the EOSC implementation by harmonising policies and federating relevant national research e-Infrastructures, scientific data and thematic services, bridging the gap between national initiatives and EOSC, making more computing, storage, datasets and tools available.

Fields of science:
Natural Sciences > Computer And Information Sciences > Software.
Social Sciences > Sociology > Governance.
Natural Sciences > Earth And Related Environmental Sciences > Atmospheric Sciences > Climatology > Climatic Changes.
Social Sciences > Political Sciences > Government Systems.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures.

Topic(s): INFRAEOSC-05-2018-2019 - Support to the EOSC Governance.

Sub call: H2020-INFRAEOSC-2018-3

Funding Scheme: RIA - Research and Innovation action.

Website: eosc-synergy.eu

Cordis: cordis.europa.eu/project/id/857647

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓					
	1.2 Researcher Engagement and Adoption	✓	✓	✓	✓	✓	✓
	1.3 Rules of Participation Compliance Monitoring		✓		✓		✓
AG 2	2.1 FAIR Metrics and Data Quality	✓		✓	✓		✓
	2.2 Semantic Interoperability	✓					
AG 3	3.1 Data Stewardship Curricula and Career Paths					✓	
	3.2 Research Careers, Recognition, and Credit		✓	✓	✓	✓	
	3.3 Upskilling Countries to Engage in EOSC		✓			✓	
AG 4	4.1 AAI Architecture						✓
	4.2 Infrastructure for Quality Research Software	✓	✓	✓	✓		✓
	4.3 Technical Interoperability of Data and Services		✓	✓	✓		✓
AG 5	5.1 Financial Sustainability						
	5.2 Long-term Data Preservation						

AG1: Implementation of EOSC | AG2: Metadata and data quality | AG3: Research careers and curricula
AG4: Technical challenges on EOSC | AG5: Sustaining EOSC

KER #1 EOSC Synergy FAIR Framework

Category: Policy Harmonisation, Technical Harmonisation, Validation Tool or Other.

Description: FAIR Framework for validating EOSC FAIR data requirements. It provides Automated deployment of data repositories and fairness verification. One of the key components is the FAIR evaluator "FAIR EVA". FAIR EVA (Evaluator, Validator and Advisor) has been developed to check the FAIRness level of digital objects from different repositories or data portals. It requires the object identifier and the repository to check and it can be adapted to different contexts and environments.

The key benefit for the audiences: Facilitate data integration in repositories according to FAIR principles. It aims at helping data producers and data managers to evaluate the adoption of the FAIR principles based on the RDA indicators.

Link: github.com/EOSC-synergy/FAIR_eva

Maturity: The FAIR EVA is a production-level service. It will certainly benefit from enhancements as the product is used and feedback is received from end users.

Exploitability: Operational service.

Sustainability: Key exploitation paths: Can be used by research communities and infrastructure managers as a requirement for EOSC FAIR data validation. CSIC has put the service in production available for all the researchers of the institution at fair.csic.es

Internationalisation: The FAIR maturity model will benefit from interactions with RDA. Currently, the FAIR_eva product is programmed according to the FAIR definitions of RDA, therefore follow-up is required.

KER #2 Services Quality Baseline

Category: Technical Harmonisation, Policy Harmonisation.

Description: A set of quality baseline criteria for services based on best practices aiming at improving the service quality.

The key benefits are: i) Assess and assure the quality and maturity of services within the EOSC through a DevOps-based approach: ii) Build trust in EOSC by strengthening the reliability and stability of the provided services, thus ensuring a proper realisation of the verification and validation processes: iii) Ensure the functional suitability of the service by promoting testing techniques that check the compliance with the user requirements: iv) Improve the usability by identifying the set of criteria that fosters the service adoption: v) Promote the automated validation of the service quality criteria. The service quality baseline is an EOSC-synergy development.

Licensed under a CC-BY SA<< 4.0.

Link: dx.doi.org/10.20350/digitalCSIC/12533

Maturity: The Baseline is a living document aiming at standardising the quality of the EOSC-delivered services and defining a minimum quality baseline. Its present status is already comprehensive. More input is welcome, and handled via the GitHub page of the project, as this is an open collaborative effort.

Exploitability: Operational service.

Sustainability: The Baseline is a living document that will be in continuous evolution supported by future projects.

Internationalisation: The Baseline is an open collaboration that will benefit from the input of software developers and service integrators. As such is an EOSC-wide endeavour.

KER #3 Quality Badge Scheme for software, services and FAIR data

Category: Policy Harmonisation, Validation Tool or Other.

Description: The Quality Badge Scheme for software, services and FAIR data is a method to reward adherence to quality best practices for software and services. The badges are defined to motivate researchers, developers and service providers to produce high-quality software, services and FAIR data. Provide feedback to end-users on the level of quality expected from EOSC products. Reward quality achievements and improve the visibility of the software, services and data quality attributes. It is used by the SQAaaS platform to highlight the quality achievements of assessed software, services and FAIR data. Foundation for the establishment of an EOSC-ready stamp.

Link: digital.csic.es/handle/10261/206348

Maturity: The Badge Scheme is operationally viable, and production level. It will certainly benefit from enhancements as the product is used and feedback is received from end users.

Exploitability: Operational service.

Sustainability: The Badge scheme is used by the SQAaaS platform to highlight the quality achievements of assessed software, services and FAIR data. Foundation for the establishment of an EOSC-ready stamp. We expect to promote this technology in future endeavours.

Internationalisation: The badge scheme is based on the international standard defined by Open Badges, of which we use the Badgr implementation. Future collaboration with Open Badges is required in order to evolve the implementation.

KER #4 SQAaaS –Software and Services Quality Assessment (SQA) for on-demand automated software validation

Category: Validation Tool or Other.

Description: SQAaaS Platform. A Software and Services Quality Assessment (SQA) for on-demand automated software validation, is offered through the EOSC portal. The SQAaaS aims at contributing to the realisation of the open science principles by putting the focus on improving the software development life cycle through the fulfilment of a specific set of good practices. The adoption of these quality practices is incentivised through an awarding mechanism that assesses the software and provides digital badges according to the achievements obtained.

Key benefits for the audience: Improve the reliability of the services offered by the EOSC Marketplace to promote adoption and quality recognition

Key exploitation paths: The SQAaaS provides two main modules that serve two different needs. On the one hand, the Pipeline as a Service is meant to be used by any researcher writing source code, as it helps to streamline the adoption of novel SQA practices. Through the graphical composition of workflows or CI/CD pipelines, the Pipeline as a Service facilitates the task of defining the steps to cover the verification and validation of the software. This task includes both the static analysis of the code as well as the dynamic validation of the software, including its deployment. Thus, a comprehensive analysis of each change in the source code is performed by the CI/CD pipelines created with the Pipeline as a Service module. On the other hand, the Quality Assessment and Awarding certifies the achievements in terms of the quality attributes of software, and services and the FAIRness of the data produced by those services through digital badges. The assessment process encompasses a series of stages where the supported quality criteria are processed by running a selection of open-source tools, which provide evidence about the fulfilment of each quality criterion. With the outputs of the assessment, the certification process issues the appropriate digital badges for each one of the software, service and FAIRness categories. All the relevant pieces of data and metrics generated during the assessment (reports, logs, etc.) are stored in the badges' metadata, which is preserved during the badge's lifetime.

Link: github.com/EOSC-synergy/SQAaaS

Maturity: The SQaaS platform is a prototype service that will be further developed using feedback the reports from end users.

Exploitability: Operational service.

Sustainability: The SQaaS is a prototype that required further evolution and funding for upcoming projects.

Internationalisation: The SQaaS is a complex service in the sense that it integrates several standards and best practices in the area of software development.

KER #5 EOSC Training Platform

Category: Training Resource.

Description: EOSC Training Platform is a set of tools, including procedures and best practices, for the creation and conduct EOSC related training courses. It facilitates cloud-related courses providing tools for interactive computing. The platform is modular and is based on the container's technologies, which allows for combining together in a suitable learning setup for students/training participants. It allows for the dynamic creation of the infrastructure for tutorials for trainers. The platform provides fully-fledged capabilities for training. It can support online training by providing the services that facilitate it (from content creation to delivery), a database with tutorials and access to computing resources to support the practical exercises when needed.

Link: learn.eosc-synergy.eu

Maturity: The training platform is a production-level service. Our training best practices templates are already being exploited in other EOSC-related projects, such as EOSC Future.

Exploitability: Operational service.

Sustainability: The training portal will be used by other projects and institutions in its present form. That will allow a certain level of sustainability.

Internationalisation: The training platform would benefit from interactions with training projects funded in the EOSC ecosystem. At the moment it is being exploited already to develop training material in EOSC Future.

KER #6 Methodology to integrate Thematic Services in the EOSC MVE

Category: Validation Tool or Other.

Description: Methodology to integrate Thematic Services in the EOSC MVE. We have piloted the integration of six thematic services by adapting their architecture to the EOSC Interoperability Framework.

Link: eosc-synergy.eu/for-researchers

Maturity: The thematic services are all production-level quality. They are already onboarded in the EOSC Marketplace.

Exploitability: Operational service.

Sustainability: Service sustainability depends on end-user evolution and adoption. By using an EOSC-integrated platform the exploitation paths may increase:

By using the EOSC infrastructure services, the costs of maintenance and acquisition of computational power are no longer attributed to the research communities.

The products delivered by the service will be widely used by the research communities and private companies in a panoply of distinct applications.

Internationalisation: Thematic services are highly dependent on the user community behind them. In general standards related to AAI, and service interoperability will need to be monitored in order to guarantee the technical sustainability of the solutions implemented.

FAIRsFAIR

Fostering FAIR Data Practices in Europe – FAIRsFAIR

Grant agreement ID: 831558

DOI: 10.3030/831558

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 9.998.848,75

EU contribution: € 9.998.848,75

Start date: 1 March 2019

End date: 28 February 2022

Coordinated by: Koninklijke Nederlandse Akademie Van Wetenschappen – Knaw.

Brief description of the project: The FAIRsFAIR project developed solutions and ensured the uptake and implementation of the FAIR principles in the EOSC by all the data providers throughout the research data life cycle to support research data management and ensure that European scientists reap the full benefits of FAIR data.

Fields of science:

Social Sciences > Sociology > Governance.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures.

Topic(s): INFRAEOSC-05-2018-2019 - Support to the EOSC Governance.

Sub call: H2020-INFRAEOSC-2018-4

Funding Scheme: SA - Coordination and support action.

Website: fairsfair.eu

Cordis: cordis.europa.eu/project/id/831558

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation		✓	✓		✓	✓
	1.2 Researcher Engagement and Adoption	✓			✓		
	1.3 Rules of Participation Compliance Monitoring						
AG 2	2.1 FAIR Metrics and Data Quality	✓		✓	✓	✓	
	2.2 Semantic Interoperability			✓			✓
AG 3	3.1 Data Stewardship Curricula and Career Paths						
	3.2 Research Careers, Recognition, and Credit	✓					
	3.3 Upskilling Countries to Engage in EOSC		✓	✓	✓		
AG 4	4.1 AAI Architecture						
	4.2 Infrastructure for Quality Research Software						
	4.3 Technical Interoperability of Data and Services						✓
AG 5	5.1 Financial Sustainability			✓			
	5.2 Long-term Data Preservation			✓			

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 FAIR Adoption Handbook for Universities

Category: Training Resource.

Description: FAIR Adoption Handbook for Universities: "How to be FAIR with your data". This is a teaching and training handbook for higher education institutions to help universities to apply the competence framework to their specific situation and needs. It does so by providing ready-to-use model lesson plans on a variety of topics, including FAIR data, Data Management Plans (DMPs), repositories, data creation and reuse. The handbook also offers FAIR competence profiles and learning outcomes for the bachelor, master and doctoral levels, as well as information on course design and the implementation of the FAIR principles at the institutional level.

Link: zenodo.org/record/5787046

Maturity: B/C - the handbook is a final version and has excellent uptake, almost 9,000 downloads from Zenodo already.

Exploitability: Concept, plan, or demonstrator.

Sustainability: The open-access handbook has been published on the project website and in Zenodo. The University of Minho has committed to the publication of an Open Access version of the handbook and a print version. A GitBook version of the handbook will also be ready by the end of the project. The Universities of Minho and Göttingen have committed to maintaining the Gitbook for 7 years and monitoring its use/re-use (ie. translations).

Internationalisation: FAIRsFAIR engaged with and participated in many of the relevant RDA WGs and IGs. All of the KERs benefit from international alignment.

KER #2 FAIR Data Policy Checklist

Category: Policy Harmonisation.

Description: A checklist to enable policymakers to self-assess whether their data policies are FAIR-enabling and a template to support them to describe the content of their policies in a structured and comparable way.

Link: zenodo.org/record/6225775

Exploitability: Concept, plan, or demonstrator.

Sustainability: The checklist, template and related guidance are openly available via the FAIRsFAIR Zenodo community under a CC-BY licence.

Internationalisation: FAIRsFAIR engaged with and participated in many of the relevant RDA WGs and IGs. All of the KERs benefit from international alignment.

KER #3 ACME-FAIR: a guide for Research Performing Organisations (RPOs)

Category: Validation Tool or Other.

Description: A capability Model and Guidance for FAIR-enabling Organisations: "ACME-FAIR: a guide for RPOs": The overall purpose of ACME-FAIR is to help those managing and delivering relevant professional services to self-assess how they are enabling researchers and their colleagues to do just that. Each part deals with one of the key issues that Research Performing Organisations (RPOs) face in establishing the capabilities to put the FAIR principles into practice. It is informed by the project's engagement with community initiatives to 'turn FAIR into Reality', and by the report of the same name. It is recommended that universities, institutes and other RPO consider providing these capabilities as vital steps towards "FAIR-enabling practice". Each of the 7 guides has a thematic introduction, an overview of the relevant capabilities, and a rubric for assessing the levels of maturity and community engagement for each capability.

Link: zenodo.org/communities/acme-fair

Explotability: Concept, plan, or demonstrator.

Sustainability: The framework is published. The DCC will be the main partner taking on the sustainability of this output. The FAIRsFAIR Zenodo community is under a CC-BY licence. The discussion has begun regarding the formation of an RDA Community of Practice in the context of the Professionalising Data Stewardship Interest Group (IG).

Internationalisation: FAIRsFAIR engaged with and participated in many of the relevant RDA WGs and IGs. All of the KERs benefit from international alignment.

KER #4 FAIR-Aware

Category: Training Resource.

Description: The FAIR-Aware tool provides practical information and resources to (further) develop skills for FAIR data and is meant to incentivise researchers to make their data FAIR. This tool can be used both as a teaching tool and as a resource for researchers and data stewards.

Link: fairaware.dans.knaw.nl

Maturity: TRL7.

Exploitability: Operational service.

Sustainability: Since the creation of the tool, DANS has been hosting FAIR-Aware and will continue to do so after the completion of the FAIRsFAIR project. DANS continues to play a key role in the maintenance of the tool by conducting regular updates. The tool will be further developed in the context of the FAIR-IMPACT project.

Internationalisation: FAIRsFAIR engaged with and participated in many of the relevant RDA WGs and IGs. All of the KERs benefit from international alignment.

KER #5 F-UJI: Automated FAIR Data Assessment Tool

Category: Validation Tool or Other.

Description: F-UJI is a service based on REST, piloting a programmatic assessment of the FAIRness of research datasets in five trustworthy data repositories. The F-UJI assessment is based on 16 out of 17 core FAIR object assessment metrics developed within FAIRsFAIR and each corresponding to a part or the whole of a FAIR principle. F-UJI adheres to existing web standards and PID resolution services best practices and utilises external registries and resources such as re3data and Datacite APIs, SPDX License List, RDA Metadata Standards Catalog, and Linked Open Vocabularies (LOV).

Link: -www.fairsfair.eu/f-uji-automated-fair-data-assessment-tool

Maturity: TRL7.

Exploitability: Operational service.

Sustainability: F-UJI source code is available within GitHub for co-development and/or forking and re-use. PANGAEA has committed to the long-term hosting and updating of the F-UJI tool. This will include continuing to coordinate the Open-Source development of F-UJI's program code via GitHub and contributing to Open-Source community development efforts. The tool will be further developed in the context of the FAIR-IMPACT project.

Internationalisation: FAIRsFAIR engaged with and participated in many of the relevant RDA WGs and IGs. All of the KERs benefit from international alignment.

KER #6 FAIR-enabling Repository Finder

Category: Discovery/Access platform.

Description: The Repository Finder is a searchable registry of repositories with embedded content and metadata. Through an iterative process, FAIRsFAIR further improved and reshaped the tool based on community consultation and feedback and merged it into DataCite Commons. With repositories being visible in DataCite Commons, the tool allows users to search for repositories based on filters and additionally explore their data objects, contributors, and context. Moreover, repository metadata is embedded in the PID graph to allow for enhanced machine-readable context information on research data.

Link: zenodo.org/record/6090418

Maturity: TRL8.

Exploitability: Operational service.

Sustainability: Re3data and DataCite have been involved in the creation of this service and will continue to sustain and expand it after the end of the project. Planning for long-term sustainability has been assisted by a series of stakeholder engagement workshops. The service has already been deployed as part of DataCite Commons and future development is scheduled in the roadmaps of DataCite and re3data. The community can engage and follow with the DataCite Commons repository search development activities.

Internationalisation: FAIRsFAIR engaged with and participated in many of the relevant RDA WGs and IGs. All of the KERs benefit from international alignment.

NI4OS-Europe

National Initiatives for Open Science in Europe – NI4OS-Europe

Grant agreement ID: 857645

DOI: 10.3030/857645

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 5.599.475

EU contribution: € 5.599.475

Start date: 1 September 2019

End date: 28 February 2023

Coordinated by: National Infrastructures for Research and Technology.

Brief description of the project: The EU-funded NI4OS-Europe project aims to support the development of the National Open Science Cloud initiatives in 15 EU Member States and Associated Countries and contribute strongly to the EOSC service catalogue with services from those countries.

Programme(s)
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.1. - Developing new world-class research infrastructures.

Topic(s): INFRAEOSC-05-2018-2019 - Support to the EOSC Governance.

Sub call: H2020-INFRAEOSC-2018-3

Funding Scheme: RIA - Research and Innovation action.

Website: ni4os.eu

Cordis: cordis.europa.eu/project/id/857645

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation						✓
	1.2 Researcher Engagement and Adoption	✓				✓	
	1.3 Rules of Participation Compliance Monitoring		✓	✓	✓		✓
AG 2	2.1 FAIR Metrics and Data Quality			✓			
	2.2 Semantic Interoperability	✓	✓				
AG 3	3.1 Data Stewardship Curricula and Career Paths						
	3.2 Research Careers, Recognition, and Credit						
	3.3 Upskilling Countries to Engage in EOSC	✓	✓	✓		✓	
AG 4	4.1 AAI Architecture				✓		✓
	4.2 Infrastructure for Quality Research Software	✓		✓			
	4.3 Technical Interoperability of Data and Services		✓		✓		✓
AG 5	5.1 Financial Sustainability					✓	
	5.2 Long-term Data Preservation	✓	✓	✓			

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 Training platform

Category: Training Resource.

Description: The NI4OS-Europe training platform is a Moodle-based e-learning solution that is used to host all relevant training materials that are produced in the project. It also provides links to other existing training materials to enrich the learning experience on open science and EOSC. It has an integrated webinar system used to support online training events organised by the project partners. The platform also provides self-paced courses on relevant topics and offers learning paths that help guide the users to learn more about a specific topic.

Links:

training.ni4os.eu

zenodo.org/record/7127852

Maturity: Training platform – TRL 9

Exploitability: Operational Service.

Sustainability: UKIM will continue to host the NI4OS-Europe Training Platform as an in-kind contribution to the regional collaboration. All project partners will be able to add new content to the platform and support existing and new users and events. However, further developments are required to align the platform with the evolving requirements and interoperability guidelines related to training catalogues, training materials metadata, and publications in cross-referencing catalogues. Also, funds will be needed to set up pan-European-linked training catalogues. UKIM and other partners involved will strive to obtain funding for these efforts from future EC calls aligned within SRIA, where the training should be high on the agenda.

Internationalisation: The training platform and materials description, and API-based access that is needed for automated harvesting should support a common interoperable metadata description model that will enable indexing and promoting the content in higher-level training catalogues that gather the training materials from multiple different training platforms. For these purposes, alignment with the interoperability efforts started in the related RDA groups as well as training related EOSC task forces is necessary. In addition, collaboration on the FAIRification of all training materials is of importance, which is also a topic of interest for the mentioned groups.

KER #2 Pre-production environment supports the on-boarding of service providers

Category: Technical Harmonisation, Virtual Reserch Environment (VRE).

Description: The main goal of the pre-production environment is to support service providers in the process of onboarding, maturity assessment and integration of relevant services to EOSC. The components of the pre-production environment match the minimum viable EOSC core, thus helping service providers to troubleshoot and align their services according to the requirements set by EOSC, and is an essential tool for successful technical and policy onboarding.

Link: doi.org/10.5281/zenodo.3932925

Maturity: Pre-production environment – TRL 9.

Exploitability: Operational service.

Sustainability: The project partners that host elements of the pre-production environment can continue to support a certain part of the environment based on in-kind contribution for the purposes of regional collaboration. Any further advancements in the workings of the pre-production environment, and its provision on a pan-European level, should be supported by the EOSC Partnership and enabled by obtaining funding from future EC calls.

Internationalisation: The pre-production environment should always follow the latest recommendations and standardised rules of participation and EOSC core architecture design. For these purposes, a liaison with the relevant EOSC task forces and working groups is essential. Such a platform should be harmonised and provided on the pan-European level.

KER #3 FAIR/ORDM tools

Category: Policy Harmonisation, Validation Tool or Other.

Description: LCT - License Clearance Tool, RoLECT - EOSC RoP Legal & Ethics Compliance, RePol - Repository Policy Generator: LCT is an online tool for the automatic clearance of rights of derivative works and the selection of the most appropriate license for your work. RoLECT is a guided self-assessment tool for EOSC Rules of Participation focusing on legal and ethical aspects of compliance. RePol is a step-by-step wizard tool for creating repository and privacy policies.

Links:

repol.ni4os.eu

lct.ni4os.eu/lct/login

rolect.ni4os.eu/rolect/auth/login

Maturity: Current: LCT - TRL 8, RoLECT - TRL 7 RePol -TRL 8. Expected (EoP): LCT - TRL 8, RoLECT - TRL 8 RePol -TRL 9.

Exploitability: Operational service.

Sustainability: LCT and RoLECT are web applications currently hosted in a virtual machine (VM) provided by GRNET. After the end of the project, the plan is to maintain the services either by continuing to use the existing VM or by deploying it to ATHENA's on-premises infrastructure. The resources

needed are mostly related to user support and technical maintenance, which will be provided by ATHENA's personnel. RePol addresses the genuine need for repositories supported by the UoB through contracts with local institutions, and will remain so in the foreseeable future. The technical requirements of RePol are minimal. The main effort will be in keeping the content in line with the needs.

Internationalisation: LCT will benefit from any standardisation effort in the domain of licensing. Standardisation of licence elements and practices is important and will make the application more robust, facilitating the automatic assessment of compatibility among licenses. Collaboration with related RDA groups is already in place. RoLECT has analysed the EOSC rules of participation (RoP) and is focused on providing specific questions about the ethics and legal aspects of the RoP. The plan is to be aligned with the final RoP and act as a tool for assisting the resource providers in the onboarding process. Towards this objective, the standardisation of RoP is of high importance. RePol offers a bottom-up expression of common variations of repository and privacy policies, and it can therefore contribute to both their standardisation and operationalisation of established standards in terms of content, options, and machine-readability.

KER #4 NI4OS-Europe Login (AAI) service

Category: Authentication and Authorisation Infrastructure (AAI).

Description: The NI4OS-Europe Login (AAI) service is the Authentication and Authorisation Infrastructure (AAI) for the NI4OS-Europe infrastructure. NI4OS-Europe Login enables the integration of external academic and social identity providers with the services and resources offered through NI4OS-Europe. Thus, it provides a single integration point allowing individual researchers, research communities and citizen scientists to access the NI4OS-Europe services and resources (web and non-web-based) using existing credentials from their home organisations. The implementation of the AARC Blueprint Architecture guidelines and the adoption of open technologies, including SAML 2.0 and OpenID Connect, facilitates interoperability and integration with the existing AAIs of other eInfrastructures and research communities in EOSC.

Link: zenodo.org/record/3932925

Maturity: The NI4OS-Europe Login (AAI) service is an implementation (TRL 9) of the AARC Blueprint Architecture model which is required for interoperability with the EOSC AAI. Participation in the EOSC AAI Federation will allow for scalable integration into the global ecosystem for identity and access control infrastructures for EOSC. Registration in the EOSC AAI Federation (both as a Community AAI and an Infrastructure Proxy) will be completed by September 2022.

Exploitability: Operational service.

Sustainability: GRNET will maintain the NI4OS-Europe Login (AAI) Service as an in-kind contribution to the regional collaboration and access to regional services. However, further developments will be required to meet the evolving requirements and interoperability guidelines for the EOSC AAI Architecture. GRNET and the partners involved will seek funding for these developments from future EC Calls and are looking for alignment on these issues with the EOSC Association and the Partnership.

Internationalisation: NI4OS-Europe Login (AAI) is already aligned with the current EOSC AAI architecture and the relevant policy guidelines and will benefit from collaborating further in standardisation and harmonisation activities in the domain of federated identity and access management to meet the evolving requirements and address the identified gaps. Such standardisation activities include participation in the EOSC AAI Task Force, the AARC Engagement Group for Infrastructures (AEGIS), REFEDS Working groups (e.g. Assurance), and the Research & Education (R&E) OpenID Working Group (RANDE).

KER #5 National Open Science Cloud Initiatives (NOSCIs)

Category: Knowledge Centre.

Description: NOSCIs and blueprint (D2.2 National OSC initiatives model). The National Open Science Cloud Initiatives (NOSCIs) are a coalition of national organisations that have a prominent role and interest in the EOSC with the main objective to promote synergies at the national level for optimising participation in EOSC, supporting its governance and developing national open science (OS) policies. NOSCIs are key elements of the NI4OS-Europe project and the cornerstone to reducing OS policy fragmentation in the region. To support the establishment of NOSCIs, NI4OS-Europe presented a comprehensive framework– the Blueprint, which includes three elements: a. a set of indicative indicators to support the establishment and the monitoring of NOSCIs (checklist - indicators for the NOSCIs establishment), b. the workflows for setting up the initiatives which include three different approaches: top-down, bottom-up and hybrid (workflows for setting up NOSCI), c. the operational aspects such as EOSC governance, strategy and sustainability issues. The main advantage of the blueprint is that it can be further customised by any country and can be used as a valuable tool to advance the national OS agenda and facilitate the governance of EOSC. This approach was very successful, and already 10 NOSCIs have been established in south east Europe (SEE), and five more countries are in the progress of creating a NOSCI.

Links:

zenodo.org/record/4061801

zenodo.org/record/4662573

Maturity: Limited community practice. The Blueprint for establishing national OS initiatives is available and is accompanied by two checklists for implementation and one video with possible workflows and recommendations. Currently, nine NOSCIs have signed an MoU, and six more MoUs are expected to be signed before the end of the NI4OS-Europe project.

Exploitability: Prototype.

Sustainability: The operation of the NOSCIs is managed by a memorandum of understanding (MoU). The MoUs signed by the NOSCIs include, among others, provisions about organisational structure, available resources and national contribution to EOSC and have a duration of at least three years. Moreover, NOSCIs are, by design, inclusive national OS ecosystems bringing together all major OS players in the countries that have a stake in their activities and operation. Finally, as part of the NI4OS-Europe project, support from the relevant ministries had been sought in advance. All the above ensure the sustainability of NOSCIs, however, the EOSC Partnership should ensure support too.

Internationalisation: NOSCIs would certainly benefit from a collaboration with similar initiatives in other countries and European regions. NI4OS-Europe representatives participate in all relevant policy exchange and harmonisation working groups and activities, as part of the INFRAEOSC collaboration. A direct and more structured exchange between the national OS initiatives would strengthen convergence and EOSC capacity at the European level, but has also the potential to support a strong international presence of EOSC.

KER #6 AGORA service portfolio management tool

Category: Policy Harmonisation, Technical Harmonisation.

Description: AGORA + onboarding procedures. The NI4OS-Europe Onboarding procedures use the AGORA Service Portfolio Management tool (agora.ni4os.eu) for the curation of the services to be onboarded to EOSC. AGORA was the 1st regional catalogue to be fully integrated with the EOSC Service Catalogue and is a central production service of the project. The proposed NI4OS-Europe onboarding procedures are based on the latest recommendations by EOSC, comprising different possible levels of integration, along with the desired readiness levels of the services to be onboarded. The onboarding and the verification of the services are done using the NI4OS-Europe pre-production environment.

Links:

catalogue.ni4os.eu

zenodo.org/record/5078116

Maturity: AGORA: TRL 8.

Exploitability: Operational service.

Sustainability: GRNET will maintain the NI4OS-Europe AGORA Service as an in-kind contribution to the regional collaboration. However further developments will be required to follow future updates and developments in the EOSC Profiles. GRNET and the partners involved will seek funding for this development from future EC Calls and are looking for alignment on these issues with the EOSC Association.

Internationalisation: Agora will benefit from the standardisation of EOSC Profiles and the relative integration APIs, while the current catalogues should be harmonised across Europe. The onboarding procedures will adapt to follow the latest recommendations of the RoP-CM TF, as well as other relevant TFs.

EOSC Future

EOSC Future

Grant agreement ID: 101017536

DOI: 10.3030/101017536

Start date: 1 April 2021

End date: 30 September 2023

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 42.077.088,84

EU contribution: € 40.877.088,83

Coordinated by: Athina-Erevnitiko Kentro Kainotomias Stis Technologies Tis Pliroforias, Ton Epikoinonion Kai Tis Gnosis.

Brief description of the project: The EU-funded EOSC Future project will integrate and connect e-infrastructures, research communities and initiatives in open science to advance the European Open Science Cloud (EOSC) platform of services (EOSC-Core, EOSC- Exchange, Interoperability Framework) to uncover the potential of European research.

Fields of science:
Natural Sciences.
Engineering And Technology, Medical And Health Sciences.
Agricultural Sciences, Social Sciences, Humanities.

Programme(s)
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.3. - Development, deployment and operation of ICT-based e-infrastructures.

Topic(s): INFRAEOSC-03-2020 - Integration and consolidation of the existing pan-European access mechanism to public research infrastructures and commercial services through the EOSC Portal.

Sub call: H2020-INFRAEOSC-2020-2

Funding Scheme: RIA - Research and Innovation action.

Website: eoscfuture.eu

Cordis: cordis.europa.eu/project/id/101017536

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓	✓	✓	✓	✓	✓
	1.2 Researcher Engagement and Adoption	✓	✓	✓	✓	✓	✓
	1.3 Rules of Participation Compliance Monitoring	✓	✓	✓	✓	✓	✓
AG 2	2.1 FAIR Metrics and Data Quality	✓	✓	✓	✓	✓	✓
	2.2 Semantic Interoperability	✓	✓	✓	✓	✓	✓
AG 3	3.1 Data Stewardship Curricula and Career Paths	✓	✓	✓	✓	✓	✓
	3.2 Research Careers, Recognition, and Credit	✓	✓	✓	✓	✓	✓
	3.3 Upskilling Countries to Engage in EOSC	✓	✓	✓	✓	✓	✓
AG 4	4.1 AAI Architecture	✓	✓	✓	✓	✓	✓
	4.2 Infrastructure for Quality Research Software	✓	✓	✓	✓	✓	✓
	4.3 Technical Interoperability of Data and Services	✓	✓	✓	✓	✓	✓
AG 5	5.1 Financial Sustainability	✓	✓	✓	✓	✓	✓
	5.2 Long-term Data Preservation	✓	✓	✓	✓	✓	✓

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 EOSC Future Platform

Category: Technical Harmonisation, Policy Harmonisation.

Description: The EOSC Platform is composed of:

- EOSC Core & Support.
- EOSC Exchange.
- EOSC Interoperability Framework.

The EOSC Core and Support provides an essential set of internal services and support activities which allow EOSC to operate and provide the ability to seamlessly share, access and combine a multitude of research services and resources. It provides a common channel for researchers, removes fragmentation and enables cross-disciplinary collaboration across disparate research communities, allowing researchers to use resources from different communities to produce ground-breaking new research results. The EOSC-Core increases re-use of research outputs, supports Open Science principles, maximises the value of research investment, facilitates multidisciplinarity and widens the user base of research.

The EOSC Exchange consists of a catalogue and marketplace through which to discover, order and share a very wide range of research expertise and resources for storing, preserving and exploiting FAIR data and encouraging its re-use across the research community, maximising the value of research investment. The Exchange unlocks the potential of data, providing the opportunity for science communities to expose and share the services, tools, software etc they have developed and refined over many years, for the benefit of other communities and larger-scale collaboration, and for potential wider exploitation. e-Infrastructures provide more generic, "horizontal" services which are widely required in the scientific community.

The EOSC Interoperability Framework (EOSC IF) is a set of guidelines which promote standards and community best practices within EOSC. Because EOSC is a system of systems infrastructure, interoperability is essential to deliver services to users and enable sharing and composability of resources. The focus is on the technical interoperability of services and semantic interoperability related to data to allow communities to interoperate. The framework supports the collection of guidelines (some existing already, some being developed) whose uptake as EOSC guidelines will be promoted; a registry to list the guidelines and who supports them, and governance to manage them. The EOSC IF supports interoperability with the EOSC Core as well as with the EOSC Exchange.

Maturity: The project is performing architecture development, realising Core and Exchange functions and adding more functionality during the project. There is a close collaboration (and personal bridges) with the EOSC Association Working Groups.

Exploitability: Operational Service.

Sustainability: There will be an EC procurement call for the provision of some elements of the EOSC platform for the period after the end of the EOSC Future project. However, long-term sustainability solutions need to be defined and agreed upon.

Internationalisation: The EOSC Platform can benefit from international efforts (US, Canada, Central and Southern America, Australia, Asia, Africa). It could create new services and increase the interoperability of the data.

KER #2 EOSC Future Science Projects

Category: Technical Harmonisation.

Description: The EOSC Future Science Projects perform new cross-disciplinary scientific analyses thanks to research collaboration between science clusters, showing how EOSC can be used to create knowledge from inter-working between communities.

Maturity: There are ten Science Projects and these will be finalised by M30 of the project.

Exploitability: Prototype.

Sustainability: Uptake of results from the science projects can be via the Science Clusters (or rather: the research infrastructures (legal entities) involved in those clusters).

Internationalisation:

Science projects – and the science clusters – already operate in an international and global environment.

KER #3 EOSC Future Observatory

Category: Knowledge Centre.

Description: The EOSC Observatory is a policy intelligence tool for monitoring policies, investments, resources and infrastructures related to EOSC. It consists of a public interactive dashboard for the collection and presentation of data on the implementation and uptake of EOSC at European and National levels. The tool visualises information such as the number and type of research outcomes in open access, the amount of money spent on Open Science (OS), and the policies in place to implement and support OS.

Maturity: KER 3: The Observatory is in the prototype stage, but content from surveys is already coming in; the Observatory will increase its functionality, esp. on reporting.

Exploitability: Prototype.

Sustainability: There is no information yet on how the Observatory will continue after the project. This implies a high risk for its sustainability.

Internationalisation: The Observatory could benefit from similar data by international partners, incl. OECD. It would increase its usability and comparability.

KER #4 EOSC Future Knowledge Hub

Category: Knowledge Centre.

Description: Seamlessly integrated with the EOSC Portal, the EOSC Knowledge Hub (KH) is a platform that delivers a highly curated training resources catalogue and a state-of-the-art Learning Management System (LMS) based on Moodle (for content delivery) and Articulate (for authoring). The catalogue focuses on free (as well as paid-for, where applicable) training content pertinent to EOSC, its services and related FAIR and Open Science concepts. By bringing together disparate sources of information, the KH acts as a centralised hub for training related to all things EOSC. Through the creation of modularised CC-BY licensed training resources and the promotion of the reuse of those resources, the KH delivers tailored content to its users.

Maturity: The Knowledge Hub is being developed. The first part (Cataloguing) is being in progress, with content continuing to be added. The second part (Virtual Learning Environment) will connect with an existing platform for hosting the VLE.

Exploitability: Prototype.

Sustainability: There will be an EC procurement call for the knowledge hub after the end of the EOSC Future project.

Internationalisation: The content of the Knowledge Hub is globally relevant, and the VLE can also host skills and training information originating from outside Europe.

KER #5 Commercial Services & Support

Category: Policy Harmonisation.

Description: Commercial services and support for EOSC aim to involve industry and SMEs in the EOSC landscape so as to improve the exploitation of scientific research products. Relying on procurement frameworks, the EOSC Future project delivers commercial cloud services for storage and computing to researchers under favourable terms and conditions. And to further stimulate take-up of these services, the project provides adoption funding. Through the involvement of the end users, the project is continuously improving this process and exploring the possibility of including a wider range of services, such as research community services, in the longer term. Through the EOSC Digital Innovation Hub (DIH), the project enables industry innovation by leveraging EOSC services and data. Bringing together industry and the scientific community, the EOSC DIH community will act both as a supplier and a user of EOSC to further stimulate cross-fertilisation across sectors, promoting innovation and digitisation of SMEs.

Maturity: Commercial Services are being procured, and DIH entails collaborations with commercial companies, with pilots running. Explorations of synergies with other Data Spaces are ongoing, a.o., the project will connect with the EC to receive more info on their developments.

Exploitability: Operational service.

Sustainability: By definition, commercial services must develop their business model.

Internationalisation: Commercial services and the DIH can benefit from reaching a bigger audience, stimulating further innovation and investments in the tools and services.

KER #6 Future Community

Category: Policy Harmonisation.

Description: The EOSC Future Community KER captures the value generated during the EOSC Future project by the collaboration and community-building aspects of the wide variety of technical developments, consultations, forums and other project events and activities which, taken together, form the EOSC Future Community. The KER identifies and documents the community-forming aspects of the activities, recording the value created and making it available for future use by other projects, organisations or initiatives. The EOSC Future Community KER is focused on the importance of community formation for the development of the EOSC. It also highlights the value generated by collaborations taking place within the project.

Maturity: The Future Community is operational with a big user group and many outreach activities. Major events are the Policy Event, the annual EOSC Symposium and the RDA Plenary 2023 in Sweden.

Exploitability: Operational service.

Sustainability: Sustainability of the EOSC Future Community is a priority goal for which EOSC Future is seeking a GDPR-compliant solution.

Internationalisation: More international users would raise the profile of EOSC and increase the use that is being made of it.

C-SCALE

Copernicus - eoSC AnaLytics Engine – C-SCALE

Grant agreement ID: 101017529

DOI: 10.3030/101017529

Start date: 1 January 2021

End date: 30 June 2023

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 1.999.670

EU contribution: € 1.999.670

Coordinated by: Eodc Earth Observation Data Centrefor Water Resources Monitoring Gmbh.

Brief description of the project: The EU-funded C-SCALE project will make the discovery, access and processing of the space-based Copernicus environmental monitoring system environmental information available through the European Open Science Cloud (EOSC) to further innovative Earth Observation-based research and development activities.

Fields of science:
Natural Sciences > Computer and Information Sciences > Data Science > Big Data.
Natural Sciences > Earth and Related Environmental Sciences > Atmospheric Sciences > Climatology > Climatic Changes.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.3. - Development, deployment and operation of ICT-based e-infrastructures.

Topic(s): INFRAEOSC-07-2020 - Increasing the service o er of the EOSC Portal.

Sub call: H2020-INFRAEOSC-2020-2

Funding Scheme: RIA - Research and Innovation action.

Website: c-scale.eu

CORDIS: cordis.europa.eu/project/id/101017529

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation						
	1.2 Researcher Engagement and Adoption				✓		
	1.3 Rules of Participation Compliance Monitoring						
AG 2	2.1 FAIR Metrics and Data Quality	✓	✓				
	2.2 Semantic Interoperability	✓	✓				
AG 3	3.1 Data Stewardship Curricula and Career Paths						
	3.2 Research Careers, Recognition, and Credit						
	3.3 Upskilling Countries to Engage in EOSC						
AG 4	4.1 AAI Architecture	✓					
	4.2 Infrastructure for Quality Research Software	✓		✓			
	4.3 Technical Interoperability of Data and Services	✓	✓				
AG 5	5.1 Financial Sustainability						
	5.2 Long-term Data Preservation						

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 Federated Earth System Simulation and Data Processing Platform (FedEarthData)

Category: Technical Harmonisation, Discovery/Access platform, Virtual Research Environment (VRE), Authentication and Authorisation (AAI).

Description: The Federated Earth System Simulation and Data Processing Platform (FedEarthData) brings together the providers of data and processing capacity, so that Earth observation products held in distributed archives across the federation can be easily discovered and seamlessly accessed and processed on batch as well as interactive analytic platforms deployed on distributed computing resources anywhere across the federation.

Links:

- D2.1 C-SCALE Copernicus Data Access and Querying Design
- D3.1 Initial Design of the Compute Federation
- D3.3 End user documentation for batch processing system
- wiki.c-scale.eu/C-SCALE
- c-scale.eu/call-for-use-cases

Maturity: The FedEarthData service is operational and usable for the public while onboarding additional resource sites at the same time. Documentation about it is openly available and continuously developed. FedEarthData will be available to the users as a service through the EOSC Portal by November 2022. At the moment, its TRL is 7.

Exploitability: Operational service.

Sustainability: The work consists mainly in integrating existing services (Sentinel archives, private clouds, private HPC/HTC resources) with existing federations. As such, the sustainability of the service is linked with the sustainability of its components as they already are, without putting additional strain on funding or effort.

Internationalisation: Major aspects of the federation's functioning are governed by well-received international standards, e.g., OpenID Connect (OIDC) for the area of federated authentication and authorisation (AAI). Yet there is a perceived benefit in standardising additional details down to attribute level, perhaps by developing extensions to applicable standards, to enable truly pluggable resource and service providers integration into the federation.

KER #2 Metadata Query Service (MQS)

Category: Technical Harmonisation, Discovery/Access Platform.

Description: The C-SCALE Metadata Query Service (MQS) makes Copernicus data distributed across partners within the federation discoverable and searchable. It is a STAC-compliant API that redistributes incoming queries among the federated sites and provides a consolidated response containing the list of aggregated results. The MQS exposes all STAC collections available within the federation on a single endpoint and provides a search interface that accepts the core parameters of the STAC API Item Search specification. Thanks to the rich ecosystem that has evolved around STAC and the growing list of tools that can interact with STAC APIs, working with the MQS is straightforward.

Links:

- mqs.eodc.eu/help
- mqs.eodc.eu/browser
- mqs.eodc.eu/stac/v1
- D2.1 C-SCALE Copernicus Data Access and Querying Design

Maturity: The Metadata Query Service has been deployed in an operational environment and is accessible and usable for the public. Software documentation to explain the service functionality exists and is made available for end-users on a public host. The MQS is still under development. Thus, the lookup feature is only partially complete and can be expected to undergo modifications to further enhance usability. Therefore, the TRL is 7.

Exploitability: Prototype.

Sustainability: The result contributes to the Integration of metadata databases task which is a central component of the Copernicus Data Federation activity within C-SCALE. The MQS will be maintained throughout the timeline of the project and the generated expertise is going to be used beyond the project for realising federated metadata integration. The STAC-APIs developed at the individual sites present a clear added value for the discoverability of their hosted data and are likely to sustain beyond the project.

Internationalisation: The key technology used for this service is STAC, a metadata specification for spatiotemporal data. STAC, by its very definition, strives to harmonise and facilitate the discoverability of geospatial assets by providing a simple set of tools to describe satellite imagery and related datasets. The MQS fosters the acceptance of STAC within the international community by enabling users to search across the C-SCALE federated metadata catalogues using this JSON-based language. Since there is a great interest within the EO community to engage in STAC, continued efforts put into this activity would further internationalise this KER both from a user perspective and the perspective of potential data providers.

KER #3 openEO Platform

Category: Virtual Research Environment (VRE), Technical Harmonisation, Discovery/Access platform.

Description: The growing data stream from Earth Observation (EO) satellites has advanced scientific knowledge about the environmental status of planet earth and has enabled detailed environmental monitoring services. However, the growing data lake has become an obstacle for scientists, value adders and decision makers. openEO platform provides intuitive programming libraries alongside with a large earth observation data repository to simplify processing and data management. This large-scale data access and computation is performed on multiple infrastructures allowing use cases from explorative research to large-scale production of EO-derived maps and information in an accelerated way.

Link: The service is available to anyone for 30 days after sign-up on openeo.cloud. On this page a collection of documentation websites and direct links to openeo.org – the original project for establishing the API – is available.

Maturity: openEO Platform is currently still under development, however is a working service and can be used by users. Users have been successful in creating results and demonstrating them on international conferences. The service is available in TRL Level 8.

Exploitability: Prototype.

Sustainability: openEO Platform contributes to scientific equity, to the federated European-wide computation infrastructure for earth observation data and provides an open source alternative to commercial Earth observation analysis tools. The service provides freely available training and documentation for any level of expertise. openEO Platform is providing a sustainable service for the public, private and research sector which eases access to EO data and compute resources.

Internationalisation: openEO Platform is based on the de-facto standard openeo which is widely used in the Earth Observation community. The consortium in openeo platform is willing to federate with more openeo backends to actually enable international harmonisation of access to Earth Observation cloud providers. Specifically, lately activities with the UN have shown that openEO Platform can remove barriers in science and education and allow people from the global south equal access to Earth Observation data and cloud compute capabilities. openEO Platform is open to federate and support further providers who are willing to come onboard.

KER #4 C-SCALE Workflow solutions

Category: Technical Harmonisation, Training Resource.

Description: Solutions to easily deploy workflows supporting monitoring, modelling and forecasting of the Earth system. They provide adaptable templates and examples, in the form of Jupyter Notebooks, of Earth Observation and Copernicus data and analysis workflows enabling users to more easily arrange a processing pipeline to create results on the C-SCALE federation.

Links:

- Workflow solution for coastal hydrodynamic and water quality modelling using Delft3D FM
- Workflow solution for satellite derived surface water change monitoring for a geographic area of interest
- Workflow solution for real-time satellite derived surface water area estimates for a geographic area of interest (in development)
- Workflow solution for high resolution, seasonal, ensemble river discharge forecast for a river basin of interest (in development)

Maturity: Some of the workflow solutions are usable in their current form (TRL 5) but would benefit from additional work to be generalised or more widely usable.

Exploitability: Prototype.

Sustainability: The workflow solution provider offers:

open-source workflows with documentation (incl. training material) on how to deploy the workflow towards creating a result for a user's region of interest.

no warranty or dedicated support for the service, but can offer guidance and training on how to deploy the workflow.

The workflow images/software containers are hosted on AppDB.

Internationalisation: The workflow solutions would benefit from improved standardisation, in particular, metadata standards for EO data and unstructured grid data would benefit from engagement with e.g. OGC.

KER #5 C-SCALE community: forum, documentation, training, scientific publication and news

Category: Training Resource, Knowledge Centre.

Description: Set of activities and resources to engage with existing and new stakeholders, including both researchers and service providers in Earth Observation. This helps the project establish a two-way communication where project members and external stakeholders can exchange knowledge and best practices about optimising data analytics in Earth Observation.

Links:

- c-scale.eu

- wiki.c-scale.eu/C-SCALE
- github.com/c-scale-community
- github.com/c-scale-community/discussions/discussions
- twitter.com/C_SCALE_EU
- zenodo.org/communities/c-scale

Maturity: The C-SCALE forum and documentation pages (see Links below) are available to users and providers to discuss and document how to make good use of the C-SCALE services. Both the forum and the documentation are continuously being updated as the project moves forward to respond to the needs of the use cases.

Exploitability: Operational service.

Sustainability: Most of the communication channels discussed in the exploitation path are free to use. We hope to keep the momentum in the C-SCALE community long-term and therefore the exchange of knowledge and best practices around optimising data analytics in Earth Observation will be sustained after the project ends.

Internationalisation: We believe that the output produced by the forum, documentation, training, scientific publications and news articles are mostly specific to the C-SCALE project services and resources, and therefore additional efforts for standardisation are not required.

DICE

Data infrastructure capacity for the European Open Science Cloud – DICE

Grant agreement ID: 101017207

DOI: 10.3030/101017207

Start date: 1 January 2021

End date: 30 June 2023

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 6 997 706

EU contribution: € 6 997 706

Coordinated by: Cineca Consorzio Interuniversitario.

Brief description of the project: The EU-funded DICE project provides cutting-edge multidisciplinary data management services together with the back-end resources to fulfil the needs of different research communities. These services enhance the EOSC infrastructure and ensure the best possible support to guide European research and innovation into the future. DICE offers horizontal state of the art services to store, find, and access data in a consistent and persistent way. Under DICE, the services are being improved further through the development of new solutions and features to fill the gaps still present in the research data lifecycle, in particular: increasing the quality of data and their re-usability, supporting long term preservation, managing sensitive data, and bridging between data and computing resources.

Fields of science:

Natural Sciences > Computer and Information Sciences > Data Science > Big Data.
Natural Sciences > Computer and Information Sciences > Software > Software Applications > System Software.
Social Sciences > Economics and Business > Economics > Production Economics > Productivity.
Natural Sciences > Computer and Information Sciences > Databases > Non-Relational Databases.

Programme(s)
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures MAIN PROGRAMME.
H2020-EU.1.4.1.3. - Development, deployment and operation of ICT-based e-infrastructures.

Topic(s): INFRAEOSC-07-2020 - Increasing the service offer of the EOSC Portal.

Sub call: H2020-INFRAEOSC-2020-2

Funding Scheme: RIA - Research and Innovation action.

Website: dice-eosc.eu

Cordis: cordis.europa.eu/project/id/101017207

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓			✓	✓	
	1.2 Researcher Engagement and Adoption			✓		✓	
	1.3 Rules of Participation Compliance Monitoring				✓		
AG 2	2.1 FAIR Metrics and Data Quality	✓					
	2.2 Semantic Interoperability						
AG 3	3.1 Data Stewardship Curricula and Career Paths						
	3.2 Research Careers, Recognition, and Credit						
	3.3 Upskilling Countries to Engage in EOSC						
AG 4	4.1 AAI Architecture				✓	✓	
	4.2 Infrastructure for Quality Research Software				✓		
	4.3 Technical Interoperability of Data and Services	✓			✓	✓	
AG 5	5.1 Financial Sustainability					✓	
	5.2 Long-term Data Preservation		✓				

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 PID integrity check

Category: Validation Tool or Other.

Description: Persistent Identifier (PID) integrity check includes two key aspects of PIDs' integrity: Integrity check for PID infrastructure (PID resolution) and PID metadata (the content of PID records and the usage of data types).

Link: dice-eosc.eu/deliverables/pilots-integration-otherservices-platforms

Maturity: The PID integrity check is implemented for the B2HANDLE service (TRL 6). For the integration into other PID services, additional development work is needed.

Exploitability: Prototype.

Sustainability: The provided Prefix Information Service needs a maintained platform for uptake by the Persistent Identifier Consortium for eResearch (ePIC) that would also allow a transparent view on non-DICE-offered PID services. The willingness to provide a minimum viable infrastructure is currently being discussed by the main provider behind the service (GWDG).

The provided TypeAPI service needs continuous adaptability to the frequently changing best practices of the various communities. It is planned to suggest the service for uptake by ePIC to moderate the necessary discussions with the main user communities after the project end. Further support might be helpful.

Internationalisation: The PID integrity check is implemented for the B2HANDLE service. For the integration in other PID services, additional efforts for standardisation and further work to create international harmonisation between the various PID technologies (Handle, DOI, URN, ARK, etc) are needed. Also, fostering the overall acceptance of using PID types would be helpful. There is a wide interest to participate in such developments.

KER #2 Long term preservation policy template

Category: Policy Harmonisation.

Description: Policy template for long-term preservation (LTP) for re-use by a wide range of repositories and policy-based data archives to compose their LTP policies. This includes guidance on applying the Long-Term Preservation Policy Template and provides an introduction to cost models.

Link: dice-eosc.eu/deliverables/pilots-integration-otherservices-platforms

Maturity: The LTP policy template has initially been created to be applied to B2SHARE and B2SAFE services part of the EUDAT CDI service catalogue, but it should be made usable by other repository systems and data archives and includes a guideline on how to do that. The maturity level of the template can be considered "prototyped" since services will typically adapt the template to their own needs.

Exploitability: Operational service.

Sustainability: There is no existing exploitation plan after the project ends. It would be good practice if this output (LTP Policy Template) will be brought to the attention of the EOSC Long-Term Data Preservation Task Force, among others.

Internationalisation: The LTP-Policy Template is currently written in English. Translations to other languages would increase the reusability and usage. However, this also increases the effort to maintain the LTP policy.

KER #3 EOSC data management services use cases

Category: Knowledge Centre.

Description: Exemplary use cases in the use of EOSC data management services from three different communities (CompBioMed, LOFAR and ICOS).

Link: dice-eosc.eu/deliverables/pilots-description-and-validation

Maturity: The success stories include extending discipline-specific data services from the community platforms as well as generic services for storage and publication accessible to a larger pool of researchers.

Exploitability: Operational service.

Sustainability: While the identified use cases do not require a specific sustainability plan by themselves, the services used to support the workflows need to be sustained after the end of the EU-funded project. The sustainability plan is thus following what will be defined for the specific services.

KER #4 Operational tools integration with EOSC Core

Category: Technical Harmonisation.

Description: Integration of EUDAT CDI Operational tools with the EOSC Core services. This includes integration and full compatibility of the AGORA/SPMT with the EOSC Profiles and EOSC Portal API, integration of B2ACCESS with the EOSC AAI, monitoring service to follow the interoperability guidelines and is ready to connect with the EOSC Monitoring.

Link: dice-eosc.eu/deliverables/intermediate-reportintegration-cdi-operation-and-collaboration-tools-eosc

Maturity: AGORA/SPMT integration is completed and tested (TRL8). B2ACCESS integration is completed and tested (TRL8).

Exploitability: Operational service.

Sustainability: Support and operation of the Operational tools are maintained by the EUDAT CDI. EUDAT CDI will seek funding for further development and compliance of the tools.

Internationalisation: AAI and Monitoring will benefit from standardising exchange protocols.

KER #5 Data Management services

Category: Virtual Research Environment (VRE).

Description: A set of EOSC exchange services for data management able to support diverse communities.

Link: dice-eosc.eu/index.php/call-service-requests

Maturity: All the offered services are TRL9.

Exploitability: Operational service.

Sustainability: The services have been so far sustained by the back-end service providers and the costs are partially recovered via the virtual access mechanisms from EC funding. After the EC funding, it is expected that most of the services might become pay-per-use or reserved for specific domains or geographic communities. An exploitation plan is being prepared as part of the project activities and will be ready by June 2023.

RELIANCE

REsearch LIfecycle mAnagemeNt for Earth Science Communities and CopErnicus users in EOSC – RELIANCE

Grant agreement ID: 101017501

DOI: 10.3030/101017501

Start date: 1 January 2021

End date: 30 June 2023

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 1.999.972,50

EU contribution: € 1.999.972,50

Coordinated by: Instytut Chemii Bioorganicznej Polskiej Akademii Nauk.

Brief description of the project: The EU-funded RELIANCE project is extending the EOSC's capabilities with an enhanced support for various research activities, in alignment with the EOSC Interoperability Framework. It aims to enhance the discovery of and access to research data, including the mechanisms to recreate and use efficiently large Earth Observation (EO) datasets (e.g., from Copernicus), to extract relevant information from scientific text, and to manage the research lifecycle as a first-class entity while promoting findability, accessibility, interoperability and reusability (FAIR) as well as open science principles.

Fields of science:
Natural Sciences > Physical Sciences > Astronomy > Astrophysics.
Natural Sciences > Earth and Related Environmental Sciences.

Programme(s)
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.3. - Development, deployment and operation of ICT-based e-infrastructures.

Topic(s): INFRAEOSC-07-2020 - Increasing the service o er of the EOSC Portal.

Sub call: H2020-INFRAEOSC-2020-2

Funding Scheme: RIA - Research and Innovation action.

Website: reliance-project.eu

Cordis: cordis.europa.eu/project/id/101017501

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓	✓	✓			✓
	1.2 Researcher Engagement and Adoption			✓	✓	✓	✓
	1.3 Rules of Participation Compliance Monitoring						
AG 2	2.1 FAIR Metrics and Data Quality	✓	✓	✓	✓	✓	✓
	2.2 Semantic Interoperability	✓	✓	✓	✓	✓	✓
AG 3	3.1 Data Stewardship Curricula and Career Paths		✓	✓	✓		✓
	3.2 Research Careers, Recognition, and Credit	✓	✓	✓	✓	✓	✓
	3.3 Upskilling Countries to Engage in EOSC						
AG 4	4.1 AAI Architecture						
	4.2 Infrastructure for Quality Research Software		✓	✓			
	4.3 Technical Interoperability of Data and Services	✓	✓	✓	✓	✓	✓
AG 5	5.1 Financial Sustainability						
	5.2 Long-term Data Preservation	✓	✓	✓	✓		✓

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 Metadata model for the description of FAIR data cubes

Category: Technical Harmonisation.

Description: RELIANCE produced a metadata model for the description of FAIR data cubes, including crosswalks among existing prominent metadata models used to describe EO products and datasets as well as those proposed and used in the EOSC ecosystem. This model is usable and implemented in the Earth Science domain, and RELIANCE showcases them via its communities in Sea Monitoring, Geohazards and Climate Change.

Links:

doi.org/10.5281/zenodo.5024537

doi.org/10.5281/zenodo.4744768

Maturity: The developed metadata standard has been validated via the RELIANCE vertical and multidisciplinary use cases. The model is implemented and supported by the RELIANCE services (ROHub, ADAM).

Exploitability: Prototype.

Sustainability: The metadata model is provided as a publicly available report in Zenodo. Comments for improvements are accepted via tickets in the RELIANCE repository of the RO-crate profile implementing the model (see KER2). The RELIANCE partners involved in the metadata model definition will carry out any updates as part of their involvement in the research object community group.

Internationalisation: The metadata model is already well received by Earth Science communities participating in RELIANCE, who were involved in the process, but would benefit from a wider international acceptance including other disciplines of Earth Science. This activity contributes to the international metadata standards for data cubes. The potential collaboration initiatives would be the Open Geospatial Consortium (OGC) and European Geosciences Union (EGU). There is a wide interest in the community to participate in such developments.

KER #2 RELIANCE RO-Crates

Category: Technical Harmonisation.

Description: RELIANCE produced a RO-Crate profile for describing research objects in EOSC. RELIANCE RO-Crates are a specialisation of RO-Crate (the current standard format for describing research objects – see researchobject.org/ro-crate), to describe research objects that include data cubes to access EO data, along with all the necessary and other related artefacts like documentation, images, related infrastructures, etc. This includes the design and implementation of the vocabulary with the profile extensions. This profile is usable and implemented in the Earth Science domain, and RELIANCE showcases them via its communities in sea monitoring, geohazards and climate change.

Links:

reliance-eosc.github.io/reliance-ro-crate

github.com/RELIANCE-EOSC/ro-terms/blob/master/earth-science/vocabulary.ttl

Maturity: The developed RO-Crate profile has been validated via the RELIANCE vertical and multidisciplinary use cases. The model is implemented and supported by the ROHub platform. RO-Crates are now also one of the object types supported by the EOSC explore Research Graph.

Exploitability: Operational service.

Sustainability: The RO-Crate profile, and related vocabulary, are provided via GitHub repositories, and the profile is listed in the RO-Crate profiles section (researchobject.org/ro-crate/profiles.html) maintained by the research object community group (which includes RELIANCE members). Comments for improvements are accepted via tickets in the RELIANCE repository of the RO-Crate profile (github.com/RELIANCE-EOSC/reliance-ro-crate/issues), or users can propose directly their changes via pull requests. The RELIANCE partners involved in the profile definition will carry out any updates as part of their involvement in the research object community group.

Internationalisation: The RO-crate profile is already well received by Earth Science communities participating in RELIANCE but would benefit from wider international adoption, particularly in Earth Science disciplines. This activity could create a new international standard for managing and preserving scientific outcomes via research objects, particularly in Earth Science disciplines. This would require collaboration with related initiatives, in particular, the research object community group (to which RELIANCE members already contribute), but also others like EOSC Interoperability Framework TF, EOSC research product publishing WG, OpenAire and RDA.

KER #3 Research object management platform (ROHub)

Category: Virtual Research Environment (VRE).

Description: RELIANCE onboarded and integrated the research object management platform ROHub in EOSC as a research-enabling service supporting the management of the research lifecycle, including the storage, management and preservation of scientific outcomes, their sharing and publication (with a DOI) in line with FAIR and OS principles, and the discovery and reuse pre-existing scientific knowledge. ROHub is integrated with different EOSC services, including AAI (EGI check-in), Zenodo, B2Share, EGI Notebooks, EGI Binder and B2Drop (see D5.3 doi.org/10.5281/zenodo.6260936). ROHub also

integrates the ADAM platform to enable easy aggregation of Data Cubes, and their visualisation via the ADAM explorer (see KER4). This KER is usable across different science disciplines, although in RELIANCE we showcase it in Earth Science via its communities in sea monitoring, geohazards and climate change.

Links:

- reliance.rohub.org
- marketplace.eosc-portal.eu/services/psnc.rohub
- ROHub Service backend: api.rohub.org/api
- ROHub Web portal: reliance.rohub.org
- ROHub python API client documentation: reliance-eosc.github.io/ROHUB-API_documentation/html/modules.html
- ROHub python API client tutorials: reliance-eosc.github.io/ROHUB-API_documentation/html/tutorials.html

Maturity: ROHub is operating as a production service with TRL 8. The service is operating in PSNC (Poznan Supercomputing and Networking Center) infrastructure. The service is maintained and additional improvements will be carried out throughout the course of the RELIANCE project.

Exploitability: Operational service.

Sustainability: The ROHub platform requires a maintained computing and storage infrastructure for its operation. The service provider (PSNC) is committed to maintaining the service after the end of the RELIANCE project, as part of its service portfolio. The sustainability of this KER is based on various components, including involvement as a partner in R&D initiatives (service costs are planned as part of the project lifecycle), and funding for the development and maintenance of national research infrastructures.

Internationalisation: ROHub is already well received by scientists in different disciplines, particularly in Earth Science, as the reference platform for managing and preserving their scientific outcomes via research objects. ROHub is also now the only service in EOSC for Research Objects. Nevertheless, it would benefit from wider international adoption, in Earth Science but also in other disciplines. This activity could make ROHub one of the EOSC-recommended horizontal services and make it the international reference platform for managing research objects, particularly in Earth Science disciplines. This would require collaboration with related initiatives, in particular, the research object community group (to which RELIANCE members already contribute), but also others like EOSC Future and OpenAire.

KER #4 Advanced geospatial Data Management (ADAM) platform

Category: Discovery/Access Platform.

Description: RELIANCE onboarded and integrated the Advanced geospatial Data Management (ADAM) platform in EOSC enabling efficient EO data discovery, access, processing and visualisation of Data Cubes. ADAM is integrated with EOSC AAI (via its connection with ROHub), and it is integrated in ROHub as described in KER3. This KER is usable and implemented in the Earth Science domain, and RELIANCE showcases them via its communities in sea monitoring, geohazards and climate change.

Links:

- ADAM platform: adamplatform.eu
- ADAM platform on EOSC Portal: marketplace.eosc-portal.eu/services/adam-platform
- ADAM Data Access System backend: reliance-das.adamplatform.eu/
- ADAM Explorer web portal: reliance.adamplatform.eu
- ADAM python API client: pypi.org/project/adamapi
- Jupyter notebooks to support the ADAM adoption by user communities (see D4.2 doi.org/10.5281/zenodo.5119166)

Maturity: ADAM is operating as a production service with TRL 9. The service is operating in resources distributed across MEEO, Research (Copernicus DIAS: creodias, mundi, WEkEO) and commercial (Amazon Web Services) infrastructures but might leverage resources from EOSC to store data cubes (depending on the size of final datasets required in RELIANCE). A final release of the service will be delivered by the end of 2022.

Exploitability: Operational service.

Sustainability: The ADAM platform requires a maintained computing and storage infrastructure for its operation. The service provider (MEEO) is committed to maintaining the service after the end of the RELIANCE project, as part of its service portfolio. The sustainability of this KER is based on two main components: involvement as a partner in R&D initiatives (service costs are planned as part of the project lifecycle) and subscription fees for commercial users.

Internationalisation: ADAM is already well received by scientists in different disciplines, particularly in Earth Science, as the reference platform for managing data cubes. Ad-hoc instances are transferred into operation at the Copernicus Data Information and Access Service (DIAS) and the European Space Agency (ESA) infrastructures to enable access to Copernicus, Heritage Mission, Earth Explorer and Third-Party Missions datasets. To support and improve the FAIRness of the data cube services, evolution and extensions to support additional datasets would be required.

KER #5 Text mining services

Category: Discovery/Access Platform.

Description: RELIANCE onboarded and integrated text mining services to extract information from the scientific text in EOSC. This KER includes production-ready and extended analytic services. The former comprises i) a semantic enrichment service that generates semantic metadata out of the text content of documents and research objects, ii) a semantic search service that indexes metadata and text extracted from the research objects' aggregated resources, and iii) a recommendation service that suggests research objects that might be of interest according to the user's research interests, including an exploratory interface integrated with EOSC AAI (via its connection with ROHub). The new extended analytic services include: i) the challenge and solution extraction service, ii) the question generation service, iii) the claim analysis service, iv) the novelty scoring service and RELISH (RELIANCE Dashboard). ROhub integrates the latest release of the production services as added value services, whereas the integration of the extended analytics services will be carried out in the upcoming months. This KER is usable across different science disciplines, although in RELIANCE this is showcased in Earth Science via its communities in sea monitoring, geohazards and climate.

Links:

reliance.expertcustomers.ai

marketplace.eosc-portal.eu/services?providers=262

doi.org/10.5281/zenodo.6260513

Maturity: The text mining main services are operating as production services with TRLs 8 (recommendation) and 9 (enrichment, search). The services are operating in the service provider resources but might leverage resources from EOSC to store metadata generated (depending on the size of final datasets required in RELIANCE).

Exploitability: Operational service.

Sustainability: Text mining services require a maintained computing and storage infrastructure for their operation. The service provider (Expert.ai) is committed to maintaining the service after the end of the RELIANCE project, as part of its service portfolio. The sustainability of this KER is based on two main components: involvement as a partner in R&D initiatives (service costs are planned as part of the project lifecycle) and subscription fees for commercial users.

Internationalisation: The text mining services are already well received by scientists in Earth Science disciplines, particularly in those communities related to RELIANCE use cases, for enriching research objects and for obtaining recommendations of research objects. Nevertheless, they would benefit from wider international adoption, not only in other Earth Science disciplines but also in other scientific domains. This activity could make the text mining services an EOSC-recommended service and make them more internationally recognized. This would require collaboration with related initiatives like EOSC Future, but also the Open Geospatial Consortium (OGC) and European Geosciences Union (EGU).

KER #6 Research objects related to Earth Science

Category: Virtual Research Environment (VRE).

Description: RELIANCE has produced over 1,700 research objects related to Earth Science, aggregating over 7,000 resources. These include automatically generated research objects with unpublished materials or resources collected from existing services to make them fairer, as well as manually created research objects as part of the implementation of the use cases in RELIANCE by its communities in sea monitoring, geohazards and climate (see reliance.rohub.org/explore). Moreover, RELIANCE has produced over 120 data cubes enabling efficient access and reuse of Copernicus data, Third-Party Mission data and other relevant geospatial data (e.g., MODIS, SRTM, World Ocean Atlas, Ocean Color, etc.). These data cubes are accessible via (see D4.5 doi.org/10.5281/zenodo.6260659). These data cubes are usable and implemented in the Earth Science domain, and RELIANCE showcases them via its communities in sea monitoring, geohazards and climate change.

Link: reliance.adamplatform.eu

Maturity: Research objects will be generated until the end of the project as part of the implementation of the use cases in RELIANCE by its communities in sea monitoring, geohazards and climate change as well as from other communities onboarded via the RELIANCE open challenge. Similarly, data cubes will be generated until the end of the project as part of the implementation of the use cases in RELIANCE according to the needs of the communities mentioned above

Exploitability: Operational service.

Sustainability: The research objects created as part of the RELIANCE project are maintained in the ROHub platform, and the service provider (PSNC) is committed to maintaining the service after the end of the RELIANCE project, as part of its service portfolio (see KER3). Similarly, the data cubes created as part of the RELIANCE project are maintained in the ADAM platform, and the service provider (MEEO) is committed to maintaining the service after the end of the RELIANCE project, as part of its service portfolio (see KER4).

Internationalisation: Research objects are already well received by scientists in different disciplines, particularly in Earth Science, as the mechanism for managing and preserving their scientific outcomes. Nevertheless, they would benefit from the wider international acceptance, both by

Earth Science communities and by scholarly communication services. This activity could make research objects a standard approach for sharing, preserving and disseminating scientific outcomes, particularly in Earth Science disciplines, including their publication in scholarly communication services to be recognised contributions that can be cited and referenced. This would require collaboration with related initiatives, in particular, the research object community group (to which RELIANCE members already contribute) and others like EOSC Future and OpenAire. Similarly, data cubes are already well received by scientists in Earth Science, particularly in those communities related to RELIANCE use cases, as the mechanism for accessing and discovering EO data. Nevertheless, they would benefit from wider international adoption in other Earth Science disciplines. This activity could make data cubes a standard approach for accessing and discovering EO data, and become an EOSC recommendation. This would require collaboration with related initiatives like EOSC Future and the Open Geospatial Consortium (OGC) and European Geosciences Union (EGU).

Cos4Cloud

Co-designed Citizen Observatories Services for the EOS-Cloud – COS4CLOUD

Grant agreement ID: 863463

DOI: 10.3030/863463

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 5.999.055,75

EU contribution: € 5.999.055,75

Start date: 1 November 2019

End date: 28 February 2023

Coordinated by: Agencia Estatal Consejo Superior De Investigaciones Cientificas.

Brief description of the project: The EU-funded COS4CLOUD project aims to facilitate open science and citizen science initiatives by designing and implementing services using deep machine learning, automatic video recognition, and other cutting-edge technologies to make it easier for citizen science platforms to share data using improved networks in a user-friendly way.

Fields of science:
Natural Sciences > Biological Sciences > Ecology > Ecosystems.
Social Sciences > Political Sciences > Political Policies > Civil Society.
Natural Sciences > Computer and Information Sciences > Artificial Intelligence > Machine Learning.

Programme(s)
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.3. - Development, deployment and operation of ICT-based e-infrastructures.

Topic(s): INFRAEOSC-02-2019 - Prototyping new innovative services.

Sub call: H2020-INFRAEOSC-2019-1

Funding Scheme: RIA - Research and Innovation action.

Website: cos4cloud-eosc.eu

Cordis: cordis.europa.eu/project/id/863463

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation	✓				✓	✓
	1.2 Researcher Engagement and Adoption	✓	✓	✓	✓	✓	✓
	1.3 Rules of Participation Compliance Monitoring		✓			✓	✓
AG 2	2.1 FAIR Metrics and Data Quality	✓			✓	✓	
	2.2 Semantic Interoperability	✓			✓	✓	
AG 3	3.1 Data Stewardship Curricula and Career Paths					✓	
	3.2 Research Careers, Recognition, and Credit	✓	✓	✓	✓	✓	✓
	3.3 Upskilling Countries to Engage in EOSC	✓	✓	✓	✓	✓	✓
AG 4	4.1 AAI Architecture	✓					
	4.2 Infrastructure for Quality Research Software	✓			✓	✓	
	4.3 Technical Interoperability of Data and Services	✓		✓	✓	✓	
AG 5	5.1 Financial Sustainability						✓
	5.2 Long-term Data Preservation					✓	✓

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 Cos4Cloud services

Category: Technical Harmonisation.

Description: Cos4Cloud_services. 13 technological services codesigned - prototyped – published in the European Open Science Cloud (EOSC).

Link: Cos4Cloud Services – Cos4cloud (cos4cloud-eosc.eu) To get a general idea of the purpose, utility of the services and target users, Cos4Cloud has designed one infographic per service.

Maturity: TRL (7-9). The services are still under development as of 2022 and will be completed and published in the EOSC Marketplace by the project end-time (02/23).

Exploitability: Operational Service.

Sustainability: Most of the proposed services have already the platforms to ensure their sustainability after the project.

Internationalisation: Services are developed in the framework of the work package dedicated to standardisation, linking them to existing standards (or extending those standards according to the project needs).

KER #2 Co-design service platform for citizen observatories

Category: Technical Harmonisation.

Link: Co-design – Cos4cloud (cos4cloud-eosc.eu) Cos4Cloud has also developed an infographic to explain what co-design is using Cos4Cloud as a case study.

Description: Cos4Cloud_codesign, Methodological guide: co-design service platform for citizen observatories.

Maturity: The co-design method is already consolidated and has been used to co-design several services.

Exploitability: Operational service.

Sustainability: The co-design methodology will be one of the flagship products of one of the SMEs involved in the project (SfC). They will exploit it in new projects.

Internationalisation: Co-design methodologies are implemented in different frameworks and also with different involved international stakeholders.

KER #3 Training. Citizenscience toolbox and evidence hub

Category: Training Resource.

Description: Citizen-science toolbox and evidence hub: Training courses and material.

Maturity: The training is under development and will be completed and published in the EOSC Marketplace (as training material) by the project end-time (02/23).

Exploitability: Operational service.

Sustainability: The training outcomes will be supported in EOSC as shared products. One of the partners (Open University) will also maintain a platform to ensure their sustainability.

Internationalisation: Training is planned to reach a wide international audience.

KER #4 Do-It-Yourself guidelines for citizen observatories (CanAir.io and KdUINO)

Category: Technical Harmonisation.

Description: Do-It-Yourself guidelines for citizen observatories (CanAir.io and KdUINO).

Links: CanAirIO – Cos4cloud (cos4cloud-eosc.eu) & Kduino – Cos4cloud (cos4cloud-eosc.eu)

Maturity: The Do-It-Yourself guidelines are under development and will be completed and published in the EOSC Marketplace (as training material) by the project end-time (02/23).

Exploitability: Prototype.

Sustainability: DIY devices are offered as open hardware and software platforms (like Github), ensuring that the products will be available after the project.

Internationalisation: Do-It-Yourself devices are following open standards for communication, ensuring their internationalisation. There is a wide interest in the community to participate in such developments.

KER #5 Guidelines on best practice for building citizen observatories

Category: Training Resource.

Description: Guidelines on best practice for building citizen observatories.

Maturity: Guidelines on best practices for building citizen observatories are under development and will be completed and published in the EOSC Marketplace (as training material) by the project end-time (02/23).

Exploitability: Prototype.

Sustainability: The guidelines on best practices for building citizen observatories will be offered in EOSC and open

repositories (such as Zenodo).

Internationalisation: The guide will be available in an open and accessible format, also it will spread across communities or practices, as well as local, regional and international events.

KER #6 Sustainability

Category: Policy Harmonisation.

Description: Sustainability strategy for Cos4Cloud services in the EOSC-hub.

Maturity: The Sustainability Strategy for Cos4Cloud services are under development and will be completed and published in public repositories (Zenodo) by the project end-time (02/23).

Sustainability: The report on the sustainability strategy for Cos4Cloud services will be offered in EOSC and open repositories (such as Zenodo).

Related to the sustainability of the services, Cos4Cloud has also collaborated with the EOSC in these case studies publicly available in Zenodo:

- Connecting researchers, developers and citizen scientists in a unique mobile app environment
- Supporting knowledge creation and sharing by building a standardised interconnected repository of biodiversity data
- Supporting cross-disciplinary research in natural sciences

Internationalisation: Prototype.

INODE

Intelligent Open Data Exploration – INODE

Grant agreement ID: 863410

DOI: 10.3030/863410

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 5.732.000

EU contribution: € 5.732.000

Start date: 1 November 2019

End date: 30 April 2023

Coordinated by: Zurcher Hochschule Fur Angewandte Wissenschaften.

Brief description of the project: The EU-funded INODE project provides an end-to-end data exploration system that leverages machine learning and semantics to provide extensive access to open datasets through natural humanlike language queries in the fields of cancer biomarker research, research and innovation policy making and astrophysics.

Fields of science:
Natural Sciences > Physical Sciences > Astronomy > Astrophysics.
Engineering and Technology > Electrical Engineering, Electronic Engineering, Information Engineering.
Electronic engineering > Sensors.
Medical and health sciences > Clinical Medicine > Oncology.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.3. - Development, deployment and operation of ICT-based e-infrastructures.

Topic(s): INFRAEOSC-02-2019 - Prototyping new innovative services.

Sub call: H2020-INFRAEOSC-2019-1

Funding Scheme: RIA - Research and Innovation action.

Website: inode-project.eu

Cordis: cordis.europa.eu/project/id/863410

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation						
	1.2 Researcher Engagement and Adoption	✓	✓	✓	✓	✓	✓
	1.3 Rules of Participation Compliance Monitoring						
AG 2	2.1 FAIR Metrics and Data Quality	✓	✓	✓	✓	✓	✓
	2.2 Semantic Interoperability	✓	✓	✓	✓	✓	✓
AG 3	3.1 Data Stewardship Curricula and Career Paths						
	3.2 Research Careers, Recognition, and Credit					✓	✓
	3.3 Upskilling Countries to Engage in EOSC	✓					
AG 4	4.1 AAI Architecture						
	4.2 Infrastructure for Quality Research Software	✓	✓	✓	✓	✓	✓
	4.3 Technical Interoperability of Data and Services	✓	✓	✓	✓	✓	✓
AG 5	5.1 Financial Sustainability						
	5.2 Long-term Data Preservation	✓	✓	✓	✓	✓	✓

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 INODE system

Category: Virtual Research Environment (VRE).

Description: The INODE system enables end-users to explore complex data in natural language, with guiding operators and a visual interface. The goal is to interact with data in a human-like dialogue rather than using complex computer languages which are only mastered by a few technical experts. The system is generic and can be used for exploring the data of any domain stored in databases or in text documents. INODE uses state-of-the-art machine learning algorithms which can be trained using supervised and unsupervised approaches, to improve data exploration for new data domains that the INODE system has not seen previously.

Link: inode-project.eu/post/inode-vision-paper

Exploitability: Concept, plan, or demonstrator.

Maturity: The INODE system is still under development and will be completed by the project's end (April 2023). In particular, we are working on improving our machine learning algorithms such that the system learns how to better adapt to new databases and scientific domains that it has not seen before.

Sustainability: The INODE system requires data to be stored in relational databases or graph databases. Moreover, the INODE system needs to be hosted on servers with GPU access to provide access to the respective databases and INODE services. The main user community and infrastructure providers will maintain the databases and host the INODE systems after the project ends. For instance, some of our project partners such as the Swiss Institute of Bioinformatics or the Max Planck Institute have a long track record of supporting and maintaining research infrastructures and data resources. Hence, we will leverage existing best practices to make sure the INODE services and data sets will be available after the end of the INODE project.

Internationalisation: The INODE system enables querying complex databases in natural language, with guiding operators and visuals. Thus, INODE can directly leverage open data and metadata repositories after the initial adoption of our machine learning algorithms. Analysing data in natural language is currently active research by major companies such as Google, Meta, Microsoft, OpenAI etc. Being able to interact with data in a more human-like fashion will have a huge impact on how researchers and the public interact with data.

In summary, our community needs to work together to train and improve INODE's machine-learning algorithms for specific domains of scientific fields. The more INODE's services are used, the better the machine learning algorithms can learn and the easier it will be to access open data in an easy way.

INODE's approach does not even require standardised metadata repositories - which are often very difficult to achieve. Especially the commercial data warehousing industry, which aims at integrating hundreds and thousands of data sets within an enterprise, has shown that standardisation is a heroic goal but in practice hard to achieve. Hence, the philosophy of INODE is to apply its services to existing databases with rich ontologies (metadata) even if the metadata repositories are not standardised.

KER #2 INODE use cases

Category: Knowledge centre, Training Resource.

Description: The INODE Team applied the INODE system to three different use cases (EU policy research data, cancer research and astrophysics). The videos about the use cases have been used in various conferences, events and lectures to teach students, researchers and the interested audience about INODE and where it can be applied to enable scientific discovery and easy data exploration.

Link: inode-project.eu/use-cases

Exploitability: Operational service.

Maturity: Tthe INODE system is currently being applied to EU policy research data, cancer research and astrophysics. However, INODE is in contact with other use case providers and scientific disciplines to strengthen the system and adapt it for different domains.

KER #3 INODE Publications

Category: Knowledge centre.

Description: The INODE Team published papers and presented tutorials in prestigious database conferences and journals: ACM SIGMOD, IEEE ICDE, VLDB, Information Systems.

Exploitability: Operational service.

KER #4 Evaluation framework

Category: Validation Tool or Other.

Description: The INODE Team developed the first exhaustive evaluation framework that combines quantitative measures with qualitative user studies. This work has been accepted for publication at Human-In-the-Loop Data Analytics in conjunction with ACM SIGMOD 2022.

KER #5 Information extraction and data integration approach

Category: Technical Harmonisation.

Description: The INODE Team developed a novel approach for information extraction and data integration using linguistics- and learning-based algorithms. The work is published in Journal of Information Systems.

CS3MESH4EOSC

Interactive and agile/responsive sharing mesh of storage, data and applications for EOSC – CS3MESH4EOSC

Grant agreement ID: 863353

DOI: 10.3030/863353

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 5.956.696,25

EU contribution: € 5.858.571,25

Start date: 1 January 2020

End date: 30 June 2023

Coordinated by: Organisation Europeenne Pour La Recherche Nucleaire.

Brief description of the project: The project develops Science Mesh (sciencemesh.io) - a federated Enterprise file synchronization and sharing (EFSS) storage and cloud service infrastructure to boost collaborative research. Science Mesh allows research groups, scientists and engineers to collaborate, transfer and share data, including metadata annotations, in simple but powerful ways. Science Mesh is built from proven-sustainable building blocks which are used by the research communities and taps into already existing contributions from the member states. The goal of the project is to expose the Science Mesh service beyond the originating community (cs3community.org).

Fields of science: Multidisciplinary science.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.3. - Development, deployment and operation of ICT-based e-infrastructures.

Topic(s): INFRAEOSC-02-2019 - Prototyping new innovative services.

Sub call: H2020-INFRAEOSC-2019-1

Funding Scheme: RIA - Research and Innovation action.

Website: cs3mesh4eosc.eu

Cordis: cordis.europa.eu/project/id/863353

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation				✓		
	1.2 Researcher Engagement and Adoption			✓	✓		
	1.3 Rules of Participation Compliance Monitoring						
AG 2	2.1 FAIR Metrics and Data Quality				✓		
	2.2 Semantic Interoperability	✓			✓		
AG 3	3.1 Data Stewardship Curricula and Career Paths						
	3.2 Research Careers, Recognition, and Credit						
	3.3 Upskilling Countries to Engage in EOSC		✓				
AG 4	4.1 AAI Architecture						
	4.2 Infrastructure for Quality Research Software		✓	✓	✓	✓	✓
	4.3 Technical Interoperability of Data and Services	✓	✓		✓		✓
AG 5	5.1 Financial Sustainability		✓				
	5.2 Long-term Data Preservation						✓

AG1: Implementation of EOSC | AG2: Metadata and data quality | AG3: Research careers and curricula
AG4: Technical challenges on EOSC | AG5: Sustaining EOSC

KER #1 Interoperability standards portfolio and toolbox for Enterprise file synchronisation and sharing (EFSS) storage and application services

Category: Technical Harmonisation.

Description: The project produces and maintains a set of standard interoperable protocols and APIs for the EFSS services ecosystem. This is achieved by integrating the existing, de-facto standards and developing new ones if necessary for the EOSC use cases and by providing a supporting environment "toolbox" (reference implementations, connectors, compatibility matrix tests etc). Major European open-source EFSS platforms are supported. Examples: OCM (Open Cloud Mesh API) allows to federate, share and re-use data stored in distributed EFSS storage services (such as Owncloud, Nextcloud, CERNBox and others). CS3APIs allow interconnecting storage and application services. Webdav is used as the default data access protocol. WOPI is adopted as the industry standard to connect collaborative editing applications in a hybrid cloud environment.

Maturity: TRL 8, expected TRL 9 (by the end of the project).

Exploitability: Operational service.

Sustainability: We expect the bulk of the activity to be sustained by the CS3 community (cs3community.org) in collaboration with the EFSS vendors. Some common aspects may be handled by the Science Mesh governance in the future.

Internationalisation: It would be interesting to further progress the developed interoperability standards for wider industry uptake beyond the EFSS market as they may have a wider potential remit. Additional interoperability demonstrators based on CS3MESH4EOSC are currently in preparation (for example between Science Mesh services and EGI services).

KER #2 Science Mesh federated e-infrastructure for collaborative research

Category: Discovery/Access Platform, Virtual Research Environment (VRE).

Description: Science Mesh – federated e-infrastructure for collaborative research (sciencemesh.io). Science Mesh allows current and future users of the EFSS services (cs3community.org), and EOSC users at large, to easily share data across the federation, transparently crossing institutional and disciplinary research boundaries. In addition, Science Mesh provides a platform to integrate collaborative research workflows (CRWs), which broadly support all phases of the research data lifecycle, with the EFSS services. CRWs are provided as ready-to-use packages deployable on top of the Science Mesh reference platform by each site independently. Science Mesh is an open system and has developed procedures to add new sites beyond the original project consortium members. Modalities on how to integrate Science Mesh into EOSC are currently being discussed (EOSC Exchange, Horizontal Services, etc.).

Link: sciencemesh.io

Maturity: TRL 7, expected TRL 9 (by the end of the project).

Exploitability: Operational service.

Sustainability: All participating Science Mesh sites are already sustainable and operate autonomously. Sustainability plans for the minimal common infrastructure have been developed by the project. They assume that a Science Mesh governance body will be created and sustained by participants. Other modes of achieving sustainability of the central components by integrating them into EOSC infrastructure layers are also considered.

Internationalisation: Harmonisation with EOSC Core and EOSC Exchange service offerings. "Connecting the dots" with ERICs and possible future EDICS.

KER #3 Web-based Distributed Analysis Environments CRW

Category: Virtual Research Environment (VRE).

Description: Web-based Distributed Analysis Environments CRW addresses the interactive data analysis, interactive exploration and ease-of-use by combining Jupyter Notebook interfaces with access to complex data, compute and rich software environments, and the sync and share capabilities of the EFSS systems. Production-grade turnkey services include JRC's Big Data Analytics Platform for Geospatial Data and CERN's SWAN platform for High Energy Physics Data Analysis and machine learning (ML) applications.

Maturity: TRL 9.

Exploitability: Operational service.

Sustainability: SaaS provision to end-users is self-sustainable. Evolution of the software layers to be sustained as a community effort in collaboration with the EFSS vendors.

Internationalisation: Harmonisation with EOSC Core and EOSC Exchange service offerings. "Connecting the dots" with ERICs and possible future EDICS.

KER #4 Open Data Systems CRW

Category: Virtual Research Environment (VRE), Technical Harmonisation.

Description: Open Data Systems CRW addresses the problem of FAIR metadata annotation in the early phases of research as well as enabling other metadata-aware workflows and achieving a consistent view and interoperability with digital repositories via metadata packaging and description standards such as RO-Crate. Interactive GUI integrated with the research workspace based on EFSS is the focal point for these interactions. Production-grade components and services integrated with EFSS ecosystem include: Sciebo Research Data Services (RDS), Zenodo and Invenio RDM, Describo RO-Crate editor.

Maturity: TRL 7, expected TRL 9 (by the end of the project).

Exploitability: Operational service.

Sustainability: SaaS provision to end-users is self-sustainable. Evolution of the software layers to be sustained as a community effort in collaboration with the EFSS vendors.

Internationalisation: KER4 would benefit from EOSC at large standardising on RO-Crates as their research object standard. Harmonisation with EOSC Core and EOSC Exchange service offerings. "Connecting the dots" with ERICs and possible future EDICS.

KER #5 Collaborative Documents CRW

Category: Virtual Research Environment (VRE).

Description: Collaborative document editing CRW enables researchers to keep documents close to data, code and other files in a single research workspace and to store these documents locally, without the need to export them to untrusted external clouds. Production-grade components include EFSS integration with Collabora, Only Office and Microsoft Office 365.

Maturity: TRL 9.

Exploitability: Operational service.

Sustainability: SaaS provision to end-users is self-sustainable. Evolution of the software layers to be sustained as a community effort in collaboration with the EFSS vendors.

Internationalisation: Harmonisation with EOSC Core and EOSC Exchange service offerings. "Connecting the dots" with ERICs and possible future EDICS.

KER #6 On-demand Data Transfers CRW

Category: Virtual Research Environment (VRE), Technical Harmonisation.

Description: On-demand data transfers CRW address the problem of transferring large datasets between nodes in Science Mesh and between Science Mesh and external storage services. This workflow handles the distribution of large datasets in wide area networks, ensuring the locality of datasets for data-intensive processing, data analytics and other workflows that require low-latency access to data. Two operational modes are possible: 1) point-to-point transfers directly integrated into EFSS GUI for ad-hoc use cases based on rClone toolkit 2) orchestrated transfers handled by existing large-scale data distribution systems used by large research collaborations on a global scale for use cases which require full integration with data management systems already in use by research collaborations (such as FTS or RUCIO services).

Maturity: TRL 6, expected TRL9 (by the end of the project).

Exploitability: Prototype.

Sustainability: SaaS provision to end-users is self-sustainable. Evolution of the software layers to be sustained as a community effort in collaboration with the EFSS vendors.

Internationalisation: KER6 would be helped if an EOSC-wide standard on data transfers were adopted that KER6 could abide by. Other efforts include harmonisation with EOSC Core and EOSC Exchange service offerings and "Connecting the dots" with ERICs and possible future EDICS.

NEANIAS

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

Grant agreement ID: 863448

DOI: 10.3030/863448

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 5.597.025

EU contribution: € 5.597.025

Start date: 1 November 2019

End date: 31 October 2022

Coordinated by: Ethniko Kai Kapodistriako Panepistimio Athinon.

Brief description of the project: The EU-funded NEANIAS project aims to co-design, deliver and integrate innovative access, collaboration and interdisciplinary research services for the underwater, atmospheric, and space research communities into the EOSC to address these communities' needs in line with open science principles.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.3. - Development, deployment and operation of ICT-based e-infrastructures.

Topic(s): INFRAEOSC-02-2019 - Prototyping new innovative services.

Sub call: H2020-INFRAEOSC-2019-1

Funding Scheme: RIA - Research and Innovation action.

Website: neanias.eu

Cordis: cordis.europa.eu/project/id/863448

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation						
	1.2 Researcher Engagement and Adoption	✓	✓	✓			
	1.3 Rules of Participation Compliance Monitoring						
AG 2	2.1 FAIR Metrics and Data Quality	✓	✓	✓			
	2.2 Semantic Interoperability						
AG 3	3.1 Data Stewardship Curricula and Career Paths						
	3.2 Research Careers, Recognition, and Credit	✓	✓	✓			
	3.3 Upskilling Countries to Engage in EOSC	✓	✓	✓			
AG 4	4.1 AAI Architecture						
	4.2 Infrastructure for Quality Research Software						
	4.3 Technical Interoperability of Data and Services	✓	✓	✓			
AG 5	5.1 Financial Sustainability	✓	✓	✓			
	5.2 Long-term Data Preservation						

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 EOSC Services for underwater related studies and engineering tasks

Category: Virtual Research Environment (VRE).

Description: The NEANIAS Project has been developing and onboarding a set of innovative cross-cutting services to EOSC for tackling operationally underwater-related studies and engineering tasks including bathymetry mapping from acoustic data service, seafloor mosaicing from optical data service, and seabed classification from multispectral, multibeam data service. These services are engaging and onboarding a wide range of user communities linked to the underwater environment to EOSC including archaeologists, geologists, oil and gas energy engineers, marine robotics, submarine geohazards, and insurance.

Maturity: The NEANIAS services being developed will be operational services (category C), many of which will be onboarded to EOSC. At present, NEANIAS has 11 services already onboarded. The project end-time is 10/22.

Sustainability: The NEANIAS Project is in the process of developing a sustainability plan. One important and key challenge that would be useful to be considered for the future of EOSC and services that run on EOSC is the development of 'mobile' services. For example, if a user has a large set of data, have the service come to the data, rather than the user having to upload data sets to the infrastructure where the service is being hosted. This is a technical challenge that would go a long way towards the future of EOSC.

KER #2 EOSC Services for space-related studies

Category: Technical Harmonisation.

Description: The NEANIAS Project has been developing and onboarding a set of innovative cross-cutting services to EOSC for tackling operationally space-related studies. These are to be exploited as a springboard of operational tools for space communities including services in FAIR data management and visualisation, map-making and mosaicing of multidimensional space images, and structure detection on large scale maps with machine learning. These services are engaging a wide range of user communities including astrophysicists, planetary scientists, planetary mining engineers, planetary robotics, mobile telecommunication, and space weather experts.

Exploitability: Operational service.

Sustainability: See KER #1 EOSC Services for underwater related studies and engineering tasks.

KER #3 EOSC Services for atmospheric-related studies

Category: Technical Harmonisation.

Description: The NEANIAS Project has been developing and onboarding a set of innovative cross-cutting services for tackling operationally atmospheric-related studies and engineering tasks to EOSC. This includes a greenhouse gases flux density monitoring service, an atmospheric perturbations and components monitoring service, and an air quality estimation, monitoring and forecasting service. These services are engaging and onboarding to EOSC a wide range of user communities linked to the atmosphere including meteorologists, industrial air pollutant emitters, ecologists, rural-urban planners and air quality authorities, geohazards, civil protection, insurance, and health agencies.

Sustainability: See KER #1 EOSC Services for underwater related studies and engineering tasks.

TRIPLE

Transforming Research through Innovative Practices for Linked interdisciplinary Exploration – TRIPLE

Grant agreement ID: 863420

DOI: 10.3030/863420

Funded under: EXCELLENT SCIENCE - Research Infrastructures.

Total cost: € 5.626.555

EU contribution: € 5.626.548,75

Start date: 1 October 2019

End date: 31 March 2023

Coordinated by: Centre National De La Recherche Scientifique CNRS.

Brief description of the project: The EU-funded TRIPLE project made it easier for researchers to discover and reuse social sciences and humanities (SSH) research data and to embark on interdisciplinary collaboration initiatives, improving our assessment of and response to complex societal issues.

Triple
Transforming Research through Innovative Practices for Linked Interdisciplinary Exploration

Fields of science: Humanities Social Sciences.

Programme(s):
H2020-EU.1.4. - EXCELLENT SCIENCE - Research Infrastructures.
H2020-EU.1.4.1.3. - Development, deployment and operation of ICT-based e-infrastructures.

Topic(s): INFRAEOSC-02-2019 - Prototyping new innovative services.

Sub call: H2020-INFRAEOSC-2019-1

Funding Scheme: RIA - Research and Innovation action.

Website: project.gotriple.eu

Cordis: cordis.europa.eu/project/id/863420

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation			✓			
	1.2 Researcher Engagement and Adoption	✓				✓	
	1.3 Rules of Participation Compliance Monitoring		✓			✓	
AG 2	2.1 FAIR Metrics and Data Quality		✓	✓	✓	✓	
	2.2 Semantic Interoperability	✓	✓	✓	✓	✓	
AG 3	3.1 Data Stewardship Curricula and Career Paths		✓	✓			
	3.2 Research Careers, Recognition, and Credit	✓				✓	
	3.3 Upskilling Countries to Engage in EOSC						
AG 4	4.1 AAI Architecture	✓					
	4.2 Infrastructure for Quality Research Software						
	4.3 Technical Interoperability of Data and Services	✓	✓	✓	✓	✓	
AG 5	5.1 Financial Sustainability						
	5.2 Long-term Data Preservation		✓				

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 Discovery platform for SSH resources

Category: Discovery/Access Platform.
Description: GoTRIPLE is a multilingual and multi-cultural discovery solution for the social sciences and humanities field (SSH).
Based on the Isidore search engine developed by the French National Centre for Scientific Research (CNRS), GoTriple (currently in Beta) provides a single access point for users (researchers, institutions such as universities and libraries, but also enterprises and the media). It offers the ability to:

- Discover and reuse open scholarly SSH resources in 11 European languages, i.e., research data and publications, which are currently scattered across local repositories.
- Find and connect with other researchers and projects across disciplinary and language boundaries.
- Make use of innovative tools to support research (e.g., visualisation, annotation, trust building and recommender system).
- Discover new ways of funding research (e.g., crowdfunding).

The core of the GoTriple platform is mainly a "pipeline" where data are ingested, classified, enriched and categorised so they can be easily found and retrieved by the users.

The platform increases visibility and quality of SSH research through an easier and better SSH-focused research platform.

GoTriple facilitates more efficient and effective SSH research for societies at large by involving civil society, public institutions and companies into scientific projects, thus strengthening the links between different types of stakeholders. Non open access sources are not displayed first and get marked as not open access.

Link: gotriple.eu

Maturity: TRL8.

Exploitability: Operational service.

Sustainability: Dedicated governance and business model are currently being developed. A memorandum of understanding (MoU) is being drafted for how the individual partners will continue to coordinate and sustain the overall service, along with Operational Level Agreements (OLAs) with the individual service component providers to maintain and evolve the technical aspects of the service, which is aimed to be in place prior to the end of the project. The Research Infrastructure OPERAS will lead the partners involved in the platform and support its maintenance and provide the legal, administrative and organisational sustainability for the service.

KER #2 Multilingual Vocabulary Service

Category: Technical Harmonisation.

Description: The solution is a publicly available SSH vocabulary, published in an open format (e.g. SKOS) - "open science savvy" - Vocabulary data are downloadable as XML or Json file - future possibilities include: API - for automatic integration in digital environments to enable dynamic translation and classification. The multilingual vocabulary is scalable and may be developed further in the future as the classifications expand. The vocabulary covers 11 different languages by now but is expandable to other languages. This is relatively easy because the structure already exists and therefore a native speaker can enrich this structure with his/her language. It can be integrated in various different types of platforms (via Json/database file import or more dynamically by using the API that will be developed). The methodology of the classification process is unique: algorithms for automatic classification and translation and human-curated classification and translation.

Maturity: TRL8.

Exploitability: Operational service.

Sustainability: This aspect is part of the global governance model. However, as there is a need for regular updates to maintain it, the costs have still to be defined, but are currently being collected and analysed as part of the overall service cost analysis, which is being taken into consideration for the sustainability of the platform.

Internationalisation: A very important need for standardisation to have efficient and useful vocabularies (and updated). For the moment, 11 languages have been targeted but more can be added. This work is very valuable to increase the impact and foster the reuse of research for the SSH communities worldwide.

KER #3 SSH corpus for Machine Learning Training

Category: Training Resource.

Description: Constitution of a training textual dataset of SSH sources that can be reused for training machine learning and artificial intelligence tasks. This corpus covers each one of the 27 SSH disciplines identified in TRIPLE. It is a multilingual set covering 11 European languages: This corpus currently comprises more than 250,000 documents and has been tested in production for the implementation of the automatic classification service in GoTriple.

Maturity: TRL8.

Exploitability: Operational service.

Sustainability: This aspect is part of the global governance model. However, as there is a need for regular updates to maintain it, the costs have still to be defined, but are currently

being collected and analysed as part of the overall service cost analysis, which is being taken into consideration for the sustainability of the platform.

Internationalisation: A very important need for standardisation to have updated databases. It is hard work to create training databases in each language and for each discipline and the output is very valuable for the SSH communities in the world but also for translation companies or institutions.

KER #4 FAIR Metadata schema

Category: Validation Tool or Other.

Description: The FAIR Metadata schema is a reference data model for describing research documents, projects, authors and research profiles of the SSH community and beyond. It is based on a standard and well-known ontology such as schema.org. It provides linking with the TRIPLE vocabulary concepts. Before the end of the project, it will be formally described through a machine-readable standard ontology, paving the way to publish GoTriple data (and possibly all services reusing it) as linked data.

Maturity: TRL8.

Exploitability: Operational service.

Sustainability: This aspect is part of the global governance model. However, as there is a need for regular updates to maintain it, the costs have still to be defined, but are currently being collected and analysed as part of the overall service cost analysis, which is being taken into consideration for the sustainability of the platform.

Internationalisation: Standardisation is relevant but interoperability as well with other metadata schema for other disciplines.

KER #5 TRIPLE Open Science Training Series

Category: Training Resource.

Description: A series of 12 online training events on open science and the EOSC to support the uptake of open research practices. The training and the related materials are made available in Open Access to the SSH community (on Zenodo).

Maturity: TRL8.

Exploitability: Operational service.

Sustainability: This KER is finalised and no further costs are envisioned.

Internationalisation: Training on OS skills and knowledge is very diverse and maybe there are too many. Best practices on the development of training material are important but standardisation probably not so much, from this perspective. However, being able to identify the right one to answer the right question becomes more and more of a challenge.

KER #6 TRIPLE Training ToolkitKER

Category: Training Resource.

Description: The TRIPLE Training Toolkit is an open and reusable workflow to design and deliver training events that follow the FAIR principles and to publish training materials as OERs. It contains reproducible files to help trainers minimise the time they spend in the design and delivery of FAIR training events and supports them in addressing the frequent findability and reusability issues related to the management of digital training resources. To facilitate the uptake of the FAIR-by-design method, the Toolkit comes with a step-by-step illustration of the user journey.

Maturity: TRL8.

Exploitability: Operational service.

Sustainability: This KER is finalised and no further costs are envisioned.

Internationalisation: No geographical limitation.

ARCHIVER

Archiving and Preservation for Research Environments – ARCHIVER

Grant agreement ID: 824516

DOI: 10.3030/824516

Start date: 1 January 2019

End date: 30 June 2022

Funded under: INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT).

Total cost: € 4.886.575,25

EU contribution: € 4.397.917,73

Coordinated by: Organisation Europeenne Pour La Recherche Nucleaire

Project description: The H2020 co-funded pre-commercial procurement ARCHIVER project combines multiple ICT technologies and business models in a hybrid cloud environment to deliver end-to-end archival and preservation services that are EOSC-ready and cover the full research lifecycle for multiple research domains. ARCHIVER has been awarded for Collaboration and Cooperation by the Digital Preservation Coalition to celebrate its collaboration across institutional, professional, sectoral and geographical boundaries which has had a demonstrable and positive impact on digital preservation.

Fields of science:
Natural Sciences > Computer And Information Sciences > Software.
Social Sciences > Economics And Business > Business And Management > Business Models.
Natural Sciences > Biological Sciences > Ecology > Ecosystems.

Programme(s): H2020-EU.2.1.1. - INDUSTRIAL LEADERSHIP - Leadership in enabling and industrial technologies - Information and Communication Technologies (ICT).

Topic(s): ICT-34-2018-2019 - Pre-Commercial Procurement open.

Sub call: H2020-ICT-2018-2

Funding Scheme: PCP - Pre-Commercial Procurement.

Website: archiver-project.eu

Cordis: cordis.europa.eu/project/id/824516

Relevance of the KERs to the EOSC Advisory Groups (AGs) and Task Forces (TFs)

AG	Task Force	KER #1	KER #2	KER #3	KER #4	KER #5	KER #6
AG 1	1.1 PID Policy and Implementation						
	1.2 Researcher Engagement and Adoption						
	1.3 Rules of Participation Compliance Monitoring						
AG 2	2.1 FAIR Metrics and Data Quality	✓	✓	✓			
	2.2 Semantic Interoperability						
AG 3	3.1 Data Stewardship Curricula and Career Paths			✓			
	3.2 Research Careers, Recognition, and Credit						
	3.3 Upskilling Countries to Engage in EOSC						
AG 4	4.1 AAI Architecture			✓			
	4.2 Infrastructure for Quality Research Software	✓	✓	✓			
	4.3 Technical Interoperability of Data and Services	✓	✓	✓			
AG 5	5.1 Financial Sustainability	✓	✓	✓			
	5.2 Long-term Data Preservation	✓	✓	✓			

AG1: Implementation of EOSC	AG2: Metadata and data quality	AG3: Research careers and curricula
AG4: Technical challenges on EOSC	AG5: Sustaining EOSC	

KER #1 LABDRIVE, the ultimate Research Data Management and Digital Preservation platform

Category: Technical Harmonisation.

Description: LABDRIVE is a Research Data Management and Digital Preservation platform that focuses on scientific datasets. LABDRIVE allows organizations to transition from a siloed approach in which each series of datasets, departments or units are using multiple, disaggregated systems to keep content to a single repository that can adapt to the particularities of each dataset, unifying all content in a single platform. The platform works for all organizations from those with a few gigabytes of data, to those managing several petabytes. Digital preservation principles always present: Data protection comes first. Fully aligned with OAIS, ISO16363, redundant checks and safe processes.

Maturity: (TRL 9). Actual system proven in operational environment LABDRIVE is a platform successfully tested in a real environment, as it is already commercialised and being used by customers in both Europe and the United States.

Exploitability: Operational service.

Sustainability: Given the traditional definition of Sustainability of a project when it continues to deliver benefits to the participants for an extended period after the formal closure, Digital Preservation is conceptually a model for long-term planning and execution, that is, extending beyond the actual project. LIBNOVA's current experience dates back to many years with a consistent business model, that has been enriched, but without major changes. Even incorporating new sectors or new technologies, the business model has been resilient, as proven by long-term customers who renew their subscription and increase services year after year. ARCHIVER continues to deliver for LIBNOVA.

Internationalisation: Due to historical reasons, LIBNOVA has been focused on Europe, North America (USA, Canada, Mexico), and South & Central America. With the extra push from ARCHIVER, LIBNOVA have increase presence in South East Asia and Africa, as well as Australia joining recently, although this is relatively small compared to the other geographies. Several customers both in Europe (University of Oxford) and in the USA (University of New Mexico, and others experimenting - Stanford University) are already using LABDRIVE.

KER #2 Arkivum: Petabyte scale digital preservation, guaranteeing the long-term use of scientific research data

Category: Technical Harmonisation.

Description: Arkivum is an innovative new SaaS solution for archiving, preserving and accessing vast and hugely valuable scientific datasets from disciplines that include astronomy, particle physics, genomics and more. The solution has been purpose built to archive and preserve up to petabyte scale datasets in the most cost-effective and environmentally stable way.

Maturity: The R&D work conducted as part of the ARCHIVER project has been incorporated into the core Arkivum solution and is being actively used by Arkivum's customer base.

The solution is therefore market ready and available today including the EOSC marketplace. Available here: marketplace.eosc-portal.eu/services/arkivum-digital-archiving-and-preservation-solution.

Exploitability: Operational service.

Sustainability: There is a strong and growing market for digital preservation services, not just within the scientific research community, but further afield as well in related areas. For example, a major growth area for Arkivum's business is within the Pharmaceutical sector for GxP data. Arkivum's solution and services have already been used for research data management for nearly a decade, for example by research institutes and Higher Education Institutions.

The product developed as part of the ARCHIVER project, and the supporting business model, will ensure a strong foundation for extending this with environmentally sustainable and cost-effective services long into the future for both the European research community, as well as other sectors. Arkivum supports organisations with long-term sustainability of their data through additional tools and services. This includes:

cost calculators for the long-term total cost of ownership of preserving and accessing their content.

carbon footprint projections for helping to achieve environmental sustainability.

and detailed descriptions of how the Arkivum solution follows internationally recognised digital preservation and trusted digital repository good practice and standards, including the NDSA Levels of Preservation, DPC RAM, the FAIR principles and CoreTrustSeal.

Internationalisation: Arkivum has successfully delivered digital preservation services in Europe, North America, South America and Africa across a range of different sectors, including Scientific Research, Pharmaceutical, Life Sciences, Higher Education and Heritage organisations. As part of the post-ARCHIVER commercialisation efforts, the solution is being actively promoted to an international audience, with a focus on Europe and North America. The solution can be deployed on AWS, GCP or on-premise and in line with customers' data sovereignty requirements.

KER #3 ARCHIVER Test Suite for EOSC services validation

Category: Technical Harmonisation.

Description: This tool is intended to be used to test and validate commercial cloud services across the stack for research and education environments and it is being used as a validation tool for commercial cloud services procurement in European Commission sponsored projects such as OCRE, ARCHIVER and CloudBank EU.

Maturity: TRL 8. The EOSC Test Validation Suite was successfully used to run tests in cloud platforms in ARCHIVER and in most of those present in the OCRE framework contracts. The architectural approach is based on using widely adopted free and open technologies such as Terraform and Kubernetes. When validating commercial providers, the Test Suite is instrumental in the execution of exit strategies from commercial providers to avoid vendor lock-ins.

The development of the EOSC Test Suite benefited not only from activities as part of the Research and Development (R&D) of pre-commercial procurement projects such as ARCHIVER but also from transatlantic experiments for cloud consumption tracking and optimisation such as the CloudBank EU Next Generation Internet (NGI) project.

Exploitability: Operational service.

Sustainability: The Test Suite can be a substantial contribution to EOSC, and, as such, CERN has developed a service operation model for the Test Suite in the scope of the EOSC (see OCRE deliverable D.4.5 "Test Suite Roadmap") to ensure a model beyond the lifetime of the project where it has been used. The EOSC FUTURE project already foresees mature service provision as part of the EOSC architecture description covering aspects such as computing platforms, AAI, data processing, data archives, and digital repositories compliance, that can make use of a future Test Suite service.

The Test Suite evolution roadmap is also aligned with the feedback received by a number of parties including the EC review panel concerning the hand-over of project outputs after the end of the project. As the EOSC Test Validation Suite evolves, its applicability also potentially expands to validate the functionality of publicly funded services, contributing to ensuring the EOSC core services are aligned with requirements, and providing the ability to validate and differentiate capabilities of the EOSC Exchange service providers.

Internationalisation: The Test Suite would also provide working examples of deployments that can be replicated and provide a verification means for informed decision making on service choices, facilitate service adoption, and encourage a level playing field across EOSC service providers.

The Test Suite could be used to validate the phased releases of the EOSC core services foreseen in the EOSC Future project's roadmap, for example, to validate access of PaNOSC users to ESCAPE resources using PaNOSC IDs as foreseen in the Phase I release, or, for the validation of commercial resources or high-performance computing resources (e.g., from EuroHPC) for researchers as foreseen in the Phase III release.

5. Discussion and conclusions

The information supplied by the projects is of excellent quality and an evidence of the effort sustained by the projects, on a completely voluntary basis, in relaying their achievements and reflecting on the potential avenues for their results to be further utilised. The different axes of investigation of this survey - starting with the description of the EOSC-relevant KERs, including their maturity and exploitabilty, and then enquirying about their relevance to the EOSC-Task Forces, their sustainability potential, their needs and implemented measures in terms of internationalisation - will allow the envisaged actions of coordination, collaboration, communication and dissemination support, which the EOSC Association envisages to deliver as part of their mission, now also under the mandate of these very recent project activties.

Science is a global endeavour, and collaboration is a necessary and a recognised part of the EOSC activities. Collaboration, in this context, means an active reciprocal engagement among community representatives, within as well as outside of the European research area, enhancing the visibility, the harmonisation of approaches, the potential uptake and further development of the projects KERs and other deliverables.

Engaging in broad collaboration may be complicated for some of the projects, who are often deeply connected to the specificities of their context, and possibly aimed at rather internal interoperability issues and service provision, rather than on engaging the global scientific community. Exploitation plans and provisions, industry engagement and internationalisation measures are often developed late in the project and they hardly represent a development measure. On the other hand, all these elements can be considered as most relevant dimensions along which a KER sustainability can be articulated and supported, conducive to a number of positive outcomes, such as:

Higher quality, usability and uptake:

Collaboration exposes the KERs to much wider user communities, with new challenges and wider testing for applicability and, potentially, interoperability. This kind of exposure can identify similar frameworks amongst the KERs (e.g. catalogues, training resources) and push for alignments, making the KERs more usable at the European level as well as internationally. In some cases, this kind of collaboration can also lead to practical or even formal standardisation of solutions, which can in turn foster a higher uptake, outside the reference community as well as internationally.

Cross-fertilisation:

If the engagement is done in interdisciplinary environment, the KERs can be also used to cross-fertilise between the domains and escape the community silos, both in scientific and technical senses. Collaboration is not the only way such cross-fertilisation can happen, but some of the community engagement tools available are, by nature, cross-diciplinary or domain agnostic, making such advances more likely.

Maintenance and further development:

Other parties can contribute to development and maintenance of the KERs, as well as provide additional users. This wider acceptance can then increase further the uptake, users, and furthering the long term sustainability of the results.

The EOSC Association is indeed already responding to the challenge of providing a truly collaborative environment for its members. At the time of writing, the EOSC Association is in fact implementing the realisation of a number of avenues for collaboration, exchange and critical thinking, through a series of both physical and virtual communication and dissemination fora and initiatives, some of which will have a continuous presence in the community, also responding to the projects' articulation the community's expectation on the EOSC Association:

EOSC FORUM:

The EOSC FORUM is the web-based EOSC-community platform designed, implemented and sustained by the EOSC Association, that enables a more efficient and interactive tool for joint activities, exchange of information and networking among its members; thematic groups are being formed and members individually onboarded to the relevant sections.

Joint EOSC Association - Science Clusters operational working group:

A proposition by the EOSC Association Board of Directors, based on preliminary actions and meetings, was put forward to establish a pattern of regular meetings between representatives of the EOSC Association Board of Directors (BoD) and representatives of the Horizon2020 Science Clusters (SCs); the aim is to strenghten the collaborations and capture drivers and barriers, ultimately to facilitate the participation and visibility of all established and emerging ESFRI RIs in the EOSC.

EOSC Task Forces:

The 13 EOSC Task Forces address the key areas of the path towards a fully functioning EOSC; the Task Forces identify strategic components, possible gaps and opportunities towards realising the ambition of EOSC; the Task Forces provided their input the next versions of the SRIA, that in turn is used by the European Commission in their comitology process to feed into future Work Programmes.

Vademecum: A Handbook for Effective Collaboration within the EOSC Co-Programmed Partnership[1].

EOSC Association Strategy Working Group:

Responding to the community's inspirational vision statements and descriptions of the Association's role within the community, the Association has engaged the Board of Directors in the establishment of the EOSC Association Strategy Working Group.

While it is extremely promising that many of the KERs have been listed with some level of international collaboration, and a few examples exist of projects that addressed this aspect in the project design phase, a number of projects are evidently challenged with the timing and the resources required. While the use of own international connections is extremely useful and should be encouraged, using the RDA platforms could bring additional cross-pollination and widen the technological and social toolset available for the KERs international exploitation. Overall, the use of RDA in these context could be an easy and existing pathway, especially if it could be taken into account already during project and KER development.

Industry engagement also remains desireable but largely unplanned. Allies in this respect can be found in existing European-level initiatives, such as the European Network for Resarch Infrastructures and Industry Collaboration - ENRIITC[2] while regional intiatives can also be of relevance for more localised efforts.

Some clear areas of potential activity for the EOSC Association emerge with respect to the need for supportive actions aimed at the specific internationalisation and industry engament dimensions.

1 "Vademecum: A Handbook for Effective Collaboration within the EOSC Co-Programmed Partnership", available at: : https://eosc.eu/sites/default/files/2022-10/Vademecum_HE_EOSC-related_Projects.pdf?utm_source=newsletter&utm_medium=email&utm_campaign=20221004_october

2 www.ENRIITC.eu

6. Recommendations

It is recommended that this report is disseminated to the European Commission's EOSC-relevant Directorates and related Units, as well as to the European Research Executive Agency; to the EOSC Task Forces; to the newly awarded HE project coordinators and consortia; to Research Data Alliance members; and: to any other stakeholders who could be players in enhancing the exploitation or exploitability of the reported KERs.

The EOSC Association shall continue its role of bridging the various initiatives and provide avenues for increased communication to foster a collaborative environment where exchanges will proliferate and critical mass for thinking can be achieved, as well as forces can be brought together to create novel initiatives. A living exercise of mapping how these KERs can go into the future and link to new projects and existing or novel initiatives can be envisaged, especially through the involvement of the above mentioned stakeholders and defining the EOSC implementation gap areas, which could be brought forward through the SRIA agenda updates.

The still running H2020 projects as well as the newly awarded Horizon Europe projects are encouraged to utilise the pathways created by the EOSC Association, as wells as joint actions between the projects, the EOSC Association and RDA, to the fullest extent and participate to the creation of a culture of collaboration, cross-pollination, exchange, exportability, quality production and re-use, that will realise the fundamentals of EOSC.

7. Annex One – The H2020 EOSC-related Project survey questionnaire

The EOSC Association Board meets ongoing Horizon 2020 INFRA-EOSC Project

Q1: Major Output

What would you consider the most important Outputs (deliverables, standards, policy templates, tools, infrastructure, services, etc.) from your project?

List **up to six** major outputs which have any of the following aspects:

- They are connected to the EOSC interoperability framework:
- They are directly usable by EOSC TASK FORCES in their work
- They have a high disciplinary or multidisciplinary importance to engage major user communities in the EOSC
- They are of direct use to EOSC user communities in their engagement to EOSC.
- They contribute towards achieving the SRIA objectives and an operational EOSC infrastructure.

Motivation: *EOSC Association is looking for Outputs which could be directly usable for the EOSC development in the current and next phases of the initiative. This does not imply that other outputs would be of less value.*

Example of a type of answer: *We developed a widely approved community metadata standards in discipline XX (link to deliverable), which is usable/implemented across the YY fields of science.*

Key Exploitable Result (KERs)Please provide up to KERs

KER 1: .....

KER 2: .....

KER 3: .....

KER 4: .....

KER 5: .....

KER 6: .....

Notes for Question 1:

.....

.....

Q2 : Maturity of the Output

Of the Outputs mentioned in the previous question, can you clarify the current and expected end-of- project status (please, indicate the project end-date)?

If possible, use TRL LEVELS or please refer to the following rough categories if needed:

- Concept, plan, or demonstrator, needing additional work (in or out of the project team) to be directly usable in most contexts;
- Prototype service, limited community practice, specific technology for limited field, usable in its current form, but would benefit from additional work to be generalized or more widely usable;
- Operational service, accepted community standard, widely used technology, fully usable by target audiences, and mature for use in other parts of EOSC (if relevant).

Motivation: *The need for further development of the current status and by the end-of-project time is crucial, as the more mature results are more likely to be usable in the short term.*

Example of a type of answer:The developed community metadata standard is still under development as of 2022 and will be completed by the project end-time (06/23) and operable, as a service, in the major ESFRI infrastructures in the field. The metadata model is complete as-is but will benefit in the future from updates by the community.

Expected maturity:

KER 1: .....

KER 2: .....

KER 3: .....

KER 4: .....

KER 5: .....

KER 6: .....

Notes for Question 2:

.....

.....

Q3: EOSC DEVELOPMENT IMPACT AREAS

Please indicate in which of the following areas (eosc.eu/advisory-groups) the output mentioned will contribute to the development of the EOSC.

***Motivation**: Understanding the outcome of projects by mapping the dependencies, relations and interactions will help EOSC Association facilitate the integration of the outcome into EOSC TFs and future projects.*

***Example of a type of answer:** The project has defined common data standards for a certain practice contributing to the adoption of overall standards in the discipline xx.*

Relevance for KER 1 - SCALE BAR 1 (MIN) TO 5 (MAX)
Please rate importance for KER 1 only SCALE BAR 1 (MIN) TO 5 (MAX)

Detailed relevance for KER 1 only (Check boxes where applicable)

1. Implementation of EOSC

- ☐ PID policy and implementation
- ☐ Researcher engagement and adoption
- ☐ Rules of Participation (RoP) compliance monitoring

Metadata and data quality

- ☐ FAIR metrics and data quality
- ☐ Semantic interoperability

Research careers and curricula

- ☐ Data stewardship curricula and career paths
- ☐ Research careers, recognition and credit
- ☐ Upskilling countries to engage in EOSC

Technical challenges on EOSC

- ☐ AAI Architecture
- ☐ Infrastructures for quality research software
- ☐ Technical interoperability of data and services

Sustaining EOSC

- ☐ Financial Sustainability
- ☐ Long-term data preservation

Relevance for KER 2 - SCALE BAR 1 (MIN) TO 5 (MAX)
Please rate importance for KER 2 only SCALE BAR 1 (MIN) TO 5 (MAX)

Detailed Relevance for KER 2 only **(Check boxes where applicable)**

- ☐ Implementation of EOSC
- ☐ PID policy and implementation
- ☐ Researcher engagement and adoption
- ☐ Rules of Participation (RoP) compliance monitoring

Metadata and data quality

- ☐ FAIR metrics and data quality
- ☐ Semantic interoperability

Research careers and curricula

- ☐ Data stewardship curricula and career paths
- ☐ Research careers, recognition and credit
- ☐ Upskilling countries to engage in EOSC

Technical challenges on EOSC

- ☐ AAI Architecture
- ☐ Infrastructures for quality research software
- ☐ Technical interoperability of data and services

Sustaining EOSC

- ☐ Financial Sustainability
- ☐ Long-term data preservation

Relevance for KER 3 - SCALE BAR 1 (MIN) TO 5 (MAX)

Please rate importance for KER 3 only SCALE BAR 1 (MIN) TO 5 (MAX)

Detailed Relevance for KER 3 only **(Check boxes where applicable)**

- ☐ Implementation of EOSC
- ☐ PID policy and implementation
- ☐ Researcher engagement and adoption
- ☐ Rules of Participation (RoP) compliance monitoring

Metadata and data quality

- ☐ FAIR metrics and data quality
- ☐ Semantic interoperability

Research careers and curricula

- ☐ Data stewardship curricula and career paths
- ☐ Research careers, recognition and credit
- ☐ Upskilling countries to engage in EOSC

Technical challenges on EOSC

- ☐ AAI Architecture
- ☐ Infrastructures for quality research software
- ☐ Technical interoperability of data and services

Sustaining EOSC

- ☐ Financial Sustainability
- ☐ Long-term data preservation

Relevance for KER 4 - SCALE BAR 1 (MIN) TO 5 (MAX)

Please rate importance for KER 4 only SCALE BAR 1 (MIN) TO 5 (MAX)

Detailed Relevance for KER 4 only **(Check boxes where applicable)**

- ☐ Implementation of EOSC
- ☐ PID policy and implementation
- ☐ Researcher engagement and adoption
- ☐ Rules of Participation (RoP) compliance monitoring

Metadata and data quality

- ☐ FAIR metrics and data quality
- ☐ Semantic interoperability

Research careers and curricula

- ☐ Data stewardship curricula and career paths
- ☐ Research careers, recognition and credit
- ☐ Upskilling countries to engage in EOSC

Technical challenges on EOSC

- ☐ AAI Architecture
- ☐ Infrastructures for quality research software
- ☐ Technical interoperability of data and services

Sustaining EOSC

- ☐ Financial Sustainability
- ☐ Long-term data preservation

Relevance for KER 5 - SCALE BAR 1 (MIN) TO 5 (MAX)

Please rate importance for KER 5 only SCALE BAR 1 (MIN) TO 5 (MAX)

Detailed Relevance for KER 5 only **(Check boxes where applicable)**

- ☐ Implementation of EOSC
- ☐ PID policy and implementation
- ☐ Researcher engagement and adoption
- ☐ Rules of Participation (RoP) compliance monitoring

Metadata and data quality

- ☐ FAIR metrics and data quality
- ☐ Semantic interoperability

Research careers and curricula

- ☐ Data stewardship curricula and career paths
- ☐ Research careers, recognition and credit
- ☐ Upskilling countries to engage in EOSC

Technical challenges on EOSC

- ☐ AAI Architecture
- ☐ Infrastructures for quality research software
- ☐ Technical interoperability of data and services

Sustaining EOSC

- ☐ Financial Sustainability
- ☐ Long-term data preservation

Relevance for KER 6 - SCALE BAR 1 (MIN) TO 5 (MAX)

Please rate importance for KER 6 only SCALE BAR 1 (MIN) TO 5 (MAX)

Detailed Relevance for KER 6 only **(Check boxes where applicable)**

- ☐ Implementation of EOSC
- ☐ PID policy and implementation
- ☐ Researcher engagement and adoption
- ☐ Rules of Participation (RoP) compliance monitoring

Metadata and data quality

- ☐ FAIR metrics and data quality
- ☐ Semantic interoperability

Research careers and curricula

- ☐ Data stewardship curricula and career paths
- ☐ Research careers, recognition and credit
- ☐ Upskilling countries to engage in EOSC

Technical challenges on EOSC

- ☐ AAI Architecture
- ☐ Infrastructures for quality research software
- ☐ Technical interoperability of data and services

Sustaining EOSC

- ☐ Financial Sustainability
- ☐ Long-term data preservation

Notes for Question 3:

.....

.....

Q4: Of the Outputs mentioned above, can you describe what is the current view on their sustainability after your project ends? Is there an existing exploitation plan for their sustainability?

What kind of resources will be needed to sustain these outputs (storage, IT services, helpdesk, updates…)?

Is there a plan about who will fund and provide these resources?

(This question is concentrated on the maintenance requirements; further development needs should be indicated at question O2, above).

Motivation: *The Partnership agreement requires EOSC Association to identify, facilitate and coordinate major needs for future sustainability actions. This question helps EOSC Association map the outcome of the H2020 projects with the future requirements to achieve the long-term strategy laid down in the SRIA.*

Example of a type of answer: *The provided metadata standards need a maintained permanent wiki platform for storage and community use. The main user communities and infrastructures have created a Memorandum of Understanding, providing the necessary community support activity to maintain the wiki platform after the project end. The technical upkeep requirements are taken over by research infrastructure XYZ.*

Output sustainability

KER 1: .....

KER 2: .....

KER 3: .....

KER 4: .....

KER 5: .....

KER 6: .....

Notes for Question 4:

.....

.....

Q5: Internationalisation and standardisation needs

Of the Outputs mentioned above, which ones you think would benefit from additional efforts for standardisation, or activities to create international harmonisation (please indicate with whom)? Would your project partners be interested in the future to participate in such actions?

Motivation: *Both RDA and EOSC Association are interested in developing the necessary EOSC project outputs to more concrete, and internationally viable and accepted, standardised outputs. These future actions need to prioritise, and this provides us a way to identify potential targets.*

Example of a type of answer: *The community metadata standard is already well received in European areas but would benefit from wider international acceptance. This activity could create new international domain metadata standard. The potential collaboration initiatives would be US initiative XX and Chinese developments in YY. There is a wide interest in the community to participate in such developments.*

KER 1: .....

KER 2: .....

KER 3: .....

KER 4: .....

KER 5: .....

KER 6: .....

Notes for Question 5:

.....

.....

Q6: Communication, Dissemination, Outreach

What activities do you plan for the remaining part of your H2020 Project and is there scope and room to plan interactions with the EOSC Association, especially regarding reciprocal communication and dissemination support actions?

Have you planned interactions with other EOSC-related projects?

Motivation: *The EOSC Association is interested in establishing joint communication activities for the remainder of the H2020 projects' lifetimes. These activities could be linked to online communication outlets such as website and social media, joint events, or stakeholder engagement.*

Example of a type of answer: *The project has an interest in participating sustainability-related events and community-based efforts to activate synergies and close gaps. The project has plans for a series of events (name, dates, scope, audiences), strategic plans, focus groups, etc. which could encompass the Association's scopes xx and yy. The project website would have space for the Association to showcase their activities and multiply the reach of their call for actions. The project is keen on using the Association's communication channels to disseminate their results.*

.....

.....

.....

.....

Q7: Expectation

What do you expect from EOSC Association?

……

……

Q8: What is the acronym of your EU H2020 project?

……

……

Q9: Please, provide us with contact details

First Name .....

Last Name .....

E-mail address.....

Please, check this box if you are willing to share your project name and the information that you associated with it, in communications with the EU Commission and within the EOSC Association.

☐ Yes: I am willing to share your project name and the information that you associated with it, in communications with the EU Commission and within the EOSC Association.

8. Annex Two – Glossary

Download the The EOSC Monitoring Framework Glossary at this link: eosc.eu/sites/default/files/2022-10/EOSCPartnershipMF_Glossary.pdf

eosc.eu @eoscassociation company/eosc-a/