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OPEN SCIENCE IN CLOUD TECHNOLOGY

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Abstract: *The OSTEC project proposes an open IT environment for the scientific community to store and reuse data and scientific results. At European level, the Cloud Initiative is an important step in the evolution of "big data" exploitation by researchers. OSTEC project proposes the implementation of open access technology and scientific services, making possible to displace, exchange and reuse their data without discontinuities at global scale, for interdisciplinary research approaches.*

Using ICI's cloud infrastructure, the project proposes to create a research data warehouse in our country and an associated cloud platform for storage, exchange, management, use and re-use of data. UPB will develop a management model for cloud platform data and services, for project development and sustainability with a governance proposal outlining and overseeing the future development of the cloud platform and interconnection at EOSC, based on its social and economic impact, demonstrated by INCE's contribution. The project will exemplify a demonstration pilot, conducted by ICPE-CA and INCDMTM, by using a pre-defined service portfolio, offered to the scientific community. In this way, the institutional capacity of the consortium of the OSTEC project will be increased and concretized through the development of a training and education strategy, as part of a process of long life learning mechanism of RDI staff from public or private organizations.

Finally, we follow the development of standards and an incentive framework to address both the OSTEC consortium organizations and other stakeholders, destined to develop the capabilities necessary to operationalize an open science platform in cloud technology in Romania and its interconnection with EOSC.

Keywords*: Open Science, Cloud Technology, "Big Data" Mining, FAIR Services, Open Access*

1. Introduction

On 12 June 2017, the European Commission organised the EOSC Summit, Europe's moment of commitment to the European Open Science Cloud (EOSC) [1]. The Summit was a success in many respects. The Summit brought together, from all over Europe, 110 players that are key for the implementation of the EOSC. Participation was highly representative, including scientific fields, national scientific infrastructures, research funders and ministries of Member States and Associated Countries.
At the Summit, 110 key participants reviewed five key areas of EOSC implementation, based on specific input papers:
1. data culture, data stewardship: practical and policy tools;
2. adoption and implementation of FAIR data principles [2];
3. research data infrastructures and services;
4. sustainable funding & governance;
5. high-performance computing, big data and super connectivity.
The Summit provided strong support for the implementation of the EOSC and marked a step change in the initiative. There was strong agreement on data culture, on the need for FAIR data and on the need to develop and gear supporting infrastructure of services; there were agreements and no fundamental objections on the much-debated issues of services, governance and financing. The intents of the input papers were broadly shared and further specified. This all supported the need to act immediately and swiftly in the next few months to keep the momentum achieved by the 'coalition of doers'. Participants demonstrated a strong sense of commitment towards the implementation of the EOSC. They agreed that the EOSC is a truly common European project

which will ensure long term sustainability and support Europe to become a key player in research data.
The EOSC Summit also marked a clear division of labour between research policy makers and funders (Member States and the EC), and implementing stakeholders such as national infrastructures, projects and initiatives. Both scientific stakeholders and Member States must be engaged in the making of the EOSC via dedicated channels.
Based directly on the results of the Summit, DG Research and Innovation drafted the EOSC Declaration. Straight after the Summit, all session Chairs and Rapporteurs worked hard to draw conclusions from the event. They revisited the input papers to factor in the commitments and introduced several clarifications. The Declaration is composed of 33 high level statements meant to capture our common understanding on the required Data culture & FAIR data, Research data services & architecture, Governance and funding to make the EOSC a reality by 2020.

2. EOSC Declaration

RECOGNISING the challenges of data driven research in pursuing excellent science;
GRANTING that the vision of European Open Science is that of a research data commons, widely inclusive of all disciplines and Member States, sustainable in the long-term;
CONFIRMING that the implementation of the EOSC is a process, not a project, by its nature iterative and based on constant learning and mutual alignment;
UPHOLDING that the EOSC Summit marked the beginning and not the end of this process, one based on continuous engagement with scientific stakeholders, the European Commission;
PROPOSES that all EOSC stakeholders consider sharing the following intents and will actively support their implementation in the respective capacities:

2.1 Data culture and FAIR data

[Data culture] European science must be grounded in a common culture of data stewardship, so that research data is recognised as a significant output of research and is appropriately curated throughout and after the period conducting the research. Only a considerable cultural change will enable long-term reuse for science and for innovation of data created by research activities: no disciplines, institutions or countries must be left behind.

[Open access by-default] All researchers in Europe must enjoy access to an open-by-default, efficient and cross-disciplinary research data environment supported by FAIR data principles. Open access must be the default setting for all results of publicly funded research in Europe, allowing for proportionate limitations only in duly justified cases of personal data protection, confidentiality, IPR concerns, national security or similar (e.g. 'as open as possible and as closed as necessary').
[Skills] The necessary skills and education in research data management, data stewardship and data science should be provided throughout the EU as part of higher education, the training system and on-the-job best practice in the industry. University associations, research organisations, research libraries and other educational brokers play an important role but they need substantial support from the European Commission and the Member States.
[Data stewardship] Researchers need the support of adequately trained data stewards. The European Commission and Member States should invest in the education of data stewards via career programmes delivered by universities, research institutions and other trans-European agents.
[Rewards and incentives] Rewarding research data sharing is essential. Researchers who make research data open and FAIR for reuse and/or reuse and reproduce data should be rewarded, both in their career assessment and in the evaluation of projects (initial funding, review of performance and impact). This should go hand in hand with other career policies in universities and research institutions (appointments, promotions etc.).

[FAIR principles] Implementation of the FAIR principles must be pragmatic and technology neutral, encompassing all four dimensions: findability, accessibility, interoperability and reusability. FAIR principles are neither standards nor practices. The disciplinary sectors must develop their specific notions of FAIR data in a coordinated fashion and determine the desired level of FAIR-ness. FAIR principles should apply not only to research data but also to data related algorithms, tools, workflows, protocols, services and other kinds of digital research objects.
[Standards] The EOSC must be underpinned by minimal and rigorous global standards for open research data, as well as standards for EOSC based services for collaboration through the EOSC (e.g. to facilitate inter-disciplinarity and avoid fragmentation). These standards (technical, semantic, legal and organisational) must combine long-term sustainability with optimal freedom of local implementation. They should be jointly defined by the research communities, taking into account existing instruments (e.g. EU Rolling Plan on ICT Standardisation). Cross-disciplinary agreements/protocols will lead to specific standards, inspired directly by relevant domain specific needs. Variations across scientific disciplines and their specific efforts of making research data open and FAIR should be respected.
[FAIR Data governance] The design and implementation of FAIR principles must be built upon inclusive stakeholder participation (e.g. researchers from different scientific disciplines, EU Member States and the European Commission). Policy will go hand in hand with the implementation of technical and human resources, and a social infrastructure including education and training. To make FAIR data a reality, it is imperative to engage stakeholders and relevant multipliers, based on a solid stakeholder engagement strategy, on inter-institutional arrangements, well-established frameworks and decision making flows. Data governance needs to be agreed upon and the division of responsibilities be charted, ensuring transparency, representativity and accountability. European and national scientific research organisations, publishers and other actors must align their data-related business processes, responsibilities and expectations to achieve commonly agreed goals.
[Implementation & transition to FAIR] Implementation of FAIR principles requires careful prioritisation and orchestration. The FAIR Data Action Plan 2018-2020 is an important collaborative instrument for the embedding of FAIR principles in the first phase of the EOSC.
The plan will not necessarily suggest any specific technology, standard or implementation solution. For an even transition of data from different levels of maturity to FAIR, existing activities to make data FAIR (e.g. GO-FAIR) must be complemented by new initiatives that embed FAIR principles in all the phases of data life cycle.
[Research data repositories] Trusted research data repositories play a fundamental role in modern science. Scientist must be able to find, re-use, deposit and share data via trusted data repositories that implement FAIR data principles and that ensure long-term sustainability of research data across all disciplines. Data repositories must be easy to find and identify, and provide to users full transparency about their services.
[Accreditation/certification] Scientists must be assured that the European and national scientific research infrastructures where they deposit/ access data conform to clear rules and criteria (e.g. certified) and that their data is FAIR compliant. An accreditation or certification mechanism must be set in place based on agreed processes and an accreditation or certification body must maintain an up-to-date and accessible catalogue of certified repositories. Experience from existing accreditation processes must be taken into account.
[Data Management Plans] A key element of good data management is a Data Management Plan (DMP); the use of DMPs should become obligatory in all research projects generating or collecting publicly funded research data, based on online tools conforming to common methodologies. Funder and institutional requirements must be aligned and minimum conditions for DMPs must be defined. Researchers' host institutions have a responsibility to oversee and complete the DMPs and hand them over to data repositories.

[Technical implementation] While FAIR data must be implemented as part of good data governance at this highest possible level (e.g. certification, institutional implementation and support, as describe above), researchers also need handy tools to make data FAIR.
These include:
[Citation system] A data citation system should be put in place to reward the provision of excellent open data. This will assist both the assessment of researchers and their projects, and help implementing the findability, accessibility, interoperability and reusability of research data.
[Common catalogues] There must be catalogues (e.g. for datasets, services, standards) based on machine readable metadata and identifiable by means of a common and persistent identification mechanism that will make research data findable via an 'EOSC Portal'.
[Semantic layer] Research data must be both syntactically and semantically understandable, allowing meaningful data exchange and reuse among scientific disciplines and countries.
[FAIR tools and services] Easy access must be available to a common set of FAIR tools and services, to guide the curation of FAIR data for re-use and to assess FAIR compliance.
[Data expert organisations] The Research Data Alliance, CODATA, DDI Alliance and other organisations active in the research communities must be used as forums to reach consensus on practical implementation of FAIR data principles at European and global level.
[Legal aspects] It is essential for the success of EOSC to clarify and address the legal uncertainty of Open Access to research data, as well as the correct legal implementation of the FAIR principles. Legal barriers to access and reusability of research data must be identified and overcome and the underpinning legal framework must be made simpler and more coherent.
Conversely, issues of ownership must be addressed, particularly where institutions have created services and resources. All these measures should allow easier integration of research data across different legal frameworks, policy implementation plans and strategies.

2.2 Research data services and architecture

[EOSC architecture] The EOSC will be developed as a data infrastructure commons serving the needs of scientists. It should provide both common functions and localised services delegated to community level. Indeed, the EOSC will federate existing resources across national data centres, European e-infrastructures and research infrastructures; service provision will be based on localto-central subsidiarity (e.g. national and disciplinary nodes connected to nodes of pan-European level); it will top-up mature capacity through the acquisition of resources at pan-European level by EOSC operators, to serve a wider number of researchers in Europe. Users should contribute to define the main common functionalities needed by their own community. A continuous dialogue to build trust and agreements among funders, users and service providers is necessary for sustainability.
[Implementation] Resources, components and initiatives of pan-European relevance will be federated on the basis of objective criteria, agreed by stakeholder-driven governance, such as organisational readiness and technical capacity to deliver EOSC main functionalities: provision of core common services, certification activities, joint-procurement initiatives, definition of minimum quality standards of service (based on clear Service Level Agreements SLAs), identity provisioning and management, common cataloguing data and computing/analytic services and tools.
[Legacy] The EOSC should incentivise the re-use of existing building blocks, state-of-the-art services and solutions delivered by past and ongoing projects, local, national and European, as opposed to subsidizing actions aiming at reinventing the wheel. It should facilitate learning from the past, adopting best practices, tailoring scientific community needs through live use cases and leveraging the network effect.
[User needs] Users should see the EOSC as a one-stop-shop to find, access, and use research data and services from multiple disciplines and platforms. Services and functionalities shall be user driven and determined by clear use cases. Intermediary users and other brokers of end-users' demand – IT departments, umbrella associations, community networks – should assist data scientists and ICT specialists in the identification of key requirements for EOSC services.

[Service provision] Research Data Infrastructures, e-infrastructures and commercial operators will develop and provide services based on user needs, and discontinue provision when not justified by the level of adoption. Services will be offered at highest Technology Readiness Levels (TRLs) and kept future-proof based on a cutting-edge cloud based environment. In order to avoid lock-in by individual service providers, the EOSC should foster fair competition of public, PPP and private providers on clear value propositions of highly professional services.
[Service deployment] The EOSC shall support different deployment models (e.g. Infrastructure as a Service, Platform as a Service, Software as a Service), to meet the needs of communities at different levels of maturity in the provision and use of research data service. The EOSC shall support the whole research lifecycle by strong development at platform level that facilitate the provision of a wide set of software, infrastructure, protocols, methods, incentives, training, services. Software sustainability should be treated on an equal footing as data stewardship.
[Thematic areas] The EOSC shall promote the co-ordination and progressive federation of open data infrastructures developed in specific thematic areas (e.g. health, environment, food, marine, social sciences, transport). The EOSC will implement a common reference scheme to ensure FAIR data uptake and compliance by national and European data providers in all disciplines.
[Research infrastructures] The role of ESFRI [3] and EIROFORUM research infrastructures and organisations in the EOSC will be enhanced, Member States and the European Commission made significant investment; research infrastructures should be 'the steward of the community of standards' and provide scientists with a ramp-up for the utilisation of the EOSC.
[EU-added value and coordination] The EOSC must implement policy hand in hand with technology. Condition of national and European measures is required to link the initiative to national strategies, to maximise the added value of inter-disciplinarity by making data FAIR, and to preventing duplication of efforts and investments. Over time, coordination will provide
European added value by minimizing overlap and reducing fragmentation of infrastructures and services, helping long-term sustainability.
[High Performance Computing and the EOSC] European commitment to HPC is clearly demonstrated by the signature of the EuroHPC Declaration by eight Member States since March 23, 2017. The Member States agreed to work together and with the European Commission in the context of a multi-government agreement called EuroHPC for acquiring and deploying by 2022/2023 a pan-European integrated exascale supercomputing infrastructure that will support data-intensive advanced applications and services. It is a response to the surging demand from scientists, industry and the public sector for access to leading-edge computing capacity to cope with vast amounts of data produced in almost all scientific and engineering domains. This supercomputing and data infrastructure could support the European Open Science Cloud by providing data access and advanced computing and data management services. The EC plans to propose, by end of 2017, a legal instrument that provides a procurement framework for the exascale supercomputing and data infrastructure.
[Innovation] The EOSC should create a level playing field for businesses and innovative SMEs to develop, and co-develop with publicly funded institutions, added-value services for researchers. Funding should support the migration of cutting-edge solutions to the EOSC, increasing European added value by fostering innovation.

2.3 Governance and funding

[Governance model] A long-term, sustainable research infrastructure in Europe requires a strong and flexible governance model based on trust and increasing mutuality. As interdisciplinarity is one of the main objectives of the EOSC, the governance model should be based on representativity, proportionality, accountability, inclusiveness and transparency.
[Governance framework] The EOSC governance framework will be co-designed, stakeholder driven and composed of three main layers: 1) institutional, including EU Member States and

European Commission 2) operational, including a governance board and relevant working committees (e.g. thematic and functional) and 3) advisory, including a stakeholder forum.
[Governance board] A governance board will coordinate the efforts of stakeholders endorsing the EOSC Declaration, with the broad mandate to reach practical agreements for the implementation of an EOSC Roadmap by 2020. The board will have an advisory role and an implementing role of the decisions by Member States and European Commission concerning the programming, financing and towards the setting up of a long-term governance and business model for the EOSC. It will make best use of the outcomes of past and current projects (e.g. EOSCpilot, eInfraCentral and EOSChub) and independent expert advice and studies.
[Coordination structure] A coordination structure, funded by Horizon 2020, will help the governance board to manage the implementation, according to agreed rules and methods of stakeholder participation. The structure and its participating entities should be accountable for the responsibilities assumed, based on an objective assessment of their level of readiness in delivering the EOSC main functionalities.
[Long-term sustainability] The European Commission, Member States and Research Funders will use existing and future resources strategically, to ensure long-term sustainability of open research data and research infrastructures, facilitating inter-disciplinarity.
[Funding] Over time, a co-funding mechanism mixing different revenue streams for the EOSC will be set up, to increase the accountability of the governance, building trust, sharing resources and building long-term capacity for European research data. Early implementation of the EOSC will pilot innovative business models and support an integrated data and service platform for European research.
[Global aspects] The EOSC will be European and open to the world, reaching out over time to relevant global research partners. It will increase the global value of open research data and support stakeholder engagement, including researchers and citizens. It will gradually widen the initiative to federated network of infrastructures and nodes from global research partners. The EOSC Stakeholder Forum will have an important role in this sense.

3. EOSC Declaration Action List

3.1 Data culture

European science must be grounded in a common culture of data stewardship, so that research data is recognised as a significant output of research and is appropriately curated throughout and after the period conducting the research. Only a considerable cultural change will enable long-term reuse for science and for innovation of data created by research activities: no disciplines, institutions or countries must be left behind.
OpenAIRE [4] offered to help to involve research libraries for policy alignment and for a user-driven approach that also reach the 'long tail of research'.

3.2 Skills

The necessary skills and education in research data management, data stewardship and data science should be provided throughout the EU as part of higher education, the training system and on-the-job best practice in the industry. University associations, research organisations, research libraries and other educational brokers play an important role but they need substantial support from the European Commission and the Member States.
The League of European Research Universities (LERU) offered to raise awareness and help develop training activities for staff and doctoral students.
CESSDA [5] offered to help coordinate and organise trainings across ERICs.

3.3 FAIR Data governance

The design and implementation of FAIR principles must be built upon inclusive stakeholder

participation (e.g. researchers from different scientific disciplines, EU Member States and the European Commission). Policy will go hand in hand with the implementation of technical and human resources, and a social infrastructure including education and training. To make FAIR data a reality, it is imperative to engage stakeholders and relevant multipliers, based on a solid stakeholder engagement strategy, on inter-institutional arrangements, well-established frameworks and decision making flows. Data governance needs to be agreed upon and the division of responsibilities be charted, ensuring transparency, representativity and accountability.
European and national scientific research organisations, publishers and other actors must align their data-related business processes, responsibilities and expectations to achieve commonly agreed goals.
OpenAIRE offered to facilitate open science of coordination based on a network of 34 countries we want to see EOSC have a stronger commitment.

3.4 Implementation & transition to FAIR

Implementation of FAIR principles requires careful prioritisation and orchestration. The FAIR Data Action Plan 2018-2020 is an important collaborative instrument for the embedding of FAIR principles in the first phase of the EOSC. The plan will not necessarily suggest any specific technology, standard or implementation solution. For an even transition of data from different levels of maturity to FAIR, existing activities to make data FAIR (e.g. GO-FAIR) must be complemented by new initiatives that embed FAIR principles in all the phases of data life cycle.
The Swiss National Science Foundation offered to coordinate policies on what repositories can be used (freedom for researchers).

3.5 Research data repositories

Trusted research data repositories play a fundamental role in modern science. Scientist must be able to find, re-use, deposit and share data via trusted data repositories that implement FAIR data principles and that ensure long-term sustainability of research data across all disciplines. Data repositories must be easy to find and identify, and provide to users full transparency about their services.
The Austrian Science Fund offered to work to extend Re3Data to better understand the data repository landscape.
The German Research Foundation (DFG) offered to contribute and fund updating of Re3Data.

3.6 Data Management Plans

A key element of good data management is a Data Management Plan (DMP); the use of DMPs should become obligatory in all research projects generating or collecting publicly funded research data, based on online tools conforming to common methodologies. Funder and institutional requirements must be aligned and minimum conditions for DMPs must be defined. Researchers' host institutions have a responsibility to oversee and complete the DMPs and hand them over to data repositories.
The Netherlands Organisation for Scientific Research (NWO) offered to contribute to coordination of criteria for Research Data Management.

3.7 User needs

Users should see the EOSC as a one-stop-shop to find, access, and use research data and services from multiple disciplines and platforms. Services and functionalities shall be user driven and determined by clear use cases. Intermediary users and other brokers of end-users' demand – IT departments, umbrella associations, community networks – should assist data scientists and ICT specialists in the identification of key requirements for EOSC services.

PLAN-E & eScience Center offered to help support scientists to translate scientific requirements into practical services and infrastructural components.
GEO offered to contribute as a broker for interdisciplinary domains: a) climate changes, b) disaster risk reduction & c) sustainability development goals strategic targets to help define and serve concrete user needs.

3.8 Service deployment

The EOSC shall support different deployment models (e.g. Infrastructure as a Service, Platform as a Service, Software as a Service), to meet the needs of communities at different levels of maturity in the provision and use of research data service. The EOSC shall support the whole research lifecycle by strong development at platform level that facilitate the provision of a wide set of software, infrastructure, protocols, methods, incentives, training, services. Software sustainability should be treated on an equal footing as data stewardship.

3.9 Thematic areas

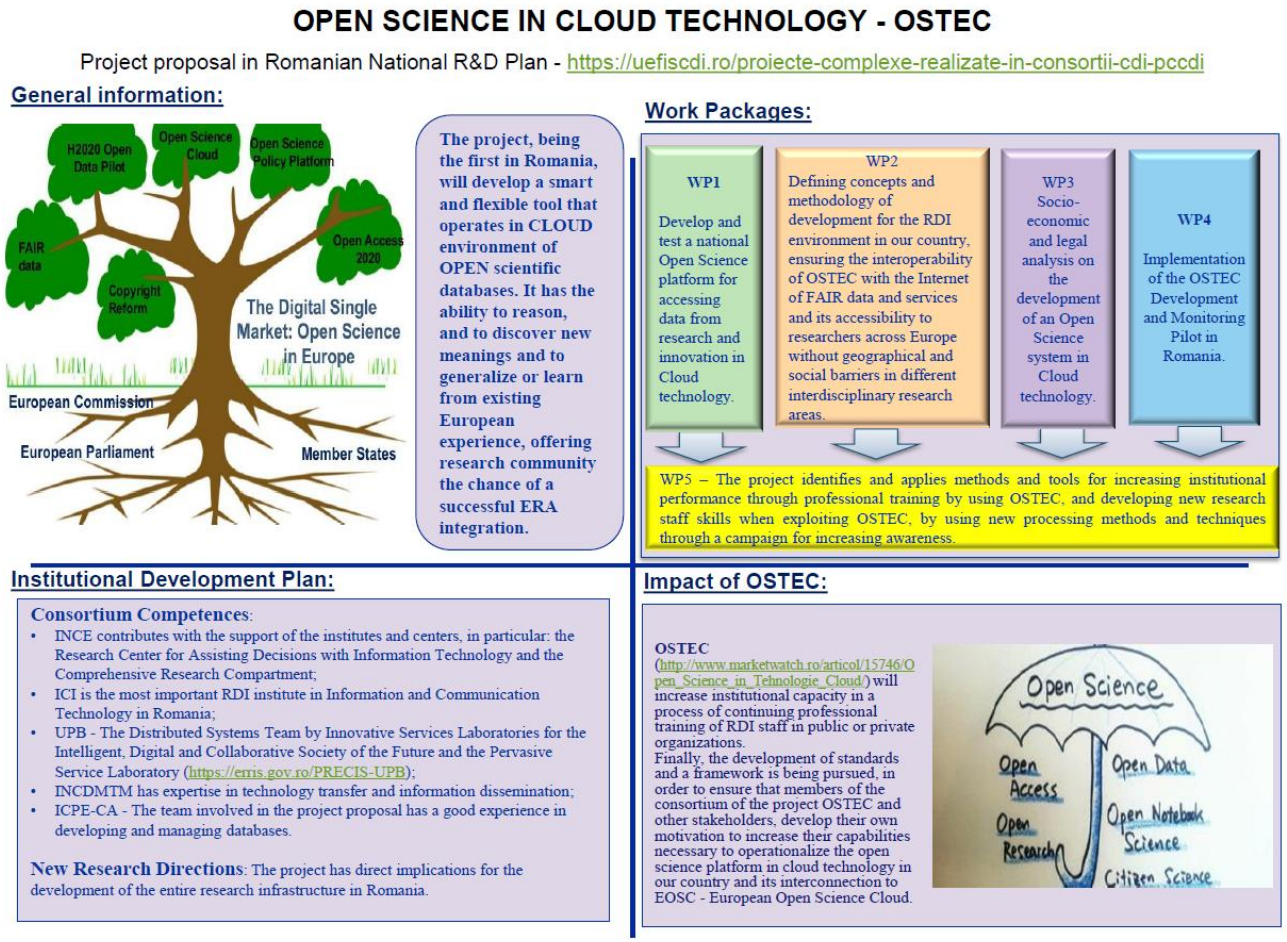
The EOSC shall promote the co-ordination and progressive federation of open data infrastructures developed in specific thematic areas (e.g. health, environment, food, marine, social sciences, transport). The EOSC will implement a common reference scheme to ensure FAIR data uptake and compliance by national and European data providers in all disciplines.
PLAN-E offered to help and promote implementing FAIR principles for data and software across all domains.

3.10 Governance model

A long-term, sustainable research infrastructure in Europe requires a strong and flexible governance model based on trust and increasing mutuality. As interdisciplinarity is one of the main objectives of the EOSC, the governance model should be based on representativity, proportionality, accountability, inclusiveness and transparency.
GEO offered to contribute to the development of governance by providing & sharing their lessons.

4. Open Science in Cloud Technology – OSTEC project

Open Science in Cloud Technology - OSTEC is a Romanian initiative, materialized within a project that proposes an open IT environment for the scientific community to store and reuse data and scientific results. At European level, the Cloud Initiative is an important step in the evolution of "big data" exploitation by researchers. OSTEC project targets the implementation of open access technology and scientific services, making possible to displace, exchange and reuse their data without discontinuities at global scale, for interdisciplinary research approaches [6].



5. Conclusions

There is no way back now, but that does not mean that everything is already written in stone. The European Commission will work with Member States, with the EOSCPilot and to make the most of the INFRA-EOSC Call, and with research funders regarding open research data policies and tools in support of the EOSC.

Stakeholder engagement with the initiative will continue and there will be plenty of occasions in future to engage and make their voice heard. The DG is working with the EOSCPilot project to ensure that the EOSC implementation takes centre stage at the First stakeholder engagement event, to be held on 28-29 November 2017 in Brussels. This event could serve as the first, pilot meeting of a future EOSC Stakeholder Forum in support of the EOSC initiative.

The Commission also announced how it plans to support the EOSC in WP 2018- 2020 to the Research infrastructures Programme Committee (27 June 2017); the draft was pre-published on 3 October. This support is provided mainly by the Call INFRA-EOSC; the Call covers all the future key functions of the EOSC, with an overall budget of 270-300 million Euro. The Call is a central piece in the implementation strategy. Moreover, several research funders expressed a desire to work jointly to make the most of open, FAIR research data policies, to support their uptake and implementation. The Commission will work with them in this respect, to ensure full implementation of the 'data culture' and 'FAIR data' action areas of the Declaration.

Finally, the Commission is strongly committed to working with Member States and Associated Countries to start discussions of concrete proposals on governance via the Roadmap on the basis of the draft Declaration. The Roadmap will put forward proposals for governance and funding - including a proposal for the future Executive Board of the EOSC. The Commission will work with the Council via the ERAC Standing Working Group on Open Science & Innovation ('ERAC OSI'),

1) to gather essential Member State input on the EOSC Roadmap, especially on the design of governance and on funding levels (MS requested this explicitly), and 2) to ensure that the initiative is aligned with national strategies for scientific data infrastructures.

References

[1] https://ec.europa.eu/research/openscience/index.cfm?pg=open-science-cloud;
[2] https://www.nature.com/articles/sdata201618;
[3] https://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri;
[4] https://www.openaire.eu/;
[5] https://www.cessda.eu/;
[6] http://www.marketwatch.ro/articol/15746/Open_Science_in_Tehnologie_Cloud/.